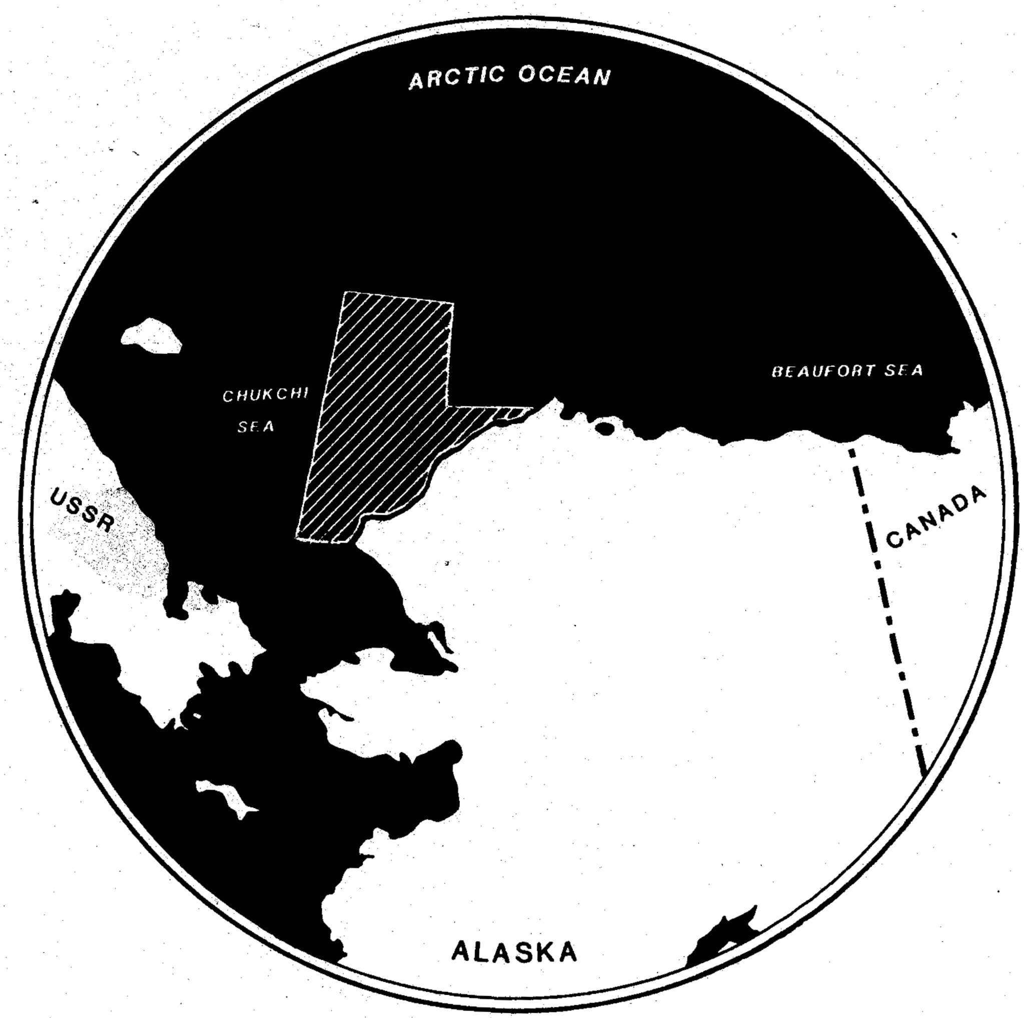
OCS EIS/EA
MMS 87-0110

Alaska Outer Continental Shelf

Chukchi Sea
Oil & Gas Lease Sale 109

Final Environmental Impact Statement

Volume I



U.S. Department of the Interior
MMS 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 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 a Minerals Management Service 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.

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Volume I

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

November 1987

FINAL ENVIRONMENTAL IMPACT STATEMENT

Proposed Outer Continental Shelf
Lease Sale 109
Chukchi Sea

Summary Sheet

( ) Draft (X) Final

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

1. Type of Action: Proposed Oil and Gas Lease Sale 109, Chukchi Sea.

(x) Administrative ( ) Legislative

2. Description of the Action: The leasing proposal consists of 11.9 million hectares (approximately 29.5 million acres) of Outer Continental Shelf (OCS) lands. The 5,450 blocks in the proposed Sale 109 area encompass the entire Chukchi Sea Planning Area and are located in waters that are from about 5 to 385 kilometers (3-239 miles) offshore in water depths that range from about 8 to 80 meters (26-263 feet). The conditional-mean economically recoverable oil resources in the area are estimated to be 2.68 billion barrels with a marginal probability of 0.20 for hydrocarbons. If implemented, this lease sale is tentatively scheduled to be held in May 1988.

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. Other measures, which are beyond the authority of this agency to apply, also have been identified. In spite of mitigating measures, some effects 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 use; and some onshore development could occur in undeveloped areas.

4. Alternatives to the Proposed Action:

a. No Sale (Alternative II).

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

c. Modify the proposed action by deferring approximately 488 blocks in the northeastern portion of the sale area (Eastern Deferral Alternative--Alternative IV).

d. Modify the proposed action by deferring approximately 289 blocks in the southern portion of the sale area around Cape Lisburne (Southern Deferral Alternative--Alternative V).

e. Modify the proposed action by deferring approximately 1,632 blocks in a coastal band running the length of the sale area (Coastal Deferral Alternative--Alternative VI).

5. Other EIS's, OCS Reports, Reference Papers, and Technical Papers: This 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 in the Department of the Interior Library in Washington, D.C. Single copies of these publications are available from the Alaska OCS Region Library and the National Technical Information Service.

6. Public Hearings: Public hearings on the Sale 109 draft EIS (DEIS) were held in April 1987 in the following Alaskan communities: Barrow on April 10, Point Hope on April 13, Point Lay on April 14, Wainwright on April 15, and Anchorage on April 22. Oral and written comments were obtained and responded to in this final EIS (FEIS).

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Final Environmental Impact Statement
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Summary of Environmental Impact Statement for Proposed Chukchi Sea Sale 109

This environmental impact statement (EIS) discusses a proposal for oil and gas leasing in the Chukchi Sea Planning Area, analyzes its potential effects on the environment, describes alternatives to the proposal, presents major issues determined through the scoping process and through staff analyses, and describes potential mitigating measures.

The proposal (Alternative I) consists of 5,450 blocks (approximately 11.9 million hectares) in the Chukchi Sea that range from about 5 to 385 kilometers offshore. Alternative II (No Sale) would cancel the proposed lease sale, tentatively scheduled for May 1988. Alternative III (Delay the Sale) would delay the proposed lease sale for a period of 2 years. Alternative IV (Eastern Deferral Alternative) would defer leasing on 488 blocks that are located along the Chukchi Sea coast from about 39 kilometers northwest of Peard Bay to 5 kilometers south of Kasegaluk Lagoon. Alternative V (Southern Deferral Alternative) would defer leasing on 289 blocks from Point Hope around Cape Lisburne and nearly to Cape Sabine. Alternative VI (Coastal Deferral Alternative) would defer leasing on 1,632 blocks located along the entire length of the sale area. 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.

The potential effects of this proposal are based in part on the assumption that the conditional-mean economically recoverable oil resources in the area are estimated to be 2.68 billion barrels with a marginal probability of 0.20 for hydrocarbons. There is a greater-than-99-percent chance that one or more spills of at least 1,000 barrels may occur over the life of the field.

The scenario used to assess the potential effects that petroleum exploitation may have on the environment describes possible activities and timing of events. Exploration and delineation wells are predicted to be drilled primarily from 1989 to 1996. Oil would be produced from nine platforms installed in 1997 and 1998; drilling of the production and service wells would occur between 1997 and 1999. Pipelines would carry the produced oil to an onshore pipeline that connects to the trans-Alaska pipeline at Pump Station No. 2.

Table S-1 summarizes the possible effects that could occur as a result of the leasing proposal (Alternative I) and of the alternatives to the proposal on those resources discussed in the EIS. (Table S-2 explains the definitions used for assessing the potential effects of the leasing proposal and of the alternatives to the proposal.) The analyses supporting the conclusions in Table S-1 assume that all laws, regulations, and orders are part of the leasing proposal. If the potential mitigating measures described in Section II.H of the EIS were adopted, some of the effects described in the EIS would be reduced. (The effectiveness of the potential mitigating measures is discussed in Sec. II.H of the EIS.)

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 a Minerals Management Service 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.

Table S-1
Summary of Effects[1/]
for the Proposal, Cumulative Case, and Deferral Alternatives[2/]

Resource Category[3/]	Alternative I Proposal	Cumulative Case	Alternative IV Eastern Deferral Alternative	Alternative V Southern Deferral Alternative	Alternative VI Coastal Deferral Alternative
1. Air Quality					
Standards	MINOR	MINOR	MINOR	MINOR	MINOR
Other	MINOR	MINOR	MINOR	MINOR	MINOR
2. Water Quality	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
3. Lower-Trophic-Level Organisms	MINOR	MINOR	MINOR	MINOR	MINOR
4. Fishes	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
5. Marine and Coastal Birds	MINOR	MODERATE	MINOR	MINOR	MINOR
6. Pinnipeds, Polar Bears, and Beluga Whales	MINOR	MINOR	MINOR	MINOR	MINOR
7. Endangered and Threatened Species					
Bowhead Whales	MINOR	MODERATE	MINOR	MINOR	MINOR
Gray Whales	MINOR	MODERATE	MINOR	MINOR	MINOR
Fin Whales	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
Humpback Whales	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
Arctic Peregrine Falcons	MINOR	MINOR	MINOR	MINOR	MINOR
8. Caribou	MINOR	MODERATE	MINOR	MINOR	MINOR
9. Economy of the North Slope Borough	NEGLIGIBLE	MINOR	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
10. Subsistence-Harvest Patterns					
Barrow	MODERATE	MAJOR	MODERATE	MODERATE	MODERATE
Wainwright	MAJOR	MAJOR	MAJOR	MAJOR	MAJOR
Point Lay	MODERATE	MAJOR	MODERATE	MODERATE	MODERATE
Point Hope	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Atqasuk[4/]	MODERATE	MAJOR	MODERATE	MODERATE	MODERATE
Nuiqsut	MAJOR	MAJOR	MAJOR	MAJOR	MAJOR
11. Sociocultural Systems	MODERATE	MAJOR	MODERATE	MODERATE	MODERATE
12. Archaeological Resources	MINOR	MINOR	MINOR	MINOR	MINOR
13. Land Use Plans and Coastal Management Programs	MAJOR	MAJOR	MAJOR	MAJOR	MAJOR

Source: MMS, Alaska OCS Region.

1/ Refer to Table S-2 for the definitions of levels of effects for each resource category.
2/ Alternative II (No Sale)--The effects associated with the proposal or other alternatives would not occur with this alternative. Alternative III (Delay the Sale)--The effects associated with this alternative would be the same as those of Alternative I (Proposal), except their occurrence would be delayed 2 years. Adverse effects of the sale in future years may be of less consequence to species whose populations are currently increasing (i.e., gray whales).
3/ See Table II-3 and Sections IV.B through IV.G for expanded discussions and analyses of effects--particularly for biological resources.
4/ Including marine resources harvested with Barrow residents. If Barrow's marine resources are excluded, effect levels would decrease to MINOR.

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

The Department of the Interior (DOI) is required by law to manage the exploration and development of oil and gas resources on the Outer Continental Shelf (OCS). To help meet the energy needs of the Nation, these resources are to be developed expeditiously, and yet carefully. While overseeing this development, 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, as amended (43 U.S.C. 1331 et seq.; hereafter referred to as the Act), the Secretary of the Interior submits a proposed 5-year leasing program to the Congress, the Attorney General, and the governors of affected states. The Secretary annually reviews, revises as necessary, and maintains the oil and gas leasing program. Goals of the leasing program include (1) the orderly development of OCS oil and gas 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. Since the 1973 Arab oil embargo, it has become increasingly apparent that our Nation must become less dependent on foreign imports, lessen our vulnerability to supply economics and supply interruptions, and prepare for the time when oil production approaches its maximum capability. In 1978, Congress mandated the Department to engage in "expedited exploration and development of "the OCS in order to "assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade." The Secretary of the Interior has stated that "we honor that mandate, and until there is other direction, it will be our foremost guideline in all OCS activity."

The OCS leasing program does <u>not</u> represent a decision to lease in a particular area. Instead, it is representative only of the Department's intent to consider leasing in certain areas, and to proceed with the offering of such areas only if it should be determined that leasing and development would be technically feasible and environmentally acceptable. As a part of the OCS leasing program, the DOI has scheduled the Chukchi Sea Sale 109 for May 1988.

A. Leasing Process

The Act 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-leasing and resource-management functions to the MMS. The ongoing MMS Alaska OCS Region Studies Program is a vital part of this leasing function. Guided directly by the data needs inherent in the OCS lease-sale schedule, the Studies Program provides relevant information to help determine and monitor the potential effects of oil and gas activities on the environment (Environmental Studies Program) and on communities, regions, or Alaska as a whole (Social and Economic Studies Program). For specific information on the MMS Alaska OCS Region Studies Program, refer to Appendix D. The OCS leasing program is implemented by 30 CFR Part 256. Lease supervision and regulation of offshore operations is implemented by 30 CFR Part 250. The following steps summarize the leasing process for the proposed lease sale.

1. Leasing Schedule: The Act requires that the Secretary of the Interior prepare and maintain a 5-year OCS oil and gas leasing program and that he review the program annually to ensure that it meets the Nation's energy needs. The current 5-Year Oil and Gas Leasing Program published in July 1987 consists of 37 proposed oil and gas lease sales for the period August 1987 through June 1992, including 12 sales offshore Alaska. Two of the Alaska sales are in the Chukchi Sea Planning Area--Sales 109 and 126. Proposed Chukchi Sea Sale 109 is currently scheduled for May 1988 and Sale 126 for May 1991.

2. Request for Resource Reports: Resource reports for a specific lease area are requested from various Federal and State agencies approximately 2 years before the first day of the month in which a lease sale is scheduled. These reports provide geological, biological, oceanographic, navigational, recreational, environmental, archaeological, and socioeconomic information on a proposed lease area. Resource reports for the Chukchi Sea Sale 109 area were requested in June 1984 and were received by the MMS Alaska OCS Region in July 1984.

3. Call for Information and Nominations and Notice of Intent to Prepare an Environmental Impact Statement: A Call for Information and Nominations (Call) and Notice of Intent to Prepare an EIS (NOI) are notices published in the Federal Register inviting the oil industry, governmental agencies, environmental groups, the State of Alaska, and the general public to comment on areas of interest or special concern in the proposed sale area. The Call and the NOI for the proposed Chukchi Sea Sale 109 were published in the Federal Register on January 28, 1985 (50 FR 3870), requesting comments on areas of interest and lease terms. Comments on the Call must be received no later than 45 days after publication. Comments on the NOI must be received generally within 30 days after Area Identification is announced. The comments received from the Call and the NOI are discussed under scoping in Section I.A.5 below and in Section I.D. The comments submitted provided information on lease terms and block size and identified significant environmental concerns. The Chukchi Sea Call area was located generally in the eastern Chukchi Sea off the northwestern coast of Alaska and covered approximately 11.9 million hectares (approximately 29.5 million acres) containing 5,448 blocks.

Twelve comments on the Chukchi Sea Call and NOI were received, including comments from the State of Alaska, the North Slope Borough, the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), the City of Wainwright, and the Environmental Protection Agency (EPA). Twelve nominations were submitted. Interest was shown in the entire Call area.

4. Area Identification: Based on information received from the resource reports and in response to the Call--together with recommendations from the MMS, NMFS, and FWS; comments from the Governor of Alaska on technological and socioeconomic information; and the DOI's environmental, technological, and socioeconomic information--the Secretary of the Interior

selects an area for further environmental analysis and study. On May 28, 1985, the Secretary of the Interior selected 5,450 blocks in the Chukchi Sea, an area of 11.9 million hectares (approximately 29.5 million acres), for analysis in this document as the proposal (see Figs. I-1 and I-2).

5. Scoping: The NOI, published in the same document as the Call (Step 3), announces 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 environmental impact statement (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 analysis in an EIS.

Comments are invited from affected Federal, State, and local government agencies; Native groups; industry; special-interest groups; and any interested persons. Information obtained from the Request for Resource Reports and the Call is considered in scoping the EIS.

Based on information gained through the scoping process--which includes MMS 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.

The MMS held scoping meetings for proposed Chukchi Sea Sale 109 in Barrow, Wainwright, and Point Lay from April 18, 1985, through April 19, 1985. The results of the scoping process for this proposed sale are presented in Section I.D of this EIS.

6. Preparation of the Draft Environmental Impact Statement (DEIS): As required by Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, an EIS is prepared on any major Federal action significantly affecting the quality of the human environment. Offshore leasing is considered a major Federal action for which an EIS should be prepared.

As an integral part of DEIS development, a Synthesis Meeting, Information-Transfer Meeting, or Information-Update Meeting is held prior to the actual writing of the DEIS. This MMS-sponsored meeting is attended by MMS staff and researchers who are knowledgeable of information available in a specific lease area. A Synthesis Meeting for the Barrow Arch (Chukchi Sea) was held October 30 through November 1, 1983, at Girdwood, Alaska, to review the status of environmental knowledge and discuss the implications of proposed oil and gas development in the Chukchi Sea area. A Chukchi Sea Information-Update Meeting was held on March 27, 1986, in Anchorage, Alaska, to review new information obtained since the 1983 Synthesis Meeting. For more information about MMS-sponsored studies that apply to the Chukchi Sea, see Appendix D.

The DEIS describes the potentially affected marine, onshore, 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 and possible alternatives to the proposal; and presents a record of consultation and coordination with others during DEIS preparation.

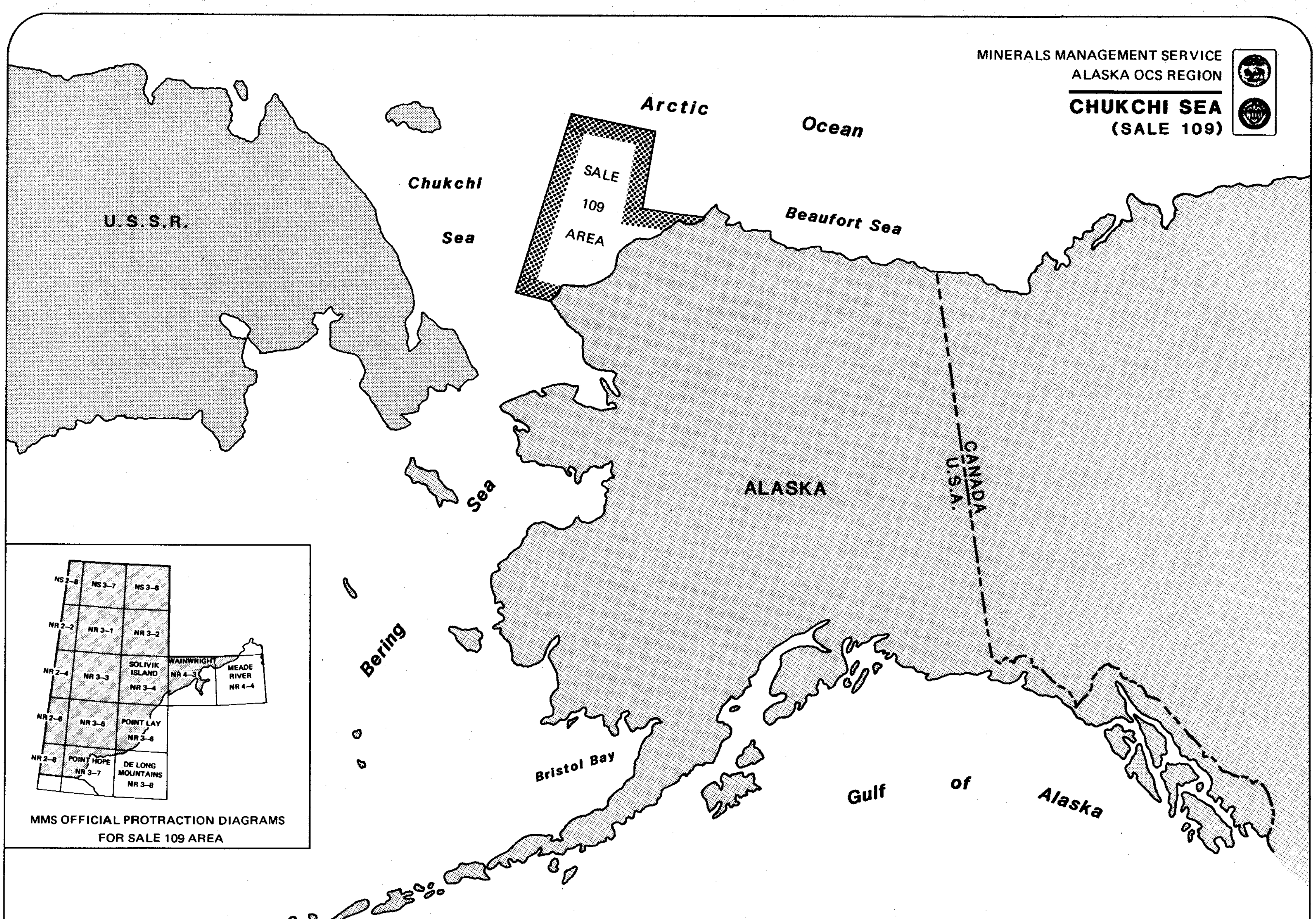


FIGURE I-1

LOCATION OF THE PROPOSED CHUKCHI SEA
SALE 109 AREA

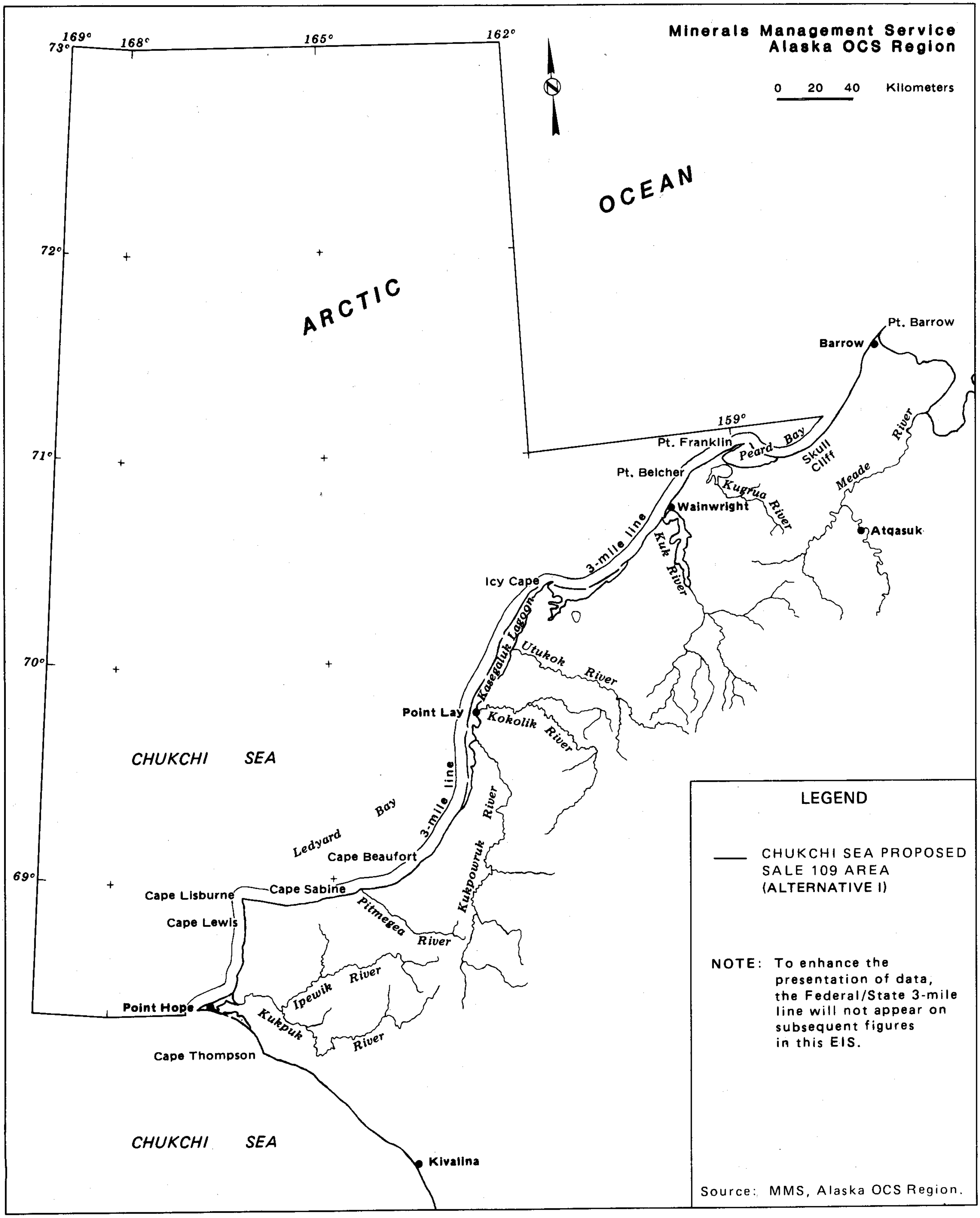


FIGURE I–2. THE PROPOSAL (ALTERNATIVE I)

The document is filed with the EPA, 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 Sale 109 DEIS was filed with the EPA on March 6, 1987.

7. Endangered Species Consultation: Pursuant to Section 7 of the Endangered Species Act of 1973, as amended (Sec. 16 U.S.C. 1536), the MMS consults with the FWS and the 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 the Chukchi Sea area.

The MMS initiated formal Section 7 consultation for Sale 109 on March 25, 1986, with the NMFS and the FWS. The NMFS biological opinion for Sale 109 on endangered whales was received on September 1, 1987; the FWS biological opinion on endangered and threatened species was received on June 24, 1986 (see Appendix B).

8. 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. Oral and written comments are obtained. Public hearings on this DEIS were held in April 1987 in the following communities: Barrow on April 10, Point Hope on April 13, Point Lay on April 14, Wainwright on April 15, and Anchorage on April 22.

9. Preparation of the FEIS: Oral and written comments on the DEIS are obtained and addressed in the FEIS, which is then filed with the EPA and made available to the public. The availability of the FEIS is announced in the Federal Register.

10. Secretarial Issue Document (SID): The SID, which is based in part on the FEIS, includes a discussion of significant information concerning the DOI's proposed lease sale. The SID provides relevant environmental, economic, social, and technological information to the Secretary to assist him in making a decision on whether to conduct a lease sale and, if so, what terms and conditions to apply to the sale and to the leases.

11. Proposed Notice of Sale: At least 90 days before the proposed lease sale, a sale proposal is furnished to the Governor of Alaska, pursuant to Section 19 of the Act, so that he and affected local governments may comment on the size, timing, and location of the sale. Comments must reach the Secretary of the Interior within 60 days after notice of the proposed lease sale. The sale proposal is accessible to the public as a Proposed Notice of Sale. A Notice of Availability for this document is published in the Federal Register.

12. Decision and Final Notice of Sale: The entire prelease process culminates in a final decision by the Secretary of the Interior regarding whether to hold a lease sale and, if so, its time and location, size, terms, and conditions. The Final Notice of Sale must be published in the Federal Register at least 30 days prior to the sale date. It may differ from the proposed notice depending upon the Secretary's final decision, i.e., size of lease sale, bidding systems, and mitigating measures.

13. Lease Sale: The Chukchi Sea Sale 109 is tentatively scheduled to be held in May 1988. Sealed bids for individual blocks and bidding units (those listed in the Notice of Sale) 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 may review the bids for compliance with antitrust laws. If the bids are determined to be acceptable, leases may be awarded to the highest qualified bidders. However, the Secretary of the Interior reserves the right to withdraw any blocks from the sale prior to written acceptance of a bid, and the right to reject any and all bids (generally within 90 days of the lease sale).

14. Lease Operations: After leases are awarded, the MMS Field Operations Office (FO) is responsible for supervising and regulating operations conducted in the lease area. Prior to the initiation of exploration activities on a lease, except preliminary activities, a lessee must submit an exploration plan and an environmental report--including an Oil-Spill-Contingency Plan and an Application for Permit to Drill (APD)--to the MMS for approval. The Office of Ocean and Coastal Resource Management, FWS, NMFS, EPA, National Park Service, U.S. Army Corps of Engineers, U.S. Coast Guard, and the State of Alaska 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 Coastal Management Program concurrence with the lessee's Federal consistency determination. The APD under an approved exploration plan will not be approved until the State's consistency certification has been received or is conclusively presumed.

B. Leasing History

No Federal offshore oil and gas lease sales have been conducted for the Chukchi Sea area. The Chukchi Sea is unexplored for oil and gas, and little exploration has taken place in adjacent onshore lands. In January 1986, Northern Technical Services, Inc. (NORTEC), issued a notice inviting interested parties to participate in the drilling of a COST (Continental Offshore Stratigraphic Test) well. However, the proposal was canceled due to lack of commitment from enough participants. In January 1987, Dome Petroleum Corporation issued a notice inviting interested parties to participate in the drilling of a COST well commencing in late July 1987. The proposal for this well also was canceled for the same reason.

This area first appeared on the July 21, 1982, 5-year schedule as Sale 85, Barrow Arch. That sale was scheduled for February 1985. Resource Reports were requested and received, and a Call for Information and Nominations was published. The entire area was subsequently identified for further study. In a letter to Alaska Governor Bill Sheffield dated March 9, 1984, the Secretary of the Interior deleted Sale 85 from the schedule "to provide for further assessment of operations in heavy ice conditions."

Activities in the Canadian and Alaskan Beaufort Sea have proven industry's ability to explore in the heavy sea-ice conditions found in those areas. More than 50 wells have been drilled in the Canadian Beaufort and 18 in the Federal waters of the Alaskan Beaufort Sea. These wells were drilled using bottom-founded platforms, such as gravel and ice islands and caisson structures in shallow water and drillships with icebreaker-support vessels in deeper areas. These operations also have provided an opportunity for further studies that support the feasibility of operations in the Chukchi Sea. Specifically, since March 1984, eight studies are in progress or have been completed by the Technical Assessment and Research Program (TA&RP) for Offshore Minerals Operations on the subject of ice and offshore structures. (See Appendix D for a list of these studies.)

A revision of the draft 5-Year Oil and Gas Lease Sale Schedule released in March 1985 renamed this area the Chukchi Sea Planning Area. The Call for Chukchi Sea Sale 109 was published on January 28, 1985, and included a request for information on the technology presently available for operations in the heavy ice conditions of the Chukchi Sea. The comments submitted indicate that the area is technologically accessible to petroleum exploration and development at the present time. Twelve companies submitted nominations; on May 28, 1985, the entire area--consisting of 5,450 blocks--was identified for further study.

In 1976 and 1981, the Arctic Slope Regional Corporation leased over 2 million acres of land for oil- and gas-drilling rights. The lands are located west of the National Petroleum Reserve-Alaska (NPR-A) and along the coast from Point Lay to Cape Sabine. These leases were issued for 10- and 15-year periods; approximately 500,000 acres are covered by leases that are still active. Three onshore wells were drilled as a result of the sales, one (Tungak Creek Well) located near Point Lay and the remaining two (Eagle Creek Well and Akulik Well) located near Cape Beaufort. All three wells were plugged and abandoned.

Prior to Federal onshore leasing in the NPR-A, the Federal Government contracted the drilling of six test wells. The wells were drilled onshore, adjacent to the Northern Chukchi Sea--from Point Barrow South to Icy Cape (see Fig. III-2).

Federal onshore leasing has occurred in the NPR-A. Sales 821 and 822, conducted in January and May 1982, respectively, resulted in the issuance of 41 leases. These leases are scattered in the southern, central, and eastern portions of the reserve. A third sale (Sale 831) was held in July 1983; 18 leases were issued. A fourth sale (Sale 841) was held in July 1984, and no bids were received. Sale 851, tentatively scheduled for August 1985, was cancelled due to lack of interest. As a result of Sale 831, one well was drilled in 1985 near the northern Chukchi Sea, 25 miles south of Point Barrow and west of Tractor Lake. The well was plugged and abandoned.

The State of Alaska's Five-Year Oil and Gas Leasing Program of January 1986 included proposed oil and gas lease Sale 58 offshore of Icy Cape for September 1989. The sale area consisted of State submerged lands located offshore of Icy Cape and extending from the northern end of Kasegaluk Lagoon south to approximately Cape Beaufort. An onshore sale located along the coast of Icy Cape to Naokak Pass and adjacent to the western border of the NPR-A--Sale 53--was proposed for September 1987.

The State of Alaska's Five-Year Oil and Gas Leasing Program released in January 1987 did not include seven of the sales that had appeared on the previously released January 1986 schedule. Sales 53 and 58 were dropped from the schedule. The State of Alaska revised its leasing schedule "to accommodate budget reductions within industry and state government. . . ."

C. Legal Mandates, Authorities, and Federal Regulatory Responsibilities

OCS Report MMS 86-0003, "Legal Mandates and Federal Regulatory Responsibilities" (Alaska OCS Region Technical Report No. 4, Second Edition [Rathbun, 1986]), incorporated herein by reference, describes legal mandates and authorities for offshore leasing and outlines Federal regulatory responsibilities. This report contains summaries of the OCS Lands Act, as amended, and related statutes; a summary of requirements for exploration, development, and production activities, including Alaska OCS Orders; a discussion on authorities of other Federal agencies affecting OCS activities; and a summary of significant litigation affecting OCS leasing policy.

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

D. Results of the Scoping Process

The scoping process for the Chukchi Sea Sale 109 EIS consisted of an analysis of the responses to the Call for Information and Notice of Intent to Prepare an EIS on Sales 85 and 109; comments from scoping meetings held in Barrow and Wainwright on April 18, 1985, and Point Lay on April 19, 1985; and staff input.

The responses to the Call for Information and Notice of Intent to Prepare an EIS are summarized as follows:

-- The State of Alaska is concerned with the adequacy of technology to operate in the Chukchi Sea and the availability of adequate studies information. The Division of Parks and Outdoor Recreation stated that there are certain sites adjacent to the sale area that are eligible for consideration as national historic places and landmarks. The State recommended that these areas be identified in the EIS, that potential effects on them be analyzed, and that their eligibility for inclusion on the National Register of Historic Places be determined.

-- The North Slope Borough (NSB) recommended that (1) there be a moratorium placed on all OCS lease sales within the U.S. arctic for at least 2 to 3 years to allow the Federal Government to conduct studies needed to adequately prepare the EIS, e.g., studies to define, among other things, the area of use by bowhead whales at times other than the spring-migration period; (2) only those areas with the highest resource potential be offered for lease; (3) blocks located where the flaw-lead zone is known, or can be predicted to occur, be deleted; (4) the entire area used by migrating bowhead whales be deleted, but that if it is included in the proposed sale area, appropriate seasonal drilling restrictions be adopted; (5) an oil-spill-risk analysis addressing the increased risk of using drillships and other floating or anchored platforms be included; (6) guidelines on the timing of seismic activities be developed to avoid potential effects on marine mammals and their subsistence use; (7) appropriate surveys be conducted to document the full extent of use of the proposed sale area by bowhead and beluga whales, ringed and bearded seals, polar bears, walruses, fishes, and migratory waterfowl; and (8) the potential cumulative effects resulting from this sale and the effects on subsistence hunting be fully analyzed in the EIS.

Other aspects of oil and gas development that concern the NSB include seismic and shipping noise; oil spills; cumulative effects on bowhead, gray, and beluga whales; effects on polar bears, ringed and bearded seals, walruses, fishes, birds, and unique habitats such as Kasegaluk Lagoon and Peard Bay; and effects on subsistence-hunting activities.

-- The NMFS expressed concern for protection of the many marine mammals that depend on the Chukchi Sea for feeding and migration. They urged that further studies be conducted to define seasonal-habitat use and requirements as well as the overall effects of oil and gas activities on marine mammals and their habitats. The NMFS recommended protecting the areas offshore Peard Bay, Kasegaluk Lagoon, and Cape Lisburne to protect subsistence hunting, whale migration, and bird foraging. They also requested that the sale be limited to the shorefast-ice zone and that any leasing beyond this area be subject to the demonstration of safe operational capabilities.

-- The FWS recommended that leasing regulations conform with National and international treaties that protect birds and mammals under FWS jurisdiction. They further stated that onshore industrial activities cannot be permitted until land-status determinations and compatibility tests on refuge lands are completed, especially on the barrier-island complex of the southern Chukchi Sea coast. The FWS recommended deletion of blocks within 12 miles of the Cape Lisburne bird rookery--the largest in the area, where most foraging occurs.

-- The City of Wainwright expressed interest in the proposed sale area and suggested a meeting with the MMS to further discuss community concerns. This meeting was held on April 18, 1985, as part of the scheduled scoping process. The City is primarily concerned about potential effects on subsistence resources, particularly whales.

-- The EPA recommended the deferral of two areas within the proposed sale area: (1) an area within a 50-mile radius of Cape Lisburne, to protect the 35-mile-wide primary seabird-feeding area and allow for a 15-mile-wide buffer, and (2) the entire area from the 3-mile limit out to the western edges of the open-water-lead system that recurs in the spring, to protect important coastal habitats and the Chukchi polynya.

The EPA recommended a seasonal drilling restriction to protect bowhead whales from potential oil spills, a stipulation on oil-spill-cleanup capability, and a stipulation on air-quality monitoring.

The EPA also had comments on and suggested discussion of the following topics in the EIS: oil-spill response and cleanup, fates and effects of spilled oil, cumulative-effects assessment, and air-quality issues.

1. Significant Issues Considered in the EIS: The significant issues listed below resulted from an evaluation of issues raised during the scoping process for this lease sale. The analyses in this EIS are focused on these issues.

a. Effects on subsistence-harvest patterns from

- oil spills
- industrial disturbance (including noise)
- reduced access to resources
- changes in subsistence practices related to oil and gas activities

(See Secs. III.C.2 and IV.B.10.)

b. Effects on sociocultural systems from

- sale-related effects on subsistence uses and needs
- changes in traditions and cultural values

(See Secs. III.C.3 and IV.B.11.)

c. Effects on lower-trophic-level organisms from

- oil spills
- construction
- drilling-mud discharges

(See Secs. III.B.1 and IV.B.3.)

d. Effects on fishes from

- oil spills
- construction
- drilling-mud discharges

(See Secs. III.B.2 and IV.B.4.)

e. Effects on marine and coastal birds from

- oil spills
- noise disturbance
- habitat loss

(See Secs. III.B.3 and IV.B.5.)

f. Effects on marine mammals (including polar bears) from

- oil spills
- noise disturbance
- habitat loss (construction and siting)

(See Secs. III.B.4 and IV.B.6.)

g. Effects on endangered whales from

- oil spills
- noise disturbance (during habitat use)
- habitat disturbance (including ships in ice leads)

(See Secs. III.B.5 and IV.B.7.)

h. Effects on caribou from

- oil spills
- noise disturbance
- habitat alteration

(See Secs. III.B.6 and IV.B.8.)

i. Cumulative effects on all resource categories from

- this sale in combination with other ongoing or proposed projects on the North Slope

(See Secs. IV.B through IV.G.)

j. Oil-Spill-Containment and -Cleanup-Capability Issues:

- in open water
- in broken ice
- on and under ice
- along coastal areas
- during storms and winds

(See Sec. IV.A.1.)

k. Fate and Behavior of Spilled Oil:

(See Sec. IV.A.2.)

l. Oil-Spill-Risk Analysis:

(See Sec. IV.A.1.)

m. Offshore-Technology Issues:

- capability of manmade structures such as offshore drilling units, production platforms, oil-storage facilities, or transportation systems to withstand the hazards of the Chukchi Sea

- major constraints on technology such as sea ice, waves and currents--particularly during storm surges, and superstructure icing

(See Sec. IV.A.3.)

n. Offshore Loading:

(See Appendix C, Summary of Potential Effects Resulting from the High and Low Resource Cases, Low Case.)

o. Archaeological Resources:

° effects of oil exploration and development on onshore-archaeological-resource sites at Point Hope, Cape Lisburne, Point Lay, Icy Cape, Wainwright, Point Belcher, and Point Franklin

(See Sec. IV.B.12.)

p. Water-Quality Issues:

° effects from oil spills, construction, and drilling-muds and cuttings discharges

(See Sec. IV.B.2.)

q. Air-Quality Issues:

° performance of a screening-level air-quality-modeling analysis for all proposed sources

(See Sec. IV.B.1.)

r. Economic Issues:

° effects on the local economy from increases in employment and population

(See Sec. IV.B.9.)

s. Land Use Plans and Coastal Management Programs:

(See Secs. III.C.5 and IV.B.13.)

2. Issues Not Considered in the EIS: The following issues raised during the scoping process are not analyzed in the EIS for the reasons indicated below.

a. Earthquakes and Tidal Waves: Earthquake data indicate that the Sale 109 and adjacent coastal areas historically are regions of low seismic activity. Thus, earthquakes, and associated tsunamis, are not expected to be significant hazards to petroleum-industry operations.

b. The Effect of Oil and Gas Operations on a Limited Supply of Freshwater: Water is needed for drilling operations and for consumption. Supplies for offshore drilling and consumption are generated by desalinizing seawater. This process also could be used to meet onshore requirements if other options were not available to provide industry with an adequate independent water supply. One option currently used to supply onshore water for

Prudhoe Bay operations relies on water that collects in the pits that remain after gravel has been extracted. Gravel-extraction processes that are used to support sale-related activities might generate a similar source of water. Either method of supplying water would preclude the occurrence of effects on the local water supply.

c. Completion of Land-Status and Compatibility Tests on Refuge Lands Before Industrial Activities Are Permitted: Portions of the Chukchi Sea Unit of the Alaska Maritime National Wildlife Refuge are in the vicinity of proposed Sale 109. Capes Lisburne and Thompson are particularly notable. The purposes for which the Alaska Maritime National Wildlife Refuge was established are to conserve fish and wildlife populations and habitats in their natural diversity, fulfill international fish and wildlife treaty obligations, provide for continued subsistence uses by local residents, provide for scientific research, and ensure water quality and quantity (ANILCA, Sec. 303[1][A][i] and [B]). This EIS examines the potential effects of Sale 109 on the natural resources, water quality and quantity, and subsistence pursuits throughout the sale area--including Capes Lisburne and Thompson. As a result, the EIS should provide the information necessary for FWS refuge managers to address those elements of the Refuge Management Plan that might be affected by Sale 109.

d. The Statewide Economy: The economic effects of proposed Sale 109 would occur primarily in the North Slope Borough (NSB). The State of Alaska would receive an indeterminate amount of money from Section 8(g) blocks those blocks lying within 3 to 6 miles offshore, for which the State receives a percentage of all revenues collected (Sec. 8[g] of the Act). Some sale-related and -induced employment effects would be experienced outside of the NSB, but the magnitude of these two effects is not expected to significantly affect the statewide economy. Therefore, this EIS does not describe the statewide economy or the statewide economic effects of the proposed sale.

e. Availability of Adequate Studies Information: Since the Chukchi Sea (Barrow Arch) Planning Area was first placed on the 5-year OCS oil and gas leasing program, over 100 studies pertinent to increasing our knowledge of this remote area have been completed. In addition, over 25 studies are ongoing or planned in the near future. Although more studies can be conducted in a sale area, it is the judgment of the MMS that the information base currently available is adequate for environmental assessment and for the Secretary of the Interior to make a decision concerning this lease sale. Ongoing and additional environmental studies will facilitate the decision-making process for future offshore oil and gas leasing activities in the Chukchi Sea region. (See Appendix D, MMS Alaska OCS Region Studies Programs, for a listing of Chukchi Sea environmental studies.)

f. Eligibility of Archaeological Sites for Inclusion in the National Register of Historic Places: At this stage of the leasing process, the identification of previously recorded archaeological sites, an evaluation of the probability (high, medium, or low) of finding archaeological resources in a given area, and a determination of effect are included in the EIS. The MMS will not consider making a recommendation of eligibility for the National Register of Historic Places until site-specific exploration and development plans are submitted to the MMS.

g. Eskimo Curlew: The coastal area adjacent to the eastern boundary of the sale area is within the historic breeding range where the endangered Eskimo curlew nested on the open tundra. However, the Eskimo curlew has not been sighted in Alaska for decades (USDOI, FWS, 1980); therefore, the effects of oil and gas development associated with this sale area on the Eskimo curlew are not analyzed.

h. Potential for Fog and Ice-Fog Formation Caused by Onshore and Offshore OCS and Related Sources: Fog and ice fog are not considered to be pollutants under the air-quality regulations and do not pose a significant hazard to oil and gas operations or human health.

3. Mitigating Measures Suggested During the Scoping Process: During the scoping process, the following suggestions for mitigating measures to protect certain resources were received and are discussed below. The potential mitigating measures proposed by the MMS to mitigate the possible effects of Sale 109 are found in Section II.H.2. It should be noted that a Secretarial decision on these potential mitigating measures will not be made until the Notice of Sale is published. The analysis in this EIS does not assume that the measures are in place.

a. Some means, such as OCS revenue sharing, should be developed to compensate local subsistence users for damage to subsistence resources as a result of an oil spill.

The Offshore Oil Pollution Compensation Fund (43 U.S.C. 1801 et seq.) provides compensation for claims arising from oil pollution that results in the injury, destruction, or loss of use of natural resources.

b. Proven methods of oil-spill cleanup should be required, especially during ice-override conditions.

The Secretary of the Interior requires that the Best Available and Safest Technologies be used on the OCS. Most ice-override conditions are observable and would give operators enough warning to respond before a problem developed (see also Sec. IV.A.2.c).

c. Kasegaluk Lagoon should be designated as an area meriting special attention.

Kasegaluk Lagoon is one of the areas listed in the ITL on Areas of Special Biological Sensitivity (see Sec. II.H.2).

d. Industry should be required to use only previously disturbed sites for onshore support bases.

Industry would most likely use any convenient, existing onshore support facilities in the area, particularly during the exploration phase. If new or expanded facilities were needed, it is anticipated that industry would negotiate with the landowner for use of additional land. Moreover, through its Land Management Regulations and the policies of the Alaska Coastal Management Program, as amended by the North Slope Borough Coastal Management Program, the NSB has the authority to require that development occur in areas previously developed to the extent that such an option is feasible and prudent. The ITL on Coastal Zone Management addresses the issue of energy-facility siting.

e. The lessee should be required to conduct site-specific environmental surveys prior to drilling activity to determine if biological populations or habitats requiring additional protection are in the vicinity.

Under the Protection of Biological Resources Stipulation (see Sec. II.H.2), the Regional Supervisor, Field Operations (RSFO), may require the lessee to conduct biological surveys if biological populations or habitats that may require additional protection are identified by the RSFO in the lease area. It is not necessary to require a site-specific survey prior to drilling each well. It is possible that surveys would be required of the first well in a location if nothing were known of the area. The RSFO would evaluate all pertinent information, including the recommendations of the Chukchi Sea Biological Task Force--if this mitigating measure is selected by the Secretary to be part of the Notice of Sale (see Sec. II.H.2)--to determine the necessity of site-specific surveys and the appropriate course of action once surveys have been conducted.

f. A stipulation on air-quality monitoring should be included in the EIS to establish air-monitoring sites adjacent to the sale area to determine existing air-pollutant concentrations and to track potential air-quality degradation.

A requirement that industry conduct background-monitoring studies is not justified at this time in this remote sale area because no company has proposed any permanent facilities large enough to be subject to air-quality regulations. When exploration plans and development and production plans are submitted, further analysis will be done to determine potential onshore effects; and the need for a stipulation or an MMS-imposed operating requirement to monitor air quality could be evaluated.

g. Guidelines on the timing of seismic activities should be developed to avoid potential effects on marine mammals and their subsistence use.

Regulations covering seismic activities are found in 30 CFR 250 for exploration plans and preliminary activities and 30 CFR 251 for geological and geophysical permits. Additionally, Notices to Lessees (NTL's) are issued by the MMS to address specific aspects of the conduct of preliminary activities in a particular sale area. An NTL similar to NTL 86-2 for the Beaufort Sea, which specifies performance standards for preliminary activities in the Chukchi Sea, will be issued prior to this sale. Also, when the MMS issues a permit for conduct of geophysical operations prior to a lease sale or approves the conduct of preliminary activities on a specific lease, it sends a letter of notification to the operator of such approval. The letter advises the operator of any further guidelines on conducting seismic surveys, clarifies applicable NTL's, and recommends actions for protecting marine mammals and subsistence activities.

h. A seasonal drilling restriction should be adopted to protect bowhead whales from potential oil spills.

Stipulation No. 5--Seasonal Drilling Restriction for Protection of Bowhead Whales From Potential Effects of Oil Spills--is evaluated as a potential mitigating measure in Section II.H.2.

4. Alternatives Suggested During the Scoping Process: Many alternatives were suggested during the scoping process on Sale 109. Three deferral alternatives were developed by the MMS in response to these suggestions: the Eastern Deferral Alternative, the Southern Deferral Alternative, and the Coastal Deferral Alternative. They are described as follows.

Eastern Deferral Alternative:

Description: The Eastern Deferral Alternative (Alternative IV) would remove from the Sale 109 area 488 whole and partial blocks (about 993,028 hectares) located along the Chukchi Sea coast from about 39 kilometers northeast of Peard Bay to 5 kilometers south of Kasegaluk Lagoon (see Fig. I-3). (See Sec. IV.E for the analysis of this alternative.)

The deferred area varies in width from 10 kilometers from shore at Point Franklin to 48 kilometers from shore east of Icy Cape and west of Kasegaluk Lagoon. The Eastern Deferral Alternative was designed to protect subsistence-harvest areas of Wainwright and Point Lay and the subsistence-harvest areas of Barrow and Atqasuk that occur within the boundaries of the proposal. Subsistence activities that occur in the sale area are conducted primarily within 32 kilometers of shore. This alternative excludes the areas of high subsistence use in the sale area for the communities of Barrow, Atqasuk, Wainwright, and Point Lay and creates a buffer of 8 to 16 kilometers around these areas. In the deferred area, bowhead whales are harvested in Barrow and Wainwright; and beluga whales are harvested in Barrow, Wainwright, and Point Lay. Other important subsistence resources harvested by residents of these communities include caribou; fishes; ringed, bearded, and spotted seals; birds; walruses; and polar bears. Bowhead whales pass through this deferred area during their spring migration to the eastern Beaufort Sea; during their fall migration toward the Russian coast, at least a portion of the population passes through the area as far south as Point Belcher. Some gray whales (which are not a subsistence resource in the sale area) spend the summer rearing their calves and feeding in the Chukchi Sea; several hundred have been seen around Point Belcher.

Evaluation: The analysis in Section IV.B of this EIS shows that under this alternative, air quality of the shoreline north of Naokok Pass would be more protected from offshore emissions because these emissions would be at least 29 kilometers offshore. Deliberate discharges would not affect water quality in the deferral area. Alternative IV would have localized beneficial effects for the residents of Point Lay by reducing noise and traffic disturbance to beluga whales. This alternative also would reduce the effects of noise and traffic disturbance on Point Lay's subsistence harvest of beluga whales from MODERATE to MINOR. Effects from noise and traffic disturbance also would be reduced on Wainwright's bowhead and beluga whale-subsistence harvests as well as Barrow's beluga harvest in Peard Bay. Slight reductions in disturbance of subsistence harvests of other marine mammals, birds, and

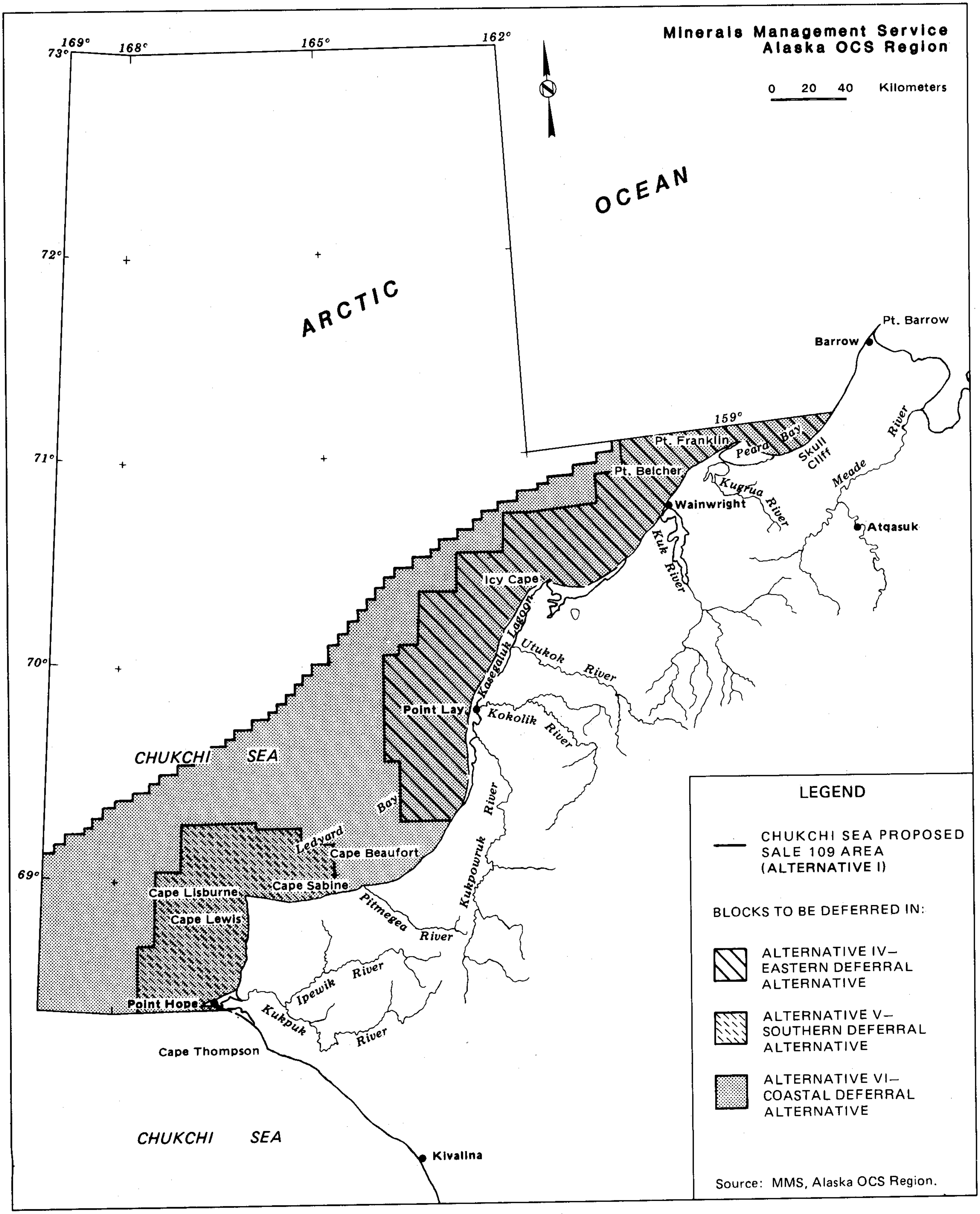


FIGURE I–3. DEFERRAL ALTERNATIVES IV,V, AND VI marine fishes also would occur. However, the level of effects on subsistence harvests remains MAJOR due to construction activities associated with the proposed landfall and shorebase facilities at Point Belcher. Oil-spill, disturbance, and habitat-alteration effects on spotted seals and beluga whales could be locally reduced near Peard Bay and Kasegaluk Lagoon. Potential disturbance of birds from air and boat traffic moving along the coast may be substantially reduced in the important Kasegaluk Lagoon and Peard Bay feeding, molting, and nesting habitats, thereby reducing local disturbance of several thousand birds. Removal of drilling discharges and platform-construction activities in the area would reduce the potential for adverse effects on the kelp-bed communities and would slightly benefit fishes.

Southern Deferral Alternative:

Description: The Southern Deferral Alternative (Alternative V) would remove from the Sale 109 area 289 whole and partial blocks (about 624,300 hectares) located from 5 to 48 kilometers offshore from Point Hope around Cape Lisburne and nearly to Cape Sabine (see Fig. I-3). (See Sec. IV.F for the analysis of this alternative.)

The Southern Deferral Alternative was developed to protect the Cape Lisburne area, which is important to the residents of Point Hope for the subsistence harvest of bowhead whales; ringed, spotted, and bearded seals; polar bears; walruses; and birds and their eggs. The largest bird rookery in the Sale 109 area is located at Cape Lisburne, where most seabird foraging occurs. A segment of the gray whale population (not a subsistence resource) feeds throughout this area during the summer. The bowhead whale spring migration passes through this deferral area.

Evaluation: The analysis in Section IV.B of this EIS shows that the air quality of the shoreline west of Cape Sabine would be more protected from offshore emissions under Alternative V because such emissions would be at least 29 kilometers offshore. This alternative would have localized benefits for water quality by eliminating the possibilities of spills and deliberate discharges occurring within the deferral area. Slight reductions in effects on fishes would result from elimination of drilling discharges and platform-construction activities within the deferred area, although the overall level of effect remains the same as for the proposal. It could reduce platform- and pipeline-spill effects on the Cape Lisburne and Cape Lewis seabird populations. The combined effects of oil spills, disturbance, and habitat changes on marine mammals could be reduced somewhat in the Point Hope/Cape Sabine coastal area. Effects from noise and traffic disturbance also would be reduced on Point Hope's bowhead and beluga whale-subsistence harvests. Slight reductions in disturbance of subsistence harvests of other marine mammals, birds, and marine fishes also would occur. However, the effect level on subsistence harvests remains MAJOR due to construction activities associated with the proposed landfall and shorebase facilities at Point Belcher.

Coastal Deferral Alternative:

Description: The Coastal Deferral Alternative (Alternative VI) would remove from the Sale 109 area 1,632 whole or partial blocks (about 3,485,140 hectares) located along the entire length of the sale area and extending from 5 to 113 kilometers offshore (see Fig. I-3). (See Sec. IV.G for the analysis of this alternative.)

The Coastal Deferral Alternative was developed (1) to encompass the bowhead whale spring-migration corridor that extends through the sale area; (2) to encompass in general the Chukchi polynya or open-water lead through which marine mammals migrate in the spring; (3) to provide a protective buffer to the offshore subsistence-harvest areas and resources of the communities of Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope over and above the buffers provided in Alternatives IV and V; and (4) to protect important coastal habitats such as the Peard Bay area, Kasegaluk Lagoon and the barrier-island system, the Cape Lisburne area and bird rookery, and the Kuk River estuary.

Evaluation: The analysis in Section IV.B of this EIS shows that the localized benefits of Alternative VI include the following:

The magnitude and rates of air-pollutant emissions would be lower than those for the proposal and would occur at least 41 kilometers from shore. Effects on water quality would be slightly lower than those for the proposal because platform spills and deliberate discharges would not occur in the deferred area.

Elimination of drilling discharges and platform-construction activities from nearshore waters under this deferral alternative reduces potential effects of these activities on kelp beds and invertebrates. Although the extent of localized effects is reduced, the level of effect is expected to remain MINOR, the same as for the proposal. The probability that oil spills would contact areas of particular concern for marine plants and invertebrates declines only slightly under this deferral alternative.

Slight reductions in effects on fishes would result from decreased drilling discharges and platform-construction activities in nearshore waters.

This alternative would defer exploration and production from the coastal habitat of over a million marine and coastal birds. It also would remove the potential for exploration and production activities within most of the spring-migration corridor used by pinnipeds and beluga whales and could reduce local effects on walruses and spotted seals.

Overall, endangered whales would be somewhat less likely under this alternative to be contacted by oil. No exploratory-drilling sites or production platforms would be located within the bowhead whale spring-migration corridor and coastal area heavily used for gray whale feeding, resulting in a slight decrease in noise-producing activities.

This alternative would remove the possibility of exploration or production occurring within the subsistence-hunting area, which would decrease noise from boats and seismic and traffic disturbance as well as eliminate the presence of platforms in the deferred area. Thus, bowhead and beluga whales are the subsistence species most affected by noise and traffic disturbance and thus are the harvests that may be affected by this alternative. However, ice-breakers could still be in the area and could cause disturbance to bowheads and thus curtail or reduce the bowhead harvest. If it were a short whaling season, noise and traffic disturbance of Point Lay's beluga whale harvest would be reduced from MODERATE to MINOR under this alternative; and noise and traffic disturbance of Barrow's and Point Hope's beluga harvest would be reduced from MINOR to NEGLIGIBLE.

The following alternatives also were suggested during the scoping process and are responded to as follows:

a. There should be no leasing within 25 miles of shore to protect subsistence hunting.

This issue is covered under Alternative IV - Eastern Deferral Alternative, and Alternative VI - Coastal Deferral Alternative. Subsistence-harvest activities in the sale area are conducted primarily within 32 kilometers (20 miles) of shore. The Eastern Deferral Alternative excludes the areas of high subsistence use in the sale area for the communities of Barrow, Atqasuk, Wainwright, and Point Lay and creates a buffer of 8 to 16 kilometers (5-10 miles) around these areas. The Coastal Deferral Alternative, which defers an area from 48 to 113 kilometers (30-70 miles) from shore, creates an additional buffer for subsistence-harvest activities.

b. A 30- to 40-mile-wide buffer area off the coast should be deferred from leasing to protect subsistence resources and subsistence hunting.

This issue is covered under Alternative VI - Coastal Deferral Alternative. This alternative defers an area from 48 to 113 kilometers (30-70 miles) from shore to protect biological resources, such as bowhead whales, seals, fishes, and birds, and the subsistence harvest of these resources.

c. There should be no leasing within 50 miles of shore to protect subsistence hunting.

This issue is covered under Alternative VI - Coastal Deferral Alternative. This alternative defers an area from 48 to 113 kilometers (30-70 miles) from shore to protect biological resources such as bowhead whales, seals, fishes, and birds, and the subsistence harvest of these resources. While the deferred area north of the Utukok River is less than 80 kilometers (50 miles) wide, it still provides a buffer zone of 16 to 32 kilometers (10-20 miles) beyond the areas used intensively by Wainwright, Barrow, and Atqasuk hunters for subsistence purposes. By deferring this area from leasing, no platforms would be built in the area and thus no blowouts could originate from this area. Although expanding any deferral area can incrementally increase protection, the Coastal Deferral Alternative has been shaped to offer significant protection to the sale area's biological resources and their use by the area's subsistence hunters.

d. The Peard Bay area should be deferred from leasing consideration because of its heavy use for subsistence purposes.

This issue is covered under Alternative IV - Eastern Deferral Alternative, and Alternative VI - Coastal Deferral Alternative. Both of these alternatives offer considerable protection from potential effects associated with exploration and production platforms on biological resources in the Peard Bay area and their associated subsistence use by the villages of Barrow, Wainwright, and Atqasuk. The closest block that could be leased under either Alternative IV or VI is 59 kilometers (37 miles) from the westernmost edge of Peard Bay.

e. The entire area used by migrating bowhead whales should be deleted from the sale area. If not, seasonal restrictions must be in place.

This issue is covered under Alternative VI - Coastal Deferral Alternative. The Coastal Deferral Alternative defers the bowhead whale spring-migration corridor. There is no evidence, however, that bowheads migrate along the entire Chukchi Sea coast in the fall. A substantial portion of the population apparently migrates west across the northern half of the sale area to the Wrangel and Herald Island areas and the nearshore waters on the northern coast of the Chukotsk Peninsula. The bowheads travel as far south as Point Belcher before heading west toward Russia. This area is so broad that a deferral covering both migration areas would leave virtually no area to lease in the Chukchi Sea. Therefore, in lieu of analyzing the fall-migration area in a deferral, this EIS considers potential mitigating measures for the fall-migration area (see Secs. II.B.1.c and II.B.1.d).

f. Only those areas with the highest resource potential should be offered for lease.

The Area of Hydrocarbon Potential corresponds with the entire Chukchi Sea Planning Area--or the Sale 109 area.

g. Leasing should not occur in the flaw-lead zone.

This issue is covered under Alternative VI - Coastal Deferral Alternative. The flaw-lead zone is a region of dynamic interaction between the relatively stable ice of the landfast-ice zone and the mobile ice of the pack-ice zone that results in the formation of ridges, leads, and polynyas. This zone varies considerably from year to year. In the Chukchi Sea, the region of most intense ridging occurs in waters that vary in depth from 15 to 40 meters. The outer boundary of the Coastal Deferral Alternative runs roughly along--and in the southern part of the sale area beyond--the 40-meter isobath, thereby including the flaw-lead zone in the area considered for deferral.

h. Subsistence areas in close proximity to villages along the Chukchi Sea coast should be protected to ensure perpetuation of the Eskimo lifestyle. These areas include:

(1) Cape Lisburne - seal-hunting, polar bear-hunting, trapping, and birding area for Point Hope.

(2) Kasegaluk Lagoon and barrier-island system - spotted seal- and beluga whale-hunting, birding, and fishing area for Point Lay and Wainwright.

(3) Kuk River estuary - fishing, birding, and seal-hunting area for Wainwright.

(4) Greater Peard Bay area - seal- and beluga whale-hunting and birding area for Barrow and Wainwright.

See Alternatives IV, V, and VI for coverage of these issues - Eastern, Southern, and Coastal Deferral Alternatives. Each of these deferral alternatives offers some degree of protection to all the subsistence-harvest areas listed above. The Eastern Deferral Alternative protects the Kasegaluk Lagoon and barrier-island system, the Kuk River estuary, and the Peard Bay area. The Southern Deferral Alternative protects the Cape Lisburne area. The Coastal Deferral Alternative protects all of the subsistence-harvest areas listed above.

i. The sale should be delayed for 2 to 3 years.

See Alternative III - Delay the Sale (Sec. IV.D). This alternative analyzes the effects of a 2-year delay.

j. There should be a moratorium on all OCS lease sales in the Arctic for 2 to 3 years to allow time for studies needed to prepare EIS's.

See Alternative III - Delay the Sale, and Table IV-16 for a list of studies that would be conducted during a 2-year delay. Although more studies can be conducted in a sale area, it is the judgment of the MMS that the information base currently available is adequate for environmental assessment and for the Secretary of the Interior to make a decision concerning leasing.

k. Blocks within 12 miles of the Cape Lisburne bird rookery, the largest in the area--where most foraging occurs, should be deleted.

This issue is covered under Alternative V - Southern Deferral Alternative. This alternative studies this option and would protect the rookery by deferring blocks within 40 to 48 kilometers (25-30 miles) of Cape Lisburne.

l. The area within a 50-mile radius of Cape Lisburne should be deferred to protect the 35-mile-wide primary seabird-feeding area, with a 15-mile-wide buffer area extending into the secondary seabird-feeding area.

This issue is covered under Alternative V - Southern Deferral Alternative, and Alternative VI - Coastal Deferral Alternative. The area proposed for deferral under Alternative V extends from 40 to 48 kilometers (25-30 miles) from shore and offers considerable protection to feeding seabirds. The Coastal Deferral Alternative would defer blocks within 80 kilometers (50 miles) of Cape Lisburne and thus extend protection into the secondary feeding area.

m. The area from the 3-mile limit out to the western edges of the open-water lead system that recurs annually in spring should be deferred to protect important coastal habitats and the Chukchi polynya.

See Alternative VI - Coastal Deferral Alternative. The Coastal Deferral Alternative was developed primarily to offer the option to protect this exact area because it is the spring-migration corridor of the bowhead whale and other migrating marine mammals.

n. The initial sale area should be limited to the stable shorefast-ice zone. Leasing beyond this zone should require test structures and a demonstrated capability to operate safely with moving-pack-ice forces.

A variety of operating prototypes, not "test" structures, have been successfully used to prove the capability of drilling units to operate in the sea-ice regimes of the Beaufort Sea; examples of these units include the artificial (gravel) and ice islands, caisson-retained islands, Concrete Island Drilling System (CIDS), Single-Steel Drilling Caisson (SSDC), Conical Drilling Unit (CDU), and ice-strengthened drillships. Prototypes can be instrumented and studied to prove and improve existing technology. Furthermore, ice-management strategies and forecasting procedures have been developed to minimize the threat that moving sea ice poses to drilling operations. Development of the drilling units, technologies, and operating procedures in the Beaufort Sea has been an evolutionary process based on research in many engineering and scientific disciplines and on empirical experiences. This process is expected to continue so that petroleum exploration, and possible development and production, can be safely conducted in the Chukchi Sea. (See Sec. IV.A.3 for a detailed discussion of applicable state-of-the-art technologies.) Therefore, no deferral alternative has been proposed by the MMS for the area beyond the shorefast-ice zone.

The MMS does not see a need to require test structures as a means of proving the capability of drilling units to withstand ice forces. The capability of drilling units and other structures to operate in sea ice is more appropriately evaluated in accordance with the following Alaska OCS Orders Governing Oil and Gas Lease Operations: (1) Order No. 2 requires the lessee to submit with the Exploration Plan evidence that drilling units are capable of withstanding the oceanographic, meteorologic, and ice conditions for the proposed area of operations, and (2) Order No. 8 requires that all new fixed or bottom-founded platforms or other structures shall be subject to review under the requirements of the Platform Verification Program. Therefore, the design, fabrication, and installation of new units must be reviewed by an independent third party--a Certified Verification Agent--who has the technical expertise to make the necessary evaluations and judgments.

Further, the requirement for test structures may (1) hinder the development of new concepts in offshore arctic technology if every new type of structure has to be field tested--particularly considering the status of oil prices today and the extremely high cost of building these structures, and (2) lead to erroneous conclusions about structural safety. Operating prototypes--not test structures--have been used effectively to demonstrate the capability of offshore and many other engineering structures. Prototypes can be instrumented and studied to prove and improve the technology.

o. An ice-hazard alternative should be evaluated in the EIS because of the severe ice conditions existing in the sale area and the attendant threat to existing drilling technology.

The development of technologies, strategies, and procedures to operate in the sea-ice regimes of the Chukchi Sea is expected to be based, in part, on the experience acquired through the activities associated with petroleum exploration in the Beaufort Sea, as noted above. Furthermore, in the National Petroleum Council Report (1981) entitled "U.S. Arctic Oil and Gas," the petroleum industry conservatively noted that proven technology, sufficient information, and technical expertise for advanced design work are available for industry to operate confidently in the 60-meter-deep waters of the more severely ice-covered areas of the northern Bering, Beaufort, and Chukchi Seas.

It would be impractical to define a deferral alternative by its ice conditions. The winter-ice regime of the Chukchi Sea can be defined in terms of a general range of water depths: the fast-ice zone extends from the shoreline out to depths of about 20 meters, and the pack-ice zone occurs in waters deeper than 20 meters. However, because of the changing oceanographic and meteorologic conditions, the relative locations of the zones vary seasonally, yearly, and geographically. Within the sale area, the seaward boundary of the fast-ice zone can vary from about 5 kilometers to as much as 60 or 70 kilometers from shore. Thus, ice zonation based on water depths, or even average ice conditions, represent an unsatisfactory way of defining zones where certain types of activities are specified, restricted, or prohibited.

The MMS carefully examines the capabilities of each drilling unit for each proposed drilling operation through the requirements of OCS Order Nos. 2 and 8.

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This section describes the proposal, alternatives to the proposal, and the low- and high-resource cases for Sale 109. It also discusses mitigating measures and compares the effects of the alternatives. In addition to the proposal (Alternative I), there are five alternatives considered in this EIS. These alternatives are shown in Figure II-1 and listed below with the number of blocks included in each alternative shown in parentheses. (The number of blocks deferred is also included for deferral alternatives.)

- Alternative I - The Proposal (5,450 blocks)
- Alternative II - No Sale
- Alternative III - Delay the Sale
- Alternative IV - Eastern Deferral Alternative (4,960 blocks - 488 blocks deferred)
- Alternative V - Southern Deferral Alternative (5,160 blocks - 289 blocks deferred)
- Alternative VI - Coastal Deferral Alternative (3,818 blocks - 1,632 blocks deferred)

This section outlines assumptions used for the assessment of the potential environmental, social, and economic effects of proposed Sale 109 and its alternatives. Assumptions include exploration, development, and production schedules and activities, and the oil and gas resources estimated for the proposed sale area. These assumptions are summarized in Table II-1. Resource estimates for all alternatives and the low- and high-resource cases are summarized in Table II-2. Derivation of resource estimates is detailed in OCS Report MMS 85-0091, "Offshore Resource Evaluation Program: Background and Functions" (Dellagiarno, 1986, Appendix A). For a description of oil-spill risks and contingency measures, constraints on OCS oil and gas activities, and major projects to be considered in cumulative-effects assessment, see Section IV.A.

The economically recoverable natural-gas resources for Sale 109 are estimated to be zero. While the physical existence of natural gas in the sale area is given a marginal probability of 20 percent, recovery of such gas is estimated to be highly uneconomic at any time during the life of the lease. Several factors make natural gas recovery prohibitively expensive and include (1) the high costs of wellhead recovery associated with production; (2) the high cost to develop feeder and trunk pipelines; and (3) the high cost of infrastructure, including a liquefaction plant and shipping facilities, processing, and delivery to markets.

Also, already discovered natural gas reserves of 28.83 trillion cubic feet in the neighboring area of Prudhoe Bay (which is economically more favorable for natural gas recovery than the Sale 109 area) are not being recovered at present. It is estimated that the world price for crude oil would need to rise above $50 per barrel in 1986 money, with gas prices rising proportionately, before Sale 109 gas could be produced economically. Because natural gas recovery would be highly uneconomic for Sale 109, the possibility that a lessee would attempt recovery during the life of the lease is extremely unlikely. However, in the unlikely event that gas does become economic, potential effects are described in Section IV.M.

Any scenario for exploiting petroleum resources is highly speculative. The strategies actually used to explore, develop, produce, and transport the petroleum resources of the Sale 109 area would vary and depend upon many factors, a number of which are unique to each leaseholder or operator. The strategies discussed in this section are used to identify characteristic activities and areas where these activities may occur, but they do not represent a recommendation, preference, or endorsement by the U.S. Department of the Interior.

A. Alternative I - The Proposal

1. Description of the Proposal: The proposed action consists of 5,450 blocks (Fig. II-1) to be offered for lease in May 1988. (A list of the blocks can be obtained from the Minerals Management Service [MMS], Alaska OCS Region.) The total areal extent of proposed Sale 109 is about 11.9 million hectares (approximately 29.5 million acres). The blocks that comprise the proposed action are located about 5 to 385 kilometers offshore in water depths that range from about 8 to 80 meters. The MMS has estimated that the conditional-mean economically recoverable oil resources for the proposal are 2.68 billion barrels, with a marginal probability of 0.20 for hydrocarbons.

2. Activities Associated With the Proposed Action (Mean-Resource Case):

a. Exploration: Assumptions associated with exploration in the mean case cover timing of activities, exploration drilling units, drilling and seismic requirements, and support and logistic functions.

(1) Timing of Activities: The level of activities and the schedule of events for exploration are depicted in Table II-3. Drilling of exploration wells would begin in 1989. By the time delineation drilling ended in 1996, 20 exploration wells and 23 delineation wells would have been drilled. The schedule is predicated on the availability of existing drilling units in the third year. During those early years, final design and construction of drilling units designed specifically for the Chukchi Sea would be completed. This assumption would guide initial drilling to areas either shallow enough to use existing bottom-founded drilling units or deep enough for drillships. The schedule assumptions also are based on the discovery of oil and average conditions where large portions of the sale area can be ice-free for 90 days. However, the drilling season can be shortened considerably during years with heavy ice. Other factors that could affect the timing of activities include severe weather patterns that generate major wind or wave action and environmental regulations or stipulations that affect drilling.

(2) Exploration Drilling Units: Water depth will be a significant factor in selecting the appropriate drilling unit. The Sale 109 area is generally between 30 and 50 meters deep, although depths of 80 meters are present in a small portion of the northwest corner of the sale area (Truett, 1984). Existing bottom-founded units can be extended to reach a maximum depth of 22 to 30 meters. Drillships can drill in deep water; their limitation is a minimum operating depth of 16 to 20 meters (Alaska Oil and Gas Association [AOGA], 1987). The use of existing drillships would enable drilling to begin using systems that offer proven technology and procedures, and allow exploration to proceed without construction delays.

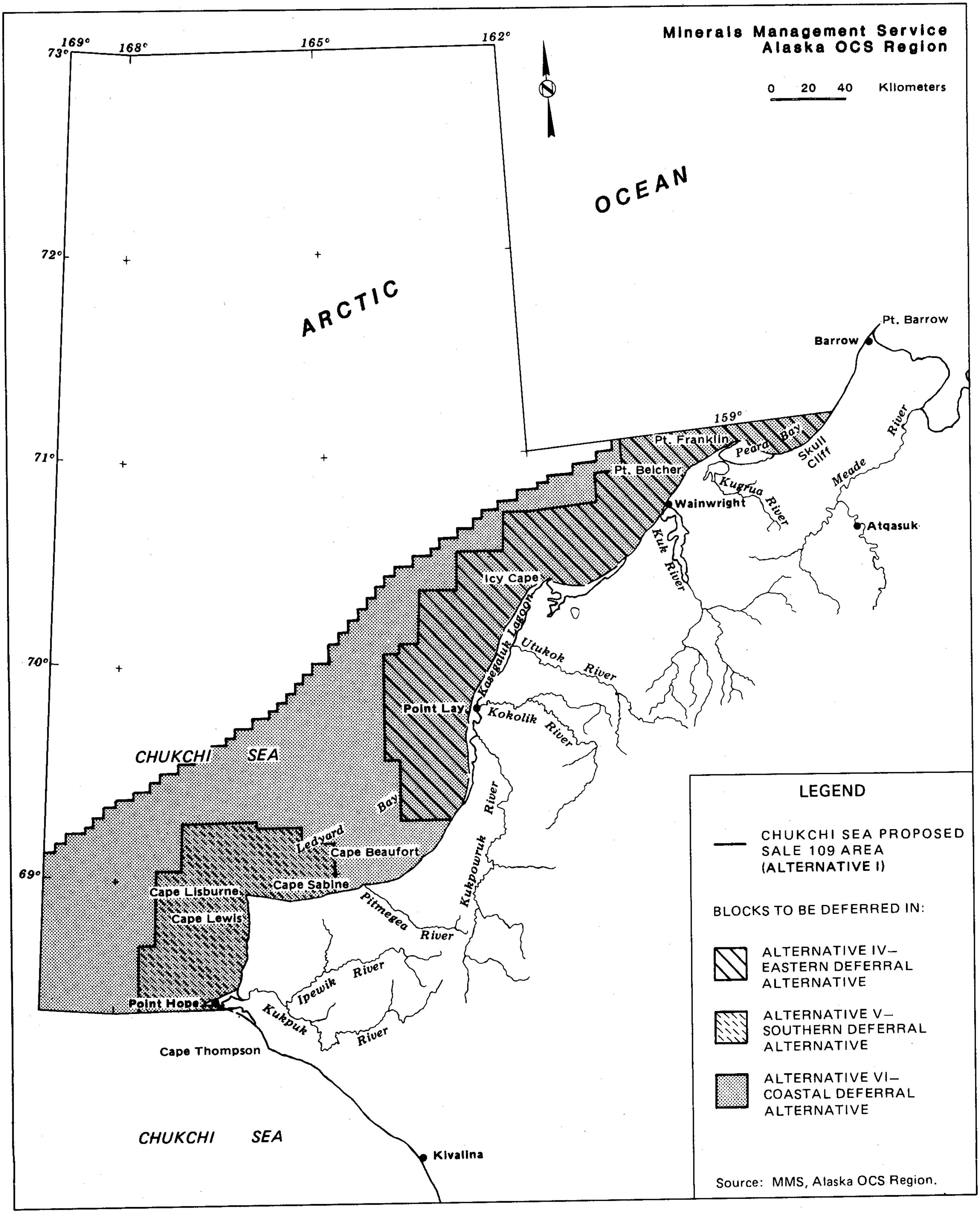


FIGURE II–1. THE PROPOSAL (ALTERNATIVE I) AND DEFERRAL ALTERNATIVES IV, V, AND VI

Table II-1
Chukchi Sea Sale 109
Summary of Mean-Case Scenario Assumptions for the Proposal and Deferral Alternatives
(Page 1 of 3)

PHASE Facility or Event	Alternatives I, IV, and V Number or Amount	Alternatives I, IV, and V Timeframe	Alternative VI Number or Amount	Alternative VI Timeframe
EXPLORATION				
Shorebase--Located Near Wainwright Airport				
Total Hectares	10	1988	10	1988
Exploration Work Force--Peak Year	719	1994	650	1994
Total Exploration/Delineation Wells (20 exploration, 23 delineation)	43	1989-1996	36	1989-1996
Drilled by Drillships (2)	14	1989-1994	11	1989-1994
Drilled by Bottom-Founded Units (2)	29	1991-1996	25	1991-1996
Drilling Muds and Cuttings Disposed--Dry Metric Tons				
Muds per Well				
Exploration	599	1989-1994	599	1989-1994
Delineation	454	1991-1996	454	1991-1996
Cuttings per Well				
Exploration	1,361	1989-1994	1,361	1989-1994
Delineation	1,179	1991-1994	1,179	1991-1994
Total Muds and Cuttings (exploration and delineation)				
Muds	22,408	1989-1996	18,954	1989-1996
Cuttings	54,340	1989-1996	45,720	1989-1996
Seismic Activity (shallow-hazard)				
Total Number of Days	301	1988-1995	191	1988-1995
Total Trackline Kilometers	7,979	1988-1995	6,598	1988-1995
Kilometers per Site-Specific Survey (50% wells)	63	1988-1995	63	1988-1995
Kilometers per Block-Wide Survey (50% wells)	303	1988-1995	303	1988-1995
Total Support Activities for Exploration Phase				
Helicopters (maximum)	6	1991-1994	6	1991-1994
Maximum Flights per Month Between Shorebase (or Barrow Airport) and Platform (1 flight/day/platform)	124	1991-1994	124	1991-1994
Ice-Management Vessels--per Year	6	1989-1996	6	1989-1996
Barges--per Year	1-8	1989-1996	1-8	1989-1996
DEVELOPMENT				
Shorebase--Located at Point Belcher				
Total Hectares	25-30	1996-1998	25-30	1996-1998
Total Cubic Meters of Gravel	500,000	1995-1998	500,000	1995-1998
Construction of an Airstrip	1,900	1996	1,900	1996
Construction of a Road Between Point Belcher and Wainwright--Kilometers	20-25	1995	20-25	1995
Possible Dredging of a Channel in Peard Bay (depth in meters)	5	1995	5	1995

Table II-1
Chukchi Sea Sale 109
Summary of Mean-Case Scenario Assumptions for the Proposal and Deferral Alternatives

	Alternatives I, IV, and V		Alternative VI	
PHASE Facility or Event	Number or Amount	Timeframe	Number or Amount	Timeframe
DEVELOPMENT (continued)				
Development Work Force--Peak Year	5,047	1998	4,500	1998
Platforms--Bottom-Founded	9	1997-1998	7	1997-1998
Wells	153	1997-1999	128	1997-1999
Drilling Muds and Cuttings Disposed--Dry Metric Tons				
Maximum Total Muds	68,005	1997-1999	56,832	1997-1999
Maximum Total Cuttings	212,363	1997-1999	177,664	1997-1999
Muds per Well (depends on amount recycled)	91-444	1997-1999	91-444	1997-1999
Cuttings per Well	1,388	1997-1999	1,388	1997-1999
Seismic Activity				
Total Number of Days	300	1995-1998	233	1995-1998
For Platforms				
Total Trackline Kilometers (3-dimensional, deep-penetration)	8,783	1996-1997	6,831	1996-1997
Area Covered per Platform--Square Kilometers	57	1996-1997	57	1996-1997
For Pipelines				
Total Trackline Kilometers (shallow-hazard)	1,609	1995-1997	1,609	1995-1997
Total Support Activities for Development Phase				
Helicopters	4-5	1997-1999	3-4	1997-1999
Flights per Day per Platform	1-3	1997-1999	1-3	1997-1999
Total Flights per Month	270-810	1997-1999	90-360	1997-1999
Work Boats	8-10	1997-1999	6-8	1997-1999
Round Trips per Day per Platform	1-2	1997-1999	1-2	1997-1999
Total Round Trips per Month	270-540	1997-1999	180-480	1997-1999
Barges--Peak Year	68	1998	58	1998
PRODUCTION				
Production Work Force--Peak Year	2,392	2003-2010	2,150	2003-2010
Peak Oil Production				
Yearly--Million Barrels	225	2000-2005	188	2001-2005
Daily--Barrels	616,438	2000-2005	515,068	2001-2005
Total Oil Produced--Million Barrels	2,680	1999-2017	2,240	1999-2017
Total Support Activities for Production Phase				
Helicopters	3	1999-2017	3	1999-2017
Maximum Flights per Month Between Shorebase and Platforms	75	1999-2017	60	1999-2017
Support/Supply Boats	3	1999-2017	3	1999-2017
Barges per Year--Average	13	2000-2017	13	2000-2017

Table II-1
Chukchi Sea Sale 109
Summary of Mean-Case Scenario Assumptions for the Proposal and Deferral Alternatives
(Page 3 of 3)

PHASE Facility or Event	Alternatives I, IV, and V Number or Amount	Alternatives I, IV, and V Timeframe	Alternative VI Number or Amount	Alternative VI Timeframe
TRANSPORTATION				
Pipelines (pipelines from the platforms would converge offshore and come onshore at Point Belcher)				
Onshore Pipeline to TAP Pump Station No. 2--Kilometers	640	1995-1998	640	1995-1998
Support Road--Kilometers	640	1995-1998	640	1995-1998
Helicopter Pads	10-12	1995-1998	10-12	1995-1998
Major River Crossings (Approx.)	10	1995-1998	10	1995-1998
Offshore Trunk Pipelines--Kilometers	400	1996-1998	400	1996-1998
Area Disturbed During Offshore-Pipeline Laying 1/				
Trenching--Hectares	946	1996-1998	946	1996-1998
Dumping--Hectares	1,892	1996-1998	1,892	1996-1998
Total Hectares	2,838	1996-1998	2,838	1996-1998
Maximum Volume of Fill Material--Cubic Meters	28,090,000		28,090,000	
OIL SPILLS				
Assumed for Analysis				
Offshore 2/				
<1,000 Barrels	777 3/		650 4/	
≧1,000 Barrels	7		5 or 6	
≧100,000 Barrels	0		0	
Onshore 5/				
2-23 Barrels (average size 6 barrels)	121		121	
24-239 Barrels (average size 98 barrels)	45		45	
>239 Barrels (average size 1,500 barrels)	22		22	

Source: MMS, Alaska OCS Region.

1/ Assumptions used to arrive at the area disturbed during pipeline laying are as follows:
(a) Side slopes assumed 1:2 (Hemphill, 1986, oral comm.).
(b) 5 kilometers placed between the 10- and 20-meter isobaths, trench depth = 3 meters (Han-Padron, 1985).
(c) 20 kilometers placed between the 20- and 30-meter isobaths, trench depth = 5 meters (Han-Padron, 1985).
(d) 375 kilometers placed between the 30- and 50-meter isobaths, trench depth = 6 meters (Han Padron, 1985).

2/ Oil-spill assumptions include all offshore spills north of the Bering Strait during exploration and production.

3/ Total volume of small spills is 3,140 barrels; the average spill size is 4.0 barrels.

4/ Total volume of small spills is 2,630 barrels; the average spill size is 4.0 barrels.

5/ Calculated from projected pipeline-spill statistics for the National Petroleum Reserve-Alaska (USDOI, BLM, NPR-A, 1983).

Table II-2
Chukchi Sea Sale 109
Summary of Resource Estimates

	Resource Estimate (billion barrels of oil)
The Proposal (Alternative I)	2.68
Eastern Deferral Alternative (Alternative IV)	2.68
Southern Deferral Alternative (Alternative V)	2.68
Coastal Deferral Alternative (Alternative VI)	2.24
Low-Resource Case	0.96
High-Resource Case	4.88

Source: MMS, Alaska OCS Region.

Table II-3
Chukchi Sea Sale 109
Estimated Schedule of Exploration, Development, and Production for the Mean-Case Resource Estimate

SALE YEAR	CAL. YEAR	EXPLORATION WELLS	DELINEATION WELLS	EXPLORATION/ DELINEATION DRILLING UNITS	PRODUCTION PLATFORMS[1/] AND EQUIPMENT	PRODUCTION AND SERVICE		TRUNK PIPELINES[2/] (Kilometers)		NUMBER OF SHOREBASES[3/]	PRODUCTION (MMbbls)
						Wells	Rigs	Offshore	Onshore		
0	1986										
1	1987										
2	1988									1.0	
3	1989	2		2							
4	1990	2		2							
5	1991	4	4	4							
6	1992	4	4	4							
7	1993	4	4	4							
8	1994	4	4	4							
9	1995		4	2					80		
10	1996		3	2				120	200	.3	
11	1997				4	12	2	120	200	.3	
12	1998				5	71	8	160	160	.4	
13	1999					70	7				67
14	2000										225
15	2001										225
16	2002										225
17	2003										225
18	2004										225
19	2005										225
20	2006										198
21	2007										174
22	2008										153
23	2009										129
24	2010										110
25	2011										96
26	2012										86
27	2013										78
28	2014										70
29	2015										62
30	2016										56
31	2017										51
Total		20	23		9	153		400	640	2	2,680

Source: USDOI, MMS, 1985d (E&D Report).

1/ Platform-placement years on the schedule represent the final placement of the platform on location. Design and construction of the platform is expected to require 3 or 4 years.
2/ It is assumed that up to two pipe-laying spreads would be used to obtain the yearly lay rates shown for offshore installation.
3/ The 1.0 represents expenditures for an exploration base during year 2; the fractions .3, .3, and .4 during years 9, 10, and 11 represent expenditure percentages to construct a shorebase.

Floating Drilling Units: Drillships can be used in waters deeper than 16 meters (AOGA, 1987). The major disadvantage of the present class of ice-strengthened drillships is that they can operate for only a relatively short period of time because of ice conditions in the sale area. For the purpose of this scenario, it is assumed that ice presence would limit the average length of time that ice-strengthened drillships, typically supported by an icebreaker and two icebreaking supply vessels, could operate in the Chukchi Sea to about 90 days--primarily August, September, and October (Stringer, Zender-Romick, and Groves, 1982; Truett, 1984). The average time for operating could be reduced further if restrictions on downhole operations were imposed during the fall bowhead whale migration (September through November) or gray whale feeding periods (June through October). However, considerable differences exist in the duration of the open-water period between the southern and northern portions of the sale area, and conditions can vary from year to year. In average years, ice breakup in the southern Chukchi Sea begins in mid-June. Open-water conditions in the Chukchi Sea typically prevail by August. Freezeup in the northern Chukchi Sea usually begins in late October and rapidly continues southward (Truett, 1984) (see Sec. III.A.4 for details). A drillship generally would be able to drill and test one well per season. Wells not completed in one drilling season could be temporarily abandoned when sea-ice conditions force the drillships to leave the drill sites. These wells could be re-entered, and drilling could be resumed during the next season.

The Kulluk, a Conical Drilling Unit (CDU), is another floating unit available for drilling in arctic waters 16 to 60 meters deep (AOGA, 1987). It was designed to break ice up to about 1 meter thick. With an icebreaking capability and a conical shape, a CDU such as the Kulluk should be able to drill and test up to two wells during its expected operational period.

Ice-strengthened, floating units would not overwinter in the sale area. Existing units are not designed to withstand the forces of thick, multiyear ice; and there are no harbors along the Alaskan Chukchi Sea coast where drillships or other relatively deep-draft vessels could move during the winter. To achieve the longest drilling season, drillships would enter and depart the sale area from the south. Breakup occurs earlier and freezeup later in the southern portion of the Sale 109 area. The presence of ice close to shore in the northern portion also is extended as a result of the convergence of the westward-drifting pack ice of the Beaufort Sea at Point Barrow.

Bottom-Founded Drilling Units: Bottom-founded mobile drilling units rest either on the seafloor or on manmade berms. The Concrete Island Drilling System (CIDS) is placed directly on the seafloor in water depths of 10.5 to 18 meters (AOGA, 1987). A steel mat, permanently incorporated into the Single Steel Drilling Caisson (SSDC) in 1986, increased the operating depth to 23 meters (AOGA, 1987). Operating depth can be further increased if the SSDC is placed on a gravel berm (Tenneco Oil, 1985). The SSDC has been used in the Canadian Beaufort Sea shear (stamukhi) zone, the CIDS in 15 meters of water in the Alaskan Beaufort Sea. However, CIDS technology can be extended to water depths of 30 meters. Both units use seawater as ballast; both have onboard monitoring systems to give an indication of sea-ice pressures and forces; and both can create grounded-ice barriers around the unit to dissipate the forces of moving sea ice. Drilling from these units can occur year-round. Crews for moving bottom-founded mobile drilling units to new locations could be on site approximately 2.5 months during the ice-free season, depending upon the amount of time needed to prepare the site for the unit (Han-Padron, 1985). The actual move could take between 1 and 2 weeks.

Monocone-type structures are mobile bottom-founded units that have been designed (but not yet constructed) for water depths and ice conditions prevalent in the Chukchi Sea (Han-Padron, 1985; Machemehl, 1985). These units probably would become the primary type of drilling platform for exploring in the Chukchi Sea. Considering how quickly the CIDS was constructed (9 months), these units should be operating by the fifth year after the proposed sale. The speed of construction would vary for a variety of reasons, such as waiting for the results of design tests and arranging complex financing and use agreements if a number of companies joined together to finance the unit.

Artificial Islands: The use of artificial islands, or more likely caisson-retained islands such as the Mobile Arctic Caisson (MAC), would be limited by water depth, sources of fill material, and availability of equipment to handle the fill material. In general, when a borrow site is more than 10 kilometers from the drill site and water depths are greater than 24 meters, bottom-founded units are more cost effective than gravel islands (Han-Padron, 1985); this conclusion was based on the costs of using large-capacity dredges with ice-strengthened hulls in the Alaskan Beaufort Sea. Only a small part of the sale area is shallower than 24 meters. Since most of the seafloor suitable for island construction lies inside the 3-geographical-mile offshore boundary that separates Federal and State areas of jurisdiction, artificial islands are more likely to be built in State waters following State Lease Sales 53 and 60, scheduled for September 1987 and May 1990, respectively. The use of gravel islands is not assumed for this sale.

(3) Shallow-Hazard Seismic Activity: High-resolution seismic-reflection data are needed for site clearance for each well. Based on past experience, it is assumed that one half the well sites would be covered by a site-specific survey that generates 63 trackline kilometers (39 statute miles) of data; the remaining sites would be covered by a block-wide survey that generates 303 trackline kilometers (188 statute miles) of data. These surveys usually are conducted 1 year prior to drilling. Surveys would be done during the open-water period, probably concentrated in August and September. The average time needed to survey each site is 1 week, allowing downtime for bad weather and equipment failure. For the purposes of this EIS, site-specific surveys are assumed to be conducted for 21 of the exploration- and delineation-well sites and block surveys are assumed for 22 exploration- and delineation-well sites. The total trackline distance would equal 7,979 kilometers (4,955 statute miles) (USDOI, MMS, 1986b).

(4) Muds and Cuttings: The average exploration well is assumed to use approximately 599 dry metric tons of mud; total muds used would equal 11,975 dry metric tons (Petrazzuolo, 1983, as cited in USDOI, MMS, 1985d). Approximately 1,361 dry metric tons of drill cuttings per exploration well also are assumed to be produced; total cuttings would equal 27,215 dry metric tons (Crockford, Gardner, and Worral, 1975, as cited in USDOI, MMS, 1985d). Delineation wells are assumed to require only 454 dry metric tons of mud per well, or 10,433 dry metric tons total. Cuttings are assumed to equal

1,179 dry metric tons per well, or 27,125 dry metric tons total. Total muds and cuttings for exploration and delineation would equal 22,408 dry metric tons for muds and 54,340 dry metric tons for cuttings.

(5) Support for Exploration Activities: The following assumptions for supporting exploration activities are speculative. They reflect what has been done in the past, but a number of factors could change in the future. Both types of exploratory drilling units--drillships and bottom-founded units--store drilling supplies for one to three wells. It is assumed that drillships would be resupplied while in port during the winter season. Bottom-founded units are assumed to be resupplied during the open-water season; supplies would be offloaded from barges directly onto the drilling unit (see Table II-4 for details on barge requirements). In the Beaufort Sea, resupply typically occurs when drilling has been shut down during the whale migrations. Groceries and emergency supplies would be transported by helicopter. As a result, the requirement for supply boats to be maintained in the area probably would be quite limited and could be fulfilled by the ice-management vessels that support drillship operations. This would minimize the amount of onshore support activity and investment in permanent facilities and equipment (ERE Systems, Ltd., 1984).

One icebreaker and two ice-strengthened support/supply boats generally have been used in the Beaufort Sea to support each drillship operation; a comparable level of support is assumed for the Chukchi Sea. Three to six tugs would be required to relocate bottom-founded units (AOGA, 1985); tugs assisting with the sealift probably would be used. Icebreaker assistance could be needed in years with unusual ice conditions. Between 1991 and 1994, four drilling units would be in use. Only two drillships are likely to be operating during any single season; the remaining units would be bottom-founded. A maximum of six ice-management/support vessels are assumed to be in the area during exploration (1989-1996) (see Table II-1). These vessels are assumed to accompany a drillship into the lease area in August and depart in October, assuming typical ice conditions and the present class of drillships. Any unit used for year-round drilling would require extended support for personnel and equipment. Most of this support could be handled with helicopters. However, icebreaking work/supply boats, air-cushioned vehicles, and rolligons also could be used.

Air support would be used primarily for crew changes, delivery of perishable goods, and visits by inspection personnel. For most of the sale area, personnel and air freight are assumed to be transferred to helicopters at either the Barrow or Wainwright airport. Barrow's paved airport, equipped with a complete instrument-landing system, is owned and operated by the State and has regularly scheduled, daily jet service as well as air-taxi service. The airport has a control tower, passenger terminal, cargo building, office buildings, and minor repair services; fuel and oil are available. Wainwright's new gravel airfield is owned and operated by the North Slope Borough. The existing facilities at Barrow and Wainwright are adequate to handle the projected needs during exploration. Military airfields also are available in both communities. If the airfields at Barrow and Wainwright are too far north to support exploration, the abandoned airstrips at Icy Cape or Cape Beaufort could be upgraded; or the Kotzebue airport could be used. Like Barrow, Kotzebue is a trunk airport with regularly scheduled jet service and airport facilities. Arrangements also could be made to use the U.S. Air Force airstrip at Point Lay. Based on exploration practices elsewhere in Alaska, a minimum of one helicopter per drilling unit with a minimum of one additional helicopter for every two drilling units generally are assumed to be used to service drilling in the sale area; thus, four to six helicopters are assumed to service the Sale 109 area (AOGA, 1985; ERA Aviation Center, Inc., 1985, oral comm.).

During the years of maximum exploration effort (1991-1994), six helicopters would be dedicated to use in the sale area. One helicopter trip per day per platform is assumed (see Table II-1).

Estimates on the number of work-months of direct OCS employment for each unit of work during the exploration phase are given in Table II-5. (The number of work units projected for the exploration phase of the proposal are given in Table II-3. The detailed assumptions used to derive the per-unit estimates are given in Appendix F, Table F-1.)

Portable housing and ancillary facilities for onshore support personnel and a workshop and warehouse would require approximately 10 hectares (Han-Padron, 1985). These facilities probably would be located near the Wainwright airport.

b. Development and Production: As noted in the introduction, the assumptions on timing and development strategies are highly speculative. The scenario described here is merely characteristic of the type of development that would accompany production. Work on offshore and onshore production and transportation facilities would not begin until the engineering and economic assessments of the potential reservoirs have been completed and the conditions of all the permits have been evaluated. The initial discovery of Sale 109 oil is projected to occur in the fourth year of the lease; the first delineation well is projected to be drilled in 1991. Production is assumed to peak between 2000 and 2005 at 225 million barrels a year and cease in 2017.

(1) Timing of Drilling: Production activities are projected to begin in 1994 with the design and initiation of construction of the production platforms. Installation of the first four production platforms is assumed to occur in 1997 (Table II-3). The remaining five production platforms are assumed to be installed in 1998. Wells are assumed to be drilled from 1997 through 1999, the year production is assumed to begin. The pipeline for the mean-case scenario is assumed to be laid from 1995 through 1998 and onshore support facilities constructed from 1996 through 1998. This timing reflects simultaneous development of the resources, average weather and ice patterns, and no delays for permit issuance or litigation.

(2) Production Platforms: Production platforms used to produce oil from the sale area probably would be structures that rest on the seafloor. For example, the National Petroleum Council (NPC) (1981) considers that monocone-type structures would be used as production platforms in the sale area. Han-Padron (1985) envisions a Conical Drilling Structure in the Beaufort Sea. Because the design was developed for Arctic conditions, the design concept probably could be transferred into the Chukchi Sea. Construction and outfitting of the platforms would occur in ice-free harbors in the North Pacific Ocean. After staging, the platforms would be towed and in-

Table II-4
Barge Requirements for Exploration, Development, and Production in the Chukchi Sea Planning Area

	Drilling Support[1/] Dry Goods	Drilling Support[1/] Fuel	Transporting Offshore Pipeline[2/]	Transporting Onshore Pipeline[3/]	Transporting Facility Modules[4/]	Total Annual Number of Barges
1989	0[5/]	0			1[6/]	1
1990	0	0			1	1
1991	2[7/]	1			2	5
1992	3	2			3	8
1993	3	2			3	8
1994	3	2			3	8
1995	2	1		6[8/]	8	17
1996	2	1	5	6	13	27
1997	6	3	5	4	15	33
1998	22	14	5		27	68
1999	21	14			21	56
2000-2017	13 per year[9/]					13 per year

Source: MMS, Alaska OCS Region.

1/ During the exploration/delineation phase, supply techniques would be similar to those of the CIDS used in the Beaufort Sea and the remote support systems used in the Navarin Basin. In 1985, the CIDS was resupplied by 1 large barge from the sealift and 2 small barges from Prudhoe Bay. For one operation in the Navarin, the weight of dry goods used for each of 5 wells would have required approximately 75% of the barge capacity (4,373 metric tons) typically used for the sealift (ERE Systems, Ltd., 1984). Fuel supplies required two-thirds the number of barges as the dry goods.

With the onset of major movements of drilling supplies for production, different types of barges would be used; i.e, special barges are available for handling pipe for lay barges. Similar dedicated barges could be used, especially those that offload directly onto production platforms, where draft is not a problem; thus, barge requirements could be halved. 1997 would be a transition year from use of smaller, general-purpose barges to larger barges dedicated to delivering various categories of drilling supplies to offshore platforms.

2/ Five barges were required to support lay-barge operations for the Statpipe Pipeline System in the North Sea. In this project, 111 kilometers of pipeline were laid during the first year and 165 kilometers during the second (Akten et al., 1985). The length of pipeline projected to be placed offshore each year in the Chukchi Sea is within these limits; therefore, 5 barges are assumed for this operation.

3/ Barge requirements for delivering onshore pipe are based on the average barge capacity of 4,373 metric tons, typical of other barges loaded for onshore support activities (ERE Systems, Ltd., 1984).

4/ The number of barges historically needed for transporting prefabricated units has totaled the number used for dry drilling supplies, including pipelines (Berger, 1984, as cited by ERE Systems, Ltd., 1984). This was modified slightly for the years 1989 and 1990 and for the years 1999 through 2017 (see 5/and 9/).

5/ Drillships are loaded while in port during the winter; therefore, no supply barges for drilling supplies are needed for the years 1989 and 1990.

6/ If constructed during exploration, this shorebase would be limited to some sheds for temporary storage and possibly a bunkhouse and an office. One bargeload should be adequate for these needs.

7/ Because 1991 is the first year in which the bottom-founded units would be used, they would arrive in the Chukchi Sea partially loaded.

8/ One-half the pipeline requirements for onshore pipelines would be delivered by barge, using barges typical for the sealift (see 3/). Pipeline for onshore construction would be delivered 1 year prior to installation (ERE Systems, Ltd., 1984).

9/ Limitations on maritime shipping are similar for the Beaufort and Chukchi Seas. Therefore, the split between marine and truck shipping is considered comparable for the two areas. Once production began at Prudhoe Bay, barge traffic ranged from a low of 2 barges in 1979 to a high of 26 barges in 1983 and averaged about 13 per year. Therefore, the number of barges used during production in the Chukchi Sea also is assumed to be 13.

Table II-5
Direct-Employment Assumptions for Sale 109 by Type of Work

Type of Work	Total Work-Months per Unit of Work
EXPLORATION	
Drilling an Exploration or Delineation Well (includes drilling crew; helicopter, supply-boat, and longshoring support; and other on-shore work)	921
Constructing an Exploration Shorebase	1,600
Operating an Exploration Shorebase (1 year)	240
Conducting a Geological-Geophysical Survey	180
DEVELOPMENT	
Constructing a Production Island	2,700
Installing a Production Platform and Equipment (includes installation crews; helicopter, tugboat, supply/anchor-boat, and longshoring support; and other onshore support)	7,520
Drilling a Production or Service Well	112
Laying Offshore Oil Pipe (160 km) (includes lay-barge crews; helicopter, tugboat, supply/anchor-boat, and longshoring support; and other onshore support)	2,907
Laying Onshore Oil Pipe (160 km)	6,667
Constructing a Production Shorebase	2,400
Constructing an Onshore Pump Station	1,600
PRODUCTION	
Operating a Production Platform (1 year) (includes platform crews; helicopter, tugboat, supply/anchor-boat, and longshoring support; and other onshore support)	2,616
Annual Maintenance of a Production Platform	80
Well Workovers for an Oil Platform	120
Operating a Production Shorebase (1 year)	960

Source: Dames and Moore, 1982, and MMS, Alaska OCS Region.

stalled during the open-water period. Drilling of the development wells could begin after 50 percent of the facility hookup was complete and while production facilities were being readied for operation (AOGA, 1985; Exxon Company U.S.A., 1985).

(3) Seismic Activity: A deep, three-dimensional, multichannel seismic-reflection survey would be conducted for each of the nine production platforms. Surveys for each platform are assumed to cover approximately 57 square kilometers (22 square miles). Assuming a tight grid pattern on 76-meter (250-foot) centers, each platform would require a survey of 975 trackline kilometers (606 statute miles) or a total of 8,783 trackline kilometers (5,454 statute miles) for all nine platforms.

High-resolution seismic-reflection data (HRD) 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 pipeline assumed for the scenario, would equal 1,609 kilometers (1,000 statute miles).

(4) Muds and Cuttings: The average total amount of mud assumed to be used for drilling production wells would range from approximately 154 dry metric tons per well (80% recycled) to 508 dry metric tons per well (20% recycled). The average "net" mud disposed of after production-well drilling is assumed to range from approximately 91 dry metric tons per well to 444 dry metric tons per well, depending upon the amount recycled. An average of 1,388 dry metric tons of drill cuttings are assumed to be produced by each production well. The maximum amount of muds discharged for all 153 production wells drilled is assumed to be 68,005 dry metric tons; the total amount of drill cuttings would be 212,363 dry metric tons.

(5) Support for Production Activities: As delineation drilling continues, support for the upcoming development of the field would shift to Point Belcher. This site was identified by the National Petroleum Council (NPC) as a likely site for a pipeline landfall (NPC, 1981). It is assumed for this scenario that oil fields developed in the Chukchi Sea would be located so that Point Belcher would be a viable onshore location. An advantage to locating the landfall at Point Belcher is its proximity to Barrow, Wainwright, and the western portion of the proposed Beaufort Sea Sale 97 area. Airfields and facilities in these communities would provide alternatives in case of emergencies and also enable the shift from existing to new infrastructure to occur more gradually, but in sufficient time to prevent overtaxing the infrastructure in those communities. A road connection between the support base and Wainwright would facilitate the shift.

The 25- to 30-hectare hypothetical service base at Point Belcher is assumed to provide base-camp facilities for development drilling and pipeline laying. A 1,900-meter airstrip is assumed to be constructed to serve the facility. Gravel bases for all the facilities assumed in the scenario probably would require approximately 500,000 cubic meters of gravel (Han-Padron, 1985). In addition to housing, the camp is assumed to have facilities for eating, recreation, health care, laundry, and offices. The service base is assumed to have storage for drilling, pipelaying, and other construction needs; facilities for maintaining onshore and offshore equipment and infrastructure; utilities; and onshore support for produced oil, such as pumping stations and storage. Prefabricated modules for the hypothetical shorebase would be delivered to Point Belcher by barges (see Table II-4). In 1998, the year of peak barge activity, 68 barges are assumed to be included in the Chukchi sealift. About one-half of these barges are assumed to offload directly onto a production platform.

If a shorebase were constructed at Point Belcher, barges could be offloaded either on the beach at Point Belcher or in Peard Bay. Use of Peard Bay is not assumed because of the potential that Peard Bay is underlain with permafrost and construction of marine facilities or moorage areas in Peard Bay is dependent upon deepening a channel across the sill to the center of the bay, where the water depth is adequate. Dredging in areas of permafrost may lead to subsidence along the shoreline; therefore, dredging of the channel would be possible only if the area to be dredged were free of permafrost. If Peard Bay is used for marine support, a road would be constructed between Peard Bay and Point Belcher.

Installation and hookup of the production platforms during the development stage would be supported by two supply boats and one helicopter per platform (Dames and Moore, 1982; Whitely, 1985, oral comm.). A total of eight workboats and four helicopters would be used in the sale area during the 11th year (1997), and ten workboats and five helicopters the following year. Supplies would be transported by barges to the Chukchi Sea (see Table II-4). During production, two icebreaker support/supply boats and two helicopters would be dedicated to the sale area; an additional support/supply boat and helicopter would be available for backup.

Estimates on the number of work-months of direct OCS employment for each unit of work during the development and production phase are given in Table II-5. (The number of work units projected for the development and production phase of the proposal is given in Table II-3. The detailed assumptions used to derive the per-unit estimates are given in Appendix F, Table F-1.)

c. Transportation: Three basic options are apparent for transporting oil to market: offshore loading, nearshore loading from an onshore terminal, and a pipeline to the trans-Alaska pipeline (TAP). An offshore-loading transportation scenario was selected for the low-resource estimate, and a nearshore-loading scenario was selected for the high-resource estimate (Sec. II.G). A pipeline to the TAP was selected for the proposal's scenario to transport the conditional mean resource of 2.68 billion barrels (see Fig. II-2). A study by Han-Padron (1985) estimated the costs of these options for transporting oil from the Beaufort Sea and indicated that the most economic choice would be the TAP. Use of the TAP has several advantages: (1) large quantities of oil could be transported; (2) under normal conditions, no produced oil would be stored offshore; (3) the technology for laying onshore pipelines in the arctic is known; (4) current North Slope Borough (NSB) "best-efforts" land management policies prohibit development that accommodates petroleum transportation via marine tankers (NSB 19.80.031[j]); and (5) once the pipeline was onshore, future risks to marine mammals in the arctic would be virtually eliminated. This option is hypothesized in OCS Report MMS 85-0013 (the Beaufort Sea Sale 97 scenario) (Roberts, 1985). Economic disincentives to use of the TAP typically are related to the assumption that a second pipeline would need to be constructed parallel to the existing pipeline, and that future tariffs would continue at current levels. This scenario assumes adequate capacity within the existing pipeline and relies on the fact that not all firms consider the tariff on the TAP to be a drawback to its use (Exxon Company, U.S.A., 1985). Construction costs for the pipeline to the TAP could be moderated if they were shared by companies interested in transporting oil from the western Beaufort Sea and the National Petroleum Reserve-Alaska (NPR-A) to the TAP.

The 1,040-kilometer pipeline, installed between 1995 and 1998, is assumed to come onshore in the vicinity of Point Belcher and continue approximately 640 kilometers eastward to TAP Pump Station No. 2. More specifically, the pipeline would follow the best alignment from the landfall site to approximately the 200-meter contour (generally north of the east-west segment of the Kigalik River and Maybe Creek), cross the Colville River near Umiat, and connect with the TAP at Pump Station No. 2 (see Fig. II-2). Approximately 10 rivers and large tributaries would be crossed. The pipeline route would vary if production within the NPR-A or the Beaufort Sea could be facilitated or gravel sources were better or more accessible with a different alignment. Gravel sources are fairly limited in the northern portion of the NPR-A. Potential sources of gravel would be abandoned stream channels above flood stage, especially in the drainages of the Ikpikpuk River, and quarried bedrock, especially in the foothills. A potential gravel source near Point Belcher would be old beach deposits or old alluvial terraces around the Kuk River. The road that parallels the pipeline to Pump Station No. 2 is assumed to be maintained as a private road. Approximately 10 to 12 helipads are assumed to be built.

Helipads typically would be located at each construction camp along the route (located about every 100 km) and at each pump station. At least one helicopter flight a day to each camp that is active is assumed. Four onshore pump stations are assumed for the new pipeline; one offshore booster station possibly would be required. Installation of the hypothetical 400-kilometer offshore pipeline by bottom-tow or lay barges is considered feasible (NPC, 1981; Han-Padron, 1985). Assuming that a lay barge is used, the period of time during which the barge could operate in the northeastern Chukchi Sea could be limited to about 70 days; but operations could be extended with icebreaker support (Dames and Moore, 1982; Han-Padron, 1985). The season also could be extended if large semisubmersible or ship-shaped lay barges were ice-strengthened and had a modified mooring system for operating in ice, a heat-recovery system, and enclosed work areas (Han-Padron, 1985). The shoreward end of the offshore pipeline could be laid during the winter from the ice in the landfast-ice zone. Pipe supplies for the offshore segment would arrive with the lay barge.

Subsidence along an offshore pipeline route is not expected to be a major problem. The soils of the Chukchi Sea tend to be well consolidated. However, during the seismic survey for the pipeline, if soils were found that were potentially susceptible to subsidence resulting from permafrost degradation, the pipeline probably would be coated with a layer of insulation to retard the subsidence (Swanson, 1986, oral comm.).

To protect the pipe from collisions with drifting ice masses, the pipeline is assumed to be laid in a trench cut into the seafloor. Gouging can occur in relatively deep water in the sale area, exceeding 60 meters in rare instances. Ice gouges are generally found in water less than 54 meters deep and decrease in frequency to the south. Ice gouges 4.5 meters deep have been recorded in water 36 to 40 meters deep; in waters shallower than 30 meters, ice gouges are rarely more than 3 meters deep (Truett, 1984). Pipeline placement below the level of ice gouging would be required in the areas where ice gouging could occur. In addition, if the trench were laid in unconsolidated sediments of the seafloor where ice scouring is evident, the pipeline might have to be covered with fill material. In areas where the sediment layer is thin or absent, the trench might have to be cut into the bedrock; a pipeline laid in a bedrock trench might not have to be covered.

During installation approximately 28 million cubic meters of subsea material is assumed to be excavated. Trenching would disturb 946 hectares and deposition of material would cover 1,892 hectares.

Pipelines from the nine platforms are assumed to converge offshore and come onshore at one landfall site. The onshore pipeline section could be buried beneath the beach or in a berm, or it could rise over the shoreline on a truss structure supported by columns.

B. Alternative II - No Sale

This alternative would eliminate the entire area proposed for leasing from further consideration. Table II-6 shows the amount of energy needed from other sources to replace the anticipated oil production from the proposal. (See also Appendix H, Alternative Energy Sources as an Alternative to the OCS Program.)

C. Alternative III - Delay the Sale

This alternative would delay the proposed sale for a 2-year period.

D. Alternative IV - Eastern Deferral Alternative

1. Description of Alternative IV: This alternative would remove from the Sale 109 area 488 whole and partial blocks (about 993,028 hectares) located along the Chukchi Sea coast from about 39 kilometers northeast of Peard Bay to 5 kilometers south of Kasegaluk Lagoon in a band from 5 to 48 kilometers wide (see Fig. II-1). The Eastern Deferral Alternative was designed to protect subsistence-harvest areas of the residents of Wainwright and Point Lay and the subsistence-harvest areas of Barrow and Atqasuk that occur within the boundaries of the proposal. Subsistence activities in the sale area are conducted primarily within 32 kilometers of shore. This alternative excludes the areas of high subsistence use in the sale area for the communities of Barrow, Atqasuk, Wainwright, and Point Lay and creates a buffer of 8 to 16 kilometers around these areas. Important subsistence resources harvested by the residents of these communities include caribou; bowhead whales in all communities except Point Lay and Atqasuk; beluga whales in Point Hope and Point Lay; fishes; ringed, bearded, and spotted seals; birds; walruses; and polar bears. Bowhead whales pass through this deferred area during their spring migration to the eastern Beaufort Sea; during their fall migration toward the Russian coast, at least a portion of the population passes through the area as far south as Point Belcher. Some gray whales (which are not a subsistence resource) spend the summer in the Chukchi Sea rearing their calves and feeding; several hundred have been seen around Point Belcher.

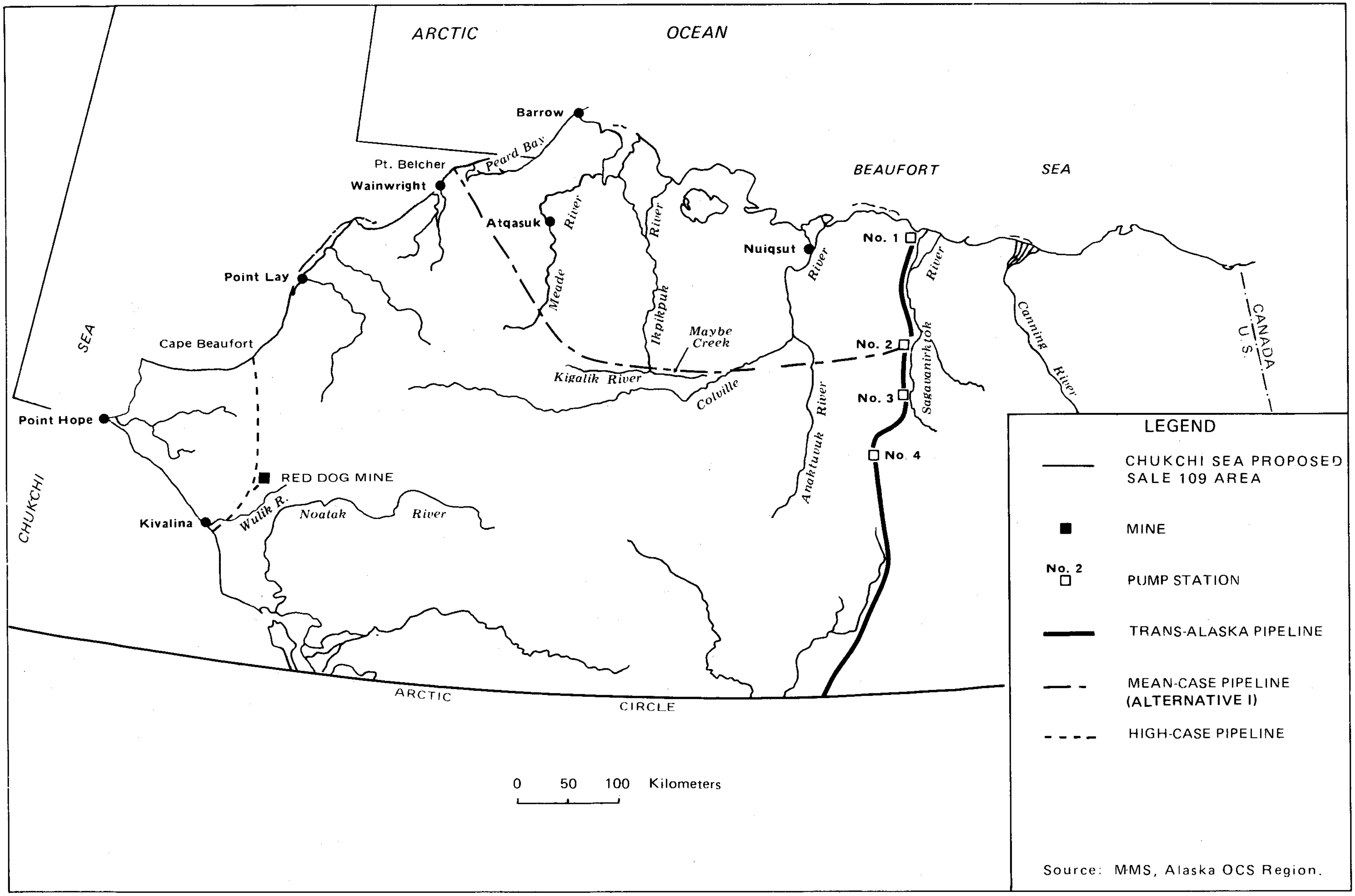


FIGURE II–2. HYPOTHETICAL ONSHORE-TRANSPORTATION ROUTES FOR PRODUCED CHUKCHI SEA OIL

Table II-6
Energy Needed From Other Sources to Replace Anticipated
Oil Production From Proposed Chukchi Sea Sale 109
(Mean Level of Resources If Resources Are Found)

	Billions
Total Crude Oil Production (barrels) (19-year production schedule)	2.68
Crude Oil BTU Equivalent at 5.6 x 10^6 BTU/bbl (BTU)	15,000,000
<u>Alternative-Energy-Source Equivalents</u>	
Oil (bbls)	2.68
Gas (cf)	14,500
Coal (tons)	
Anthracite[1/]	.590
Bituminous[2/]	.573
Sub-bituminous[3/]	.789
Lignite[4/]	1.12
Oil Shale (tons)[5/]	3.83
Tar Sands (tons)[6/]	3.57
Nuclear (Uranium Ore) (tons)	
Light Water Reactor[7/]	0.050
Breeder Reactor[8/]	0.00036

Sources: As indicated in the footnotes below.

1/ 25.4 x 10^6 BTU/ton (Williams and Meyers, 1976, p. 115).
2/ 26.2 x 10^6 BTU/ton (Ibid.).
3/ 19.0 x 10^6 BTU/ton (Ibid.).
4/ 13.4 x 10^6 BTU/ton (Ibid.).
5/ .7 barrels/ton (Science and Public Policy Program, 1975, pp. 2-3).
6/ 4.2 x 10^6 BTU/ton (Ibid., pp. 5-3).
7/ 100,000 tons of ore = 1,000 Mwe = 3 million tons of coal at 10,000 BTU/lb (Ibid., pp. 6-9.).
8/ Uses U-238 isotope, constituting 99.29 percent of naturally occurring uranium. LWR uses U235 isotope, constituting 0.71 percent of naturally occurring uranium.

2. Activities Associated With Alternative IV: Deferring this area would not alter the scenario from that used for the proposal. (See Table II-1 and Sec. II.A.2 for a complete description.) The conditional resource estimate and marginal probability of discovering mean economically recoverable oil remain the same for the Eastern Deferral Alternative as for the proposal, in which the conditional mean estimate of economically recoverable oil is 2.68 billion barrels and the marginal probability of finding economically recoverable oil is 0.20. The timeframe for development also is assumed to remain the same (see Table II-7). During exploration and delineation, 43 wells are assumed to be drilled between 1989 and 1996. Production platforms would be placed in 1997 and 1998 and wells drilled between 1997 and 1999. Pipelines would be laid between 1995 and 1998. Additional assumptions include: production would begin in 1999, peak in 2000, and cease in 2017, and peak production of 225 million barrels per year would occur between 2000 and 2005.

Infrastructure assumptions also remain the same. Point Belcher is assumed to be the site of the shorebase and landfall, even though the area to be deferred includes that offshore of Point Belcher. Subsea pipelines to Point Belcher would originate from platforms outside the deferred area (over 400 km of trunk pipeline are assumed). These platforms would influence the location of the landfall, and they would not be altered by the deferral.

3. Evaluation of Alternative IV: The analysis in Section IV.B of this EIS shows that under this alternative, air quality of the shoreline north of Naokok Pass would be more protected from offshore emissions because these emissions would be at least 29 kilometers offshore. Deliberate discharges would not affect water quality in the deferral area. Alternative IV would have localized beneficial effects for the residents of Point Lay by reducing noise and traffic disturbance to beluga whales. This also would reduce the effects of noise and traffic disturbance on Point Lay's subsistence harvest of beluga whales from MODERATE to MINOR. Effects from noise and traffic disturbance also would be reduced on Wainwright's bowhead and beluga whale-subsistence harvests as well as Barrow's beluga harvest in Peard Bay. Slight reductions in disturbance of subsistence harvests of other marine mammals, birds, and marine fish would also occur. However, the level of effects on subsistence harvests remains MAJOR due to construction activities associated with the proposed landfall and shorebase facilities at Point Belcher. Oil-spill, disturbance, and habitat-alteration effects on spotted seals and beluga whales could be locally reduced near Peard Bay and Kasegaluk Lagoon. Potential disturbance of birds from air and boat traffic moving along the coast may be substantially reduced in the important Kasegaluk Lagoon and Peard Bay feeding, molting, and nesting habitats, thereby reducing local disturbance of several thousand birds. Removal of drilling discharges and platform-construction activities in the area would reduce the potential for adverse effects on the kelp-bed communities and would slightly benefit fish.

E. Alternative V - Southern Deferral Alternative

1. Description of Alternative V: This alternative would remove from the Sale 109 area 289 whole and partial blocks (about 624,300 hectares) located from 5 to 48 kilometers offshore from Point Hope around Cape Lisburne and nearly to Cape Sabine (see Fig. II-1). The Southern Deferral Alternative was developed to protect the Cape Lisburne area, which is important to the

residents of Point Hope for the subsistence harvest of bowhead whales; ringed, spotted, and bearded seals; polar bears; walruses; and birds and their eggs. The largest bird rookery in the Sale 109 area is located at Cape Lisburne, where most seabird foraging occurs. A segment of the gray whale population (gray whales are not a subsistence resource) feeds throughout this area during the summer. The bowhead whale spring migration passes through this deferral area.

2. Activities Associated With Alternative V: Deferring the southern blocks around Cape Lisburne would not change the scenario from that assumed for the proposal. (See Table II-1 and Sec. II.A.2 for a complete description.) The conditional mean resource estimate and marginal probability of discovering economically recoverable oil remain the same for the Southern Deferral Alternative as for the proposal, in which the conditional estimate of economically recoverable oil is 2.68 billion barrels and the marginal probability of finding economically recoverable oil is 0.20. The timeframe assumed for development also remains the same (see Table II-8). During exploration and delineation, 43 wells would be drilled between 1989 and 1996. Production platforms would be placed in 1997 and 1998 and wells drilled between 1997 and 1999. Pipelines would be laid between 1995 and 1998. Production would begin in 1999, peak in 2000, and cease in 2017. Peak production of 225 million barrels per year would occur between 2000 and 2005. Furthermore, removing these blocks that are remote from the assumed landfall and shorebase reinforces the transportation assumptions used for the proposal. (See Sec. II.A.2 for a complete description of these assumptions.) The pipeline landfall and shorebase would remain at Point Belcher, and oil would be shipped via pipeline to TAP Pump Station No. 2.

3. Evaluation of Alternative V: The analysis in Section IV.B of this EIS shows that the air quality of the shoreline west of Cape Sabine would be more protected from offshore emissions under Alternative V because such emissions would be at least 29 kilometers offshore. This alternative would have localized benefits for water quality by eliminating the possibilities of spills and deliberate discharges occurring within the deferral area. Slight reductions in effects on fishes would result from elimination of drilling discharges and platform-construction activities within the deferred area, although the overall level of effect remains the same as for the proposal. It could reduce platform- and pipeline-spill effects on the Cape Lisburne and Cape Lewis seabird populations. The combined effects of oil spills, disturbance, and habitat changes on marine mammals could be reduced somewhat in the Point Hope/Cape Sabine coastal area. Effects from noise and traffic disturbance also would be reduced on Point Hope's bowhead and beluga whale-subsistence harvests. Slight reductions in disturbance of subsistence harvests of other marine mammals, birds, and marine fishes also would occur. However, the effect level on subsistence harvests remains MAJOR due to construction activities associated with the proposed landfall and shorebase facilities at Point Belcher.

F. Alternative VI - Coastal Deferral Alternative

1. Description of Alternative VI: This alternative would remove from the Sale 109 area 1,632 whole or partial blocks (about 3,485,140 hectares) located along the entire length of the sale area and extending from 5 to 113 kilometers offshore (see Fig. II-1). The Coastal Deferral Alternative

Table II-7
Chukchi Sea Sale 109
Estimated Schedule of Exploration, Development, and Production for the Eastern Deferral Alternative

SALE YEAR	CAL. YEAR	EXPLORATION WELLS	DELINEATION WELLS	EXPLORATION/ DELINEATION DRILLING UNITS	PRODUCTION PLATFORMS[1/] AND EQUIPMENT	PRODUCTION AND SERVICE Wells	PRODUCTION AND SERVICE Rigs	TRUNK PIPELINES[2/] (Kilometers) Offshore	TRUNK PIPELINES[2/] (Kilometers) Onshore	NUMBER OF SHOREBASES[3/]	PRODUCTION (MMbbls)
0	1986										
1	1987										
2	1988									1.0	
3	1989	2		2							
4	1990	2		2							
5	1991	4	4	4							
6	1992	4	4	4							
7	1993	4	4	4							
8	1994	4	4	4							
9	1995		4	2					80		
10	1996		3	2				120	200	.3	
11	1997				4	12	2	120	200	.3	
12	1998				5	71	8	160	160	.4	
13	1999					70	7				67
14	2000										225
15	2001										225
16	2002										225
17	2003										225
18	2004										225
19	2005										225
20	2006										198
21	2007										174
22	2008										153
23	2009										129
24	2010										110
25	2011										96
26	2012										86
27	2013										78
28	2014										70
29	2015										62
30	2016										56
31	2017										51
Total		20	23		9	153		400	640	2	2,680

Source: USDOI, MMS, 1985d (E&D Report).

1/ Platform-placement years on the schedule represent the final placement of the platform on location. Design and construction of the platform is expected to require 3 or 4 years.
2/ It is assumed that up to two pipe-laying spreads would be used to obtain the yearly lay rates shown for offshore installation.
3/ The 1.0 represents expenditures for an exploration base during year 2; the fractions .3, .3, and .4 during years 9, 10, and 11 represent expenditure percentages to construct a shorebase.

Table II-8
Chukchi Sea Sale 109
Estimated Schedule of Exploration, Development, and Production for the Southern Deferral Alternative

SALE YEAR	CAL. YEAR	EXPLORATION WELLS	DELINEATION WELLS	EXPLORATION/ DELINEATION DRILLING UNITS	PRODUCTION PLATFORMS 1/ AND EQUIPMENT	PRODUCTION AND SERVICE		TRUNK PIPELINES 2/ (Kilometers)		NUMBER OF SHOREBASES 3/	PRODUCTION (MMbbls)
						Wells	Rigs	Offshore	Onshore		
0	1986										
1	1987										
2	1988									1.0	
3	1989	2		2							
4	1990	2		2							
5	1991	4	4	4							
6	1992	4	4	4							
7	1993	4	4	4							
8	1994	4	4	4							
9	1995		4	2					80		
10	1996		3	2				120	200	.3	
11	1997				4	12	2	120	200	.3	
12	1998				5	71	8	160	160	.4	
13	1999					70	7				67
14	2000										225
15	2001										225
16	2002										225
17	2003										225
18	2004										225
19	2005										225
20	2006										198
21	2007										174
22	2008										153
23	2009										129
24	2010										110
25	2011										96
26	2012										86
27	2013										78
28	2014										70
29	2015										62
30	2016										56
31	2017										51
Total		20	23		9	153		400	640	2	2,680

Source: USDOI, MMS, 1985d (E&D Report).

1/ Platform-placement years on the schedule represent the final placement of the platform on location. Design and construction of the platform is expected to require 3 or 4 years.
2/ It is assumed that up to two pipe-laying spreads would be used to obtain the yearly lay rates shown for offshore installation.
3/ The 1.0 represents expenditures for an exploration base during year 2; the fractions .3, .3, and .4 during years 9, 10, and 11 represent expenditure percentages to construct a shorebase.

was developed (1) to encompass the bowhead whale spring-migration corridor and part of the fall-migration corridor that extend through the sale area; (2) to encompass in general the Chukchi polynya or open-water lead through which marine mammals migrate in the spring; (3) to provide a protective buffer to the offshore subsistence-harvest areas and resources of the communities of Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope over and above the buffer areas provided in Alternatives IV and V; and (4) to protect important coastal habitats, such as the Peard Bay area, Kasegaluk Lagoon and barrier-island system, the Cape Lisburne area and bird rookery, and the Kuk River estuary.

2. Activities Associated With Alternative VI: Deferring these 1,632 blocks would leave estimated recoverable resources of 2.24 billion barrels of oil in the remaining blocks of the sale area. These remaining blocks are the "Coastal Deferral Alternative." Deferring the entire coastal area would alter the assumptions on the number of wells drilled and platforms installed during exploration, delineation, and development and would change their likely distribution but would not alter the timeframe in which these events are assumed to occur or the infrastructure that is assumed (see Table II-1). Exploration still is assumed to begin in 1989 and continue through 1994 (see Table II-9). However, during the years 1993 and 1994, one less exploration well would be drilled per year. Delineation would occur between 1991 and 1996 at a rate of three wells per year. This is one less per year for the first 5 years than is assumed to be drilled under the proposal. The number and type of drilling units used for exploration and delineation would be the same as for the proposal (see Table II-1 and Sec. II.A.2). Installation of production platforms still is assumed to occur in 1997 and 1998. Although production platforms would be the same type as for the proposal, seven--rather than nine--are assumed. The difference would occur in the first year, when only two platforms--rather than four--would be installed. Twenty-five fewer production wells are assumed. Most of the decrease would occur during the second year of development drilling (1998). During the third year, the number of wells drilled would increase with this alternative. The hypothetical shorebase would remain at Point Belcher.

Shallow-hazard seismic activity for exploration drilling is assumed to total 6,598 kilometers. Muds for exploration and delineation drilling are assumed to total 18,954 dry metric tons and cuttings to total 45,720 dry metric tons. During development, shallow-hazard surveys conducted prior to installing pipelines are assumed to remain the same--1,609 kilometers. Trackline kilometers of three-dimensional, deep-penetration surveys would be reduced to 6,831 kilometers to reflect the assumption of two fewer platforms. Muds assumed for drilling production wells would range from 33,792 dry metric tons to 106,880 dry metric tons. The maximum "net" muds disposed are assumed to total 56,832 dry metric tons. Cuttings would equal 177,664 dry metric tons.

3. Evaluation of Alternative VI: The analysis in Section IV.B of this EIS shows that the localized benefits of Alternative VI include the following:

The magnitude and rates of air-pollutant emissions would be lower than those for the proposal and would occur at least 41 kilometers from shore. Effects

Table II-9
Chukchi Sea Sale 109
Estimated Schedule of Exploration, Development, and Production for the Coastal Deferral Alternative

SALE YEAR	CAL. YEAR	EXPLORATION WELLS	DELINEATION WELLS	EXPLORATION/ DELINEATION DRILLING UNITS	PRODUCTION PLATFORMS[1/] AND EQUIPMENT	PRODUCTION AND SERVICE		TRUNK PIPELINES[2/] (Kilometers)		NUMBER OF SHOREBASES[3/]	PRODUCTION (MMbbls)
						Wells	Rigs	Offshore	Onshore		
0	1986										
1	1987										
2	1988									1.0	
3	1989	2		2							
4	1990	2		2							
5	1991	4	3	4							
6	1992	4	3	4							
7	1993	3	3	3							
8	1994	3	3	3							
9	1995		3	2					80		
10	1996		3	2				120	200	.3	
11	1997				2	6	2	120	200	.3	
12	1998				5	45	7	160	160	.4	
13	1999					77	8				56
14	2000										186
15	2001										188
16	2002										188
17	2003										188
18	2004										188
19	2005										188
20	2006										166
21	2007										146
22	2008										128
23	2009										108
24	2010										92
25	2011										81
26	2012										72
27	2013										65
28	2014										58
29	2015										52
30	2016										47
31	2017										43
Total		18	18		7	128		400	640	2	2,240

Source: USDOI, MMS, 1985d (E&D Report).

1/ Platform-placement years on the schedule represent the final placement of the platform on location. Design and construction of the platform is expected to require 3 or 4 years.
2/ It is assumed that up to two pipe-laying spreads would be used to obtain the yearly lay rates shown for offshore installation.
3/ The 1.0 represents expenditures for an exploration base during year 2; the fractions .3, .3, and .4 during years 9, 10, and 11 represent expenditure percentages to construct a shorebase.

on water quality would be slightly lower than those for the proposal because platform spills and deliberate discharges would not occur in the deferred area.

Elimination of drilling discharges and platform-construction activities from nearshore waters under this deferral alternative reduces potential effects of these activities on kelp beds and invertebrates. Although the extent of localized effects is reduced, the level of effect is expected to remain MINOR, the same as for the proposal. The probability that oil spills would contact areas of particular concern for marine plants and invertebrates declines only slightly under this deferral alternative.

Slight reductions in effects on fishes would result from decreased drilling discharges and platform-construction activities in nearshore waters.

This alternative would defer exploration and production from the coastal habitat of over a million marine and coastal birds. It also would remove the potential for exploration and production activities within most of the spring-migration corridor used by pinnipeds and beluga whales and could reduce local effects on walruses and spotted seals.

Overall, endangered whales would be somewhat less likely under this alternative to be contacted by oil. No exploratory-drilling sites or production platforms would be located within the bowhead whale spring-migration corridor and coastal area heavily used for gray whale feeding, resulting in a slight decrease in noise-producing activities.

This alternative would remove the possibility of exploration or production occurring within the subsistence-hunting area, which would decrease noise from boats and seismic and traffic disturbance as well as eliminate the presence of platforms in the deferred area. Bowhead and beluga whales are the subsistence species most affected by noise and traffic disturbance and thus are the harvests that may be affected by this alternative. However, icebreakers could still be in the area and could cause disturbance to bowheads and thus curtail or reduce the bowhead harvest. If it were a short whaling season, noise and traffic disturbance of Point Lay's beluga whale harvest would be reduced from MODERATE to MINOR under this alternative; and noise and traffic disturbance of Barrow's and Point Hope's beluga harvest would be reduced from MINOR to NEGLIGIBLE.

G. Low- and High-Resource Cases:

1. Description of the Low- and High-Resource Cases:

The scenario for the proposal is based on discovery of 2.68 billion barrels of oil--the conditional-mean-resource estimate of economically recoverable resources in the Sale 109 area. For the low- and high-case estimates, the marginal probability that commercial quantities of hydrocarbons are present remains 0.20--the same as for the mean-resource estimate. If hydrocarbons are present, there is a 95-percent probability that 0.96 billion barrels of economically recoverable oil would be present with the low-case resource estimate, and a 5-percent probability that 4.88 billion barrels of economically recoverable oil would be present with the high-case resource estimate. The technologies for exploration and development would remain the same as described for the proposal. However, as described in the next section, differences are assumed in the method of transporting the produced oil, the level of activity, and the timing of events. Appendix C contains an analysis of the potential effects that could result from these two cases.

2. Activities Associated With the Low- and High-Resource Cases:

a. Low-Resource Case: Activity levels and timing of events for this low-case resource estimate are shown in Tables II-10 and II-11. Although activity levels are lower in the low case, production is assumed to begin in 1999--the same year as the mean case. The primary difference is that offshore loading is assumed to be used to transport the oil to a refinery. Offshore loading is considered more attractive if lower levels of resources are present (Han-Padron, 1984). The low-case resource estimate would be commensurate with that used for the "Beaufort Sea Petroleum Technology Assessment" (Han-Padron, 1985). In that report, if use of the TAP were not possible, offshore loading of economically recoverable oil from a production platform onto tankers was identified as the next most reasonable option. The report also considered offshore loading onto submarines. Although submarine tankers have the advantage of providing regular service regardless of ice and weather conditions, the report concluded that depth limitations and technological unknowns offset the advantages. It is assumed that the platforms would be in proximity, and that one production platform would include loading facilities. Using 75,000-deadweight-ton (DWT) tankers, approximately 150 tanker trips per year would be required during the years of peak production (2001-2005), when 81 million barrels are assumed to be produced annually. New facilities would not be assumed at Point Belcher; but a smaller shorebase (approximately 15-20 hectares) is assumed near Wainwright. Although reduced facilities and infrastructure needs would minimize the number of barges required to service production activities, no road connection to the Dalton Highway would be available for trucking materials. These two factors would moderate any change in the assumed level of barge activity.

b. High-Resource Case: Activities associated with discovery of this high-case resource estimate of 4.88 billion barrels of oil are shown in Tables II-12 and II-13. Activity levels for the high case are almost double those assumed for the mean case; however, the assumptions on timing do not vary significantly. Production is assumed to begin in 1999 and to peak in the following year--the same as for the mean case. Peak production of 410 million barrels per year is assumed to continue through 2005. A major difference between the mean and high cases is the method assumed to transport oil to market. In the high case, a nearshore loading scenario is used. Oil is assumed be piped from the platforms to shore near Cape Beaufort, where a 25- to 30-hectare shorebase is assumed. A pipeline landfall at Cape Beaufort would be especially reasonable if the primary oil fields were discovered south of 70°N. latitude. From there, the oil is assumed to be transported to a 300-hectare terminal located south of Kivalina via a 200-kilometer pipeline across the Lisburne Peninsula along the Kukpowruk River to the headwaters of the Wulik River. To the extent possible, the route is assumed to take advantage of the transportation corridor developed for the Red Dog Mine that also follows the Wulik River. In fact, the Arctic Slope Regional Corporation (ASRC) is previewing a similar route across the Lisburne Peninsula as an alternative for shipping coal mined in the Cape Beaufort area. However, Congressional approval probably would be required before a pipeline could be built along the portion of the road that is within the Cape Krusenstern

Table II-10

Chukchi Sea Sale 109
Summary of Low-Case Scenario Assumptions
(Page 1 of 2)

PHASE Facility or Event	Number or Amount	Timeframe
EXPLORATION		
Shorebase--Located Near Wainwright Airport		
Total Hectares	10	1988
Exploration Work Force--Peak Year	360	1994
Total Exploration/Delineation Wells	21	
Drilled by Drillships (2)	9	1989-1993
Drilled by Bottom-Founded Units (1)	12	1991-1996
Total Drilling Muds and Cuttings (Exploration and Delineation)		
Drilling Muds--Dry Metric Tons	11,419	1989-1996
Cuttings--Dry Metric Tons	24,759	1989-1996
Seismic Activity (shallow-hazard)		
Total Number of Days	147	1988-1995
Total Trackline Kilometers	3,963	1988-1995
Kilometers per Site-Specific Survey (50% wells)	63	1988-1995
Kilometers per Block-Wide Survey (50% wells)	303	1988-1995
Total Support Activities for Exploration Phase		
Helicopters (maximum)	5	
Maximum Flights per Month Between Shorebase (or Barrow Airport) and Platform (1 flight/day/platform)	90	1991-1994
Ice-Management Vessels--per Year	6	1989-1994
Barges--per Year	1-7	1989-1996
DEVELOPMENT		
Shorebase (expansion of exploration base)		
Total Hectares	15-20	1996-1998
Total Cubic Meters of Gravel	200,000	1996-1998
Development Work Force--Peak Year	2,540	1998
Platforms--Bottom-Founded (1 includes loading facilities)	3	1998
Wells	55	1998-1999
Drilling Muds and Cuttings Disposed--Dry Metric Tons		
Maximum Total Muds	24,420	1998-1999
Maximum Total Cuttings	212,363	1998-1999
Muds per Well (depends on amount recycled)	91-444	1998-1999
Cuttings per Well	1,388	1998-1999

Table II-10
Chukchi Sea Sale 109
Summary of Low-Case Scenario Assumptions
(Page 2 of 2)

PHASE Facility or Event	Number or Amount	Timeframe
Seismic Activity		
Total Number of Days For Platforms	100	1997
Total Trackline Kilometers (3-dimensional, deep-penetration)	2,925	1997
Area Covered per Platform--Square Kilometers	57	1997
Total Support Activities for Development Phase		
Helicopters	2-4	1998-1999
Flights per Day per Platform	1-3	1998-1999
Total Flights per Month	60-360	1998-1999
Work Boats	3-4	1998-1999
Trips per Day per Platform	1-2	1998-1999
Total Trips per Month	90-240	1998-1999
Barges--Peak Year	46	1999
PRODUCTION		
Production Work Force--Peak Year	1,200	2003-2010
Peak Oil Production		
Yearly--Million Barrels	81	2001-2005
Daily--Barrels	221,918	2001-2005
Total Oil Produced--Million Barrels	960	1999-2017
Total Support Activities for Production Phase		
Helicopters (maximum)	3	
Maximum Flights per Month Between Shorebase and Platforms	25	2000-2017
Support/Supply Boats	3	2000-2017
Barges per Year--Average	13	2000-2017
TRANSPORTATION		
Tankers (75,000-DWT icebreakers)		
Trips per Year (peak production)	150	2001-2005
Trips per Week (peak production)	3	2001-2005
OIL SPILLS[1/]		
Assumed for Analysis		
<1,000 Barrels[2/]	350	
≥1,000 Barrels	2	
≥100,000 Barrels	0	

Source: MMS, Alaska OCS Region.

1/ Oil-spill assumptions include all spills north of the Bering Strait during exploration and development.

2/ Total volume of small spills is 1,467 barrels; the average spill size is 4 barrels.

Table II-11
Chukchi Sea Sale 109
Estimated Schedule of Exploration, Development, and Production for the Low-Case Resource Estimate

SALE YEAR	CAL. YEAR	EXPLORATION WELLS	DELINEATION WELLS	EXPLORATION/ DELINEATION DRILLING UNITS	PRODUCTION PLATFORMS[1/] AND EQUIPMENT	PRODUCTION AND SERVICE Wells	PRODUCTION AND SERVICE Rigs	NUMBER OF SHOREBASES[2/]	PRODUCTION (MMbbls)
0	1986								
1	1987								
2	1988							1.0	
3	1989	2		2					
4	1990	2		2					
5	1991	3	2	3					
6	1992	3	2	3					
7	1993	2	1	2					
8	1994	1	1	1					
9	1995		1	1					
10	1996		1	1				.3	
11	1997							.3	
12	1998				3	9	1	.4	
13	1999					46	5		24
14	2000								79
15	2001								81
16	2002								81
17	2003								81
18	2004								81
19	2005								81
20	2006								71
21	2007								62
22	2008								55
23	2009								46
24	2010								39
25	2011								35
26	2012								31
27	2013								28
28	2014								25
29	2015								22
30	2016								20
31	2017								18
Total		13	8		3	55		2	960

Source: USDOI, MMS, 1985d (E&D Report).

1/ Platform-placement years on the schedule represent the final placement of the platform on location. Design and construction of the platform is expected to require 3 or 4 years.
2/ The 1.0 represents expenditures for an exploration base during year 2; the fractions .3, .3, and .4 during years 9, 10, and 11 represent expenditure percentages to construct a shorebase.

Table II-12
Chukchi Sea Sale 109
Summary of High-Case Scenario Assumptions
(Page 1 of 3)

PHASE Facility or Event	Number or Amount	Timeframe
EXPLORATION		
Shorebase--Located Near Wainwright Airport		
Total Hectares	10	1988
Exploration Work Force--Peak Year	1,150	1994
Total Exploration/Delineation Wells	73	
Drilled by Drillships (2)	18	1989-1994
Drilled by Bottom-Founded Units (5)	55	1991-1996
Drilling Muds and Cuttings Disposed--Dry Metric Tons		
Muds per Well		
Exploration	599	1989-1996
Delineation	454	1989-1996
Cuttings per Well		
Exploration	1,361	1989-1996
Delineation	1,179	1989-1996
Total Muds and Cuttings (exploration and delineation)		
Muds	37,927	1989-1996
Cuttings	92,073	1989-1996
Seismic Activity (shallow-hazard)		
Total Number of Days	511	1988-1995
Total Trackline Kilometers	13,479	1988-1995
Kilometers per Site-Specific Survey (50% wells)	63	1988-1995
Kilometers per Block-Wide Survey (50% wells)	303	1988-1995
Total Support Activities for Exploration Phase		
Helicopters	10	
Maximum Flights per Month Between Shorebase (or Barrow Airport) and Platform (1 flight/day/platform)	210	1992-1994
Ice-Management Vessels--per Year	9	1989-1994
Barges--Peak Year	27	1989-1996
DEVELOPMENT		
Shorebase--Located at Cape Beaufort		
Total Hectares	25-30	1996-1998
Total Cubic Meters of Gravel	500,000	1995-1998
Construction of Airstrip (meters)	1,900	1996
Terminal South of Kivalina--Hectares	300	1997-1999

Table II-12
Chukchi Sea Sale 109
Summary of High-Case Scenario Assumptions
(Page 2 of 3)

PHASE Facility or Event	Number or Amount	Timeframe
DEVELOPMENT (continued)		
Development Work Force--Peak Year	8,140	1998
Platforms--Bottom-Founded (1 installed in 1995; 5 each in 1996-1998)	16	1995-1998
Wells	279	1995-1999
Drilling Muds and Cuttings Disposed--Dry Metric Tons		
Maximum Total Muds	123,876	1995-1999
Maximum Total Cuttings	387,252	1995-1999
Muds per Well (depends on amount recycled)	91-444	1995-1999
Cuttings per Well	1,388	1995-1999
Seismic Activity		
Total Number of Days	490	1994-1998
For Platforms		
Total Trackline Kilometers (3-dimensional, deep-penetration)	15,600	1994-1997
Area Covered per Platform--Square Kilometers	57	1994-1997
For Pipelines		
Total Trackline Kilometers (shallow-hazard)	1,300	1995-1997
Total Support Activities for Development Phase		
Helicopters	8-9	1995-1999
Flights per Day per Platform	1-3	1995-1999
Total Flights per Month	480-1,440	1995-1999
Work Boats	15	1995-1999
Round Trips per Day per Platform	1-2	1995-1999
Total Round Trips per Month	480-960	1995-1999
Barges per Year--Average	170	1997-1998
PRODUCTION		
Production Work Force--Peak Year	3,830	2003-2010
Peak Oil Production		
Yearly--Million Barrels	410	2000-2005
Daily--Barrels	1,120,000	2000-2005
Total Oil Produced--Million Barrels	4,880	1999-2017
Total Support Activities for Production Phase		
Helicopters (maximum)	5	1999-2017
Maximum Flights per Month Between Shorebase and Platforms	140	1999-2017
Support/Supply Boats	5	1999-2017
Barges per Year--Average	26	1999-2017

Table II-12
Chukchi Sea Sale 109
Summary of High-Case Scenario Assumptions
(Page 3 of 3)

PHASE Facility or Event	Number or Amount	Timeframe
TRANSPORTATION		
Pipelines (pipelines from the platforms would converge offshore and come onshore at Cape Beaufort)		
Onshore Pipeline to Kivalina--Kilometers	200	1995-1998
Support Road--Kilometers	200	1994-1996
Helicopter Pads	3	1994-1996
Major River Crossings (Approx.)	3	1994-1996
Offshore Trunk Pipelines--Kilometers	325	1996-1998
Area Disturbed During Offshore-Pipeline Laying[1/]		
Trenching--Hectares	333	1996-1998
Dumping--Hectares	666	1996-1998
Total Hectares	999	1996-1998
Maximum Volume of Fill Material--Cubic Meters	8,985,000	
Tankers (150,000-DWT icebreakers)		
From Kivalina to Market or a Transshipment Terminal		
Trips per Year (peak production)	380	2000-2005
Trips per Week (peak production)	7	2000-2005
OIL SPILLS[2/]		
Assumed for Analysis		
<1,000 Barrels[3/]	1,406	
≥1,000 Barrels	15	
≥100,000 Barrels	1	

Source: MMS, Alaska OCS Region.

1/ Assumptions used to arrive at the area disturbed during pipeline laying are as follows:
(a) Side slopes assumed 1:2 (Hemphill, 1986, oral comm.).
(b) 70 kilometers placed between the 10- and 20-meter isobaths, trench depth = 3 meters (Han-Padron, 1985).
(c) 75 kilometers placed between the 20- and 30-meter isobaths, trench depth = 5 meters (Han-Padron, 1985).
(d) 180 kilometers placed between the 30- and 50-meter isobaths, trench depth = 6 meters (Han Padron, 1985).

2/ Oil-spill assumptions include all spills north of the Bering Strait during exploration and development.

3/ Total volume of small spills is 5,718 barrels; the average spill size is 4.1 barrels.

Table II-13
Chukchi Sea Sale 109
Estimated Schedule of Exploration, Development, and Production for the High-Case Resource Estimate

SALE YEAR	CAL. YEAR	EXPLORATION WELLS	DELINEATION WELLS	EXPLORATION/ DELINEATION DRILLING UNITS	PRODUCTION PLATFORMS[1/] AND EQUIPMENT	PRODUCTION AND SERVICE Wells	PRODUCTION AND SERVICE Rigs	TRUNK PIPELINES (Kilometers)[2/] Offshore	TRUNK PIPELINES (Kilometers)[2/] Onshore	NUMBER OF SHOREBASES[3/]	PRODUCTION (MMbbls)
0	1986										
1	1987										
2	1988									1.0	
3	1989	2		2							
4	1990	2		2							
5	1991	5	7	6							
6	1992	6	7	7							
7	1993	6	7	7							
8	1994	6	7	7							
9	1995	6	6	6	1	3	1		40		
10	1996		6	3	5	29	3	100	60	.3	
11	1997				5	85	9	125	60	.3	
12	1998				5	85	9	100	40	.4	
13	1999					77	8				122
14	2000										410
15	2001										410
16	2002										410
17	2003										410
18	2004										410
19	2005										410
20	2006										361
21	2007										317
22	2008										278
23	2009										234
24	2010										200
25	2011										176
26	2012										156
27	2013										142
28	2014										127
29	2015										112
30	2016										102
31	2017										93
Total		33	40		16	279		325	200	2	4,880

Source: USDOI, MMS, 1985d (E&D Report).

1/ Platform-placement years on the schedule represent the final placement of the platform on location. Design and construction of the platform is expected to require 3 or 4 years.
2/ It is assumed that up to two pipe-laying spreads would be used to obtain the yearly lay rates shown for offshore installation.
3/ The 1.0 represents expenditures for an exploration base during year 2; the fractions .3, .3, and .4 during years 9, 10, and 11 represent expenditure percentages to construct a shorebase and an oil-tanker terminal.

National Monument. Currently, the terms of the agreement set by Congress allow only a road through the Monument. One pump station and two construction camps are assumed to be located along the route. A helipad is assumed at each of these sites and a road is assumed to parallel the pipeline. Approximately three rivers would be crossed. Icebreaking tankers, or icestrengthened tankers assisted seasonally by icebreakers, are assumed to transport the oil year-round from Kivalina to market or to a transshipment terminal in an ice-free port. Using 75,000-DWT tankers (the lower end of the size range), approximately 760 tanker trips per year would be required during the years of peak production (2000-2005). If 150,000-DWT tankers were developed for transporting oil from the Arctic, the number of tanker trips would be halved; approximately 380 trips per year would be required during peak production. Because the terminal is assumed to be south of Point Hope, where ice conditions are typically less severe, the larger-sized tanker is assumed for the scenario. Road access to the Alaska Highway System is not likely. As a result, it is assumed that the average barge traffic would double.

H. Mitigating Measures

1. Mitigating Measures That Are Part of the Proposed Action and the Alternatives: Laws, regulations, and orders that provide mitigation are considered part of the proposal. Examples include the OCS Lands Act, which grants broad authority to the Secretary of the Interior to control lease operations; the Alaska OCS Orders; the Fisherman's Contingency Fund; and the Offshore Oil Pollution Compensation Fund. Incorporated by reference in Section I.C is OCS Report MMS 86-003, "Legal Mandates and Federal Regulatory Responsibilities" (Alaska OCS Region Technical Report No. 4, Second Edition; Rathbun, 1986). Also incorporated by reference are the Alaska OCS Orders published in the Federal Register on October 22, 1982, at 47 FR 47180. OCS Orders describe in detail requirements and specifications for oil and gas operations, including the requirement to use the best and safest technologies (BAST). 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.

2. Potential Mitigating Measures: The following mitigating measures are offered to reduce or eliminate potential adverse effects identified in Section IV. A 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 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 stipulations or information to lessees that follow each of the potential measures.

a. Potential Stipulations: Stipulations are specific requirements placed on the lessee by the DOI to reduce or eliminate potential adverse effects. The following stipulations will be considered for Chukchi Sea Sale 109:

No. 1 - Protection of Archaeological Resources
No. 2 - Orientation Program
No. 3 - Protection of Biological Resources
No. 4 - Transportation of Hydrocarbons
No. 5 - Seasonal Drilling Restriction for Protection of Bowhead Whales from Potential Effects of Oil Spills
No. 6 - Industry Site-Specific Bowhead Whale-Monitoring Program

Stipulation No. 1--Protection of Archaeological Resources

(a) "Archaeological resources" means any prehistoric or historic district, site, building, structure, or object (including shipwrecks); such term includes artifacts, records, and remains which are related to such a district, site, building, structure, or object (Sec. 301(5), National Historic Preservation Act, as amended, 16 U.S.C. 470w(5)). "Operations" means any drilling, mining, or construction or placement of any structure for exploration, development, or production of the lease.

(b) If the Regional Supervisor, Field Operations (RSFO), believes an archaeological resource may exist in the lease area, the RSFO will notify the lessee in writing. The lessee shall then comply with subparagraphs (1) through (3).

(1) Prior to commencing any operations, the lessee shall prepare a report, as specified by the RSFO, to determine the potential existence of any archaeological resource that may be affected by operations. The report, prepared by an archaeologist and a geophysicist, shall be based on an assessment of data from remote-sensing surveys and of other pertinent archaeological and environmental information. The lessee shall submit this report to the RSFO for review.

(2) If the evidence suggests that an archaeological resource may be present, the lessee shall either:

(i) Locate the site of any operation so as not to adversely affect the area where the archaeological resource may be; or

(ii) Establish to the satisfaction of the RSFO that an archaeological resource does not exist or will not be adversely affected by operations. This shall be done by further archaeological investigation, conducted by an archaeologist and a geophysicist, using survey equipment and techniques deemed necessary by the RSFO. A report on the investigation shall be submitted to the RSFO for review.

(3) If the RSFO determines that an archaeological resource is likely to be present in the lease area and may be adversely affected by operations, the RSFO will notify the lessee imme-

diately. The lessee shall take no action that may adversely affect the archaeological resource until the RSFO has told the lessee how to protect it.

(c) If the lessee discovers any archaeological resource while conducting operations in the lease area, the lessee shall report the discovery immediately to the RSFO. The lessee shall make every reasonable effort to preserve the archaeological resource until the RSFO has told the lessee how to protect it.

Purpose of Stipulation No. 1: The purpose of this measure is to protect prehistoric and historic archaeological resources and shipwrecks that are known or may be discovered in a lease area from any petroleum-industry activity that would disturb the area. The Prehistoric Resource Analysis for Proposed Chukchi Sea Sale 109 (Appendix E) concludes that "Extensive ice gouging, reworking by marine transgression, thermokarst erosion, and thermal abrasion cover the entire lease area. These geological processes make it highly unlikely that any prehistoric archaeological sites would have survived." If new data become available, this analysis could be reassessed to further evaluate which blocks would require an archaeological resource report at the postlease stage.

A stipulation for protection of archaeological resources has appeared in the Notices of Sale for all Federal lease sales offshore Alaska.

Effectiveness of Stipulation No. 1: Stipulation No. 1 provides a positive method to determine if archaeological resources are present in the lease area prior to the start of any operations associated with petroleum-industry activities and ways to develop effective measures to protect known or subsequently discovered archaeological resources. Therefore, the effects of industry operations on archaeological resources in the lease area would be reduced from MINOR to NEGLIGIBLE with the adoption of this stipulation.

Stipulation No. 2--Orientation Program

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 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 (RSFO). The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns which relate to the sale and adjacent areas. The program shall be formulated by qualified instructors experienced in each pertinent field of study and shall employ effective methods to ensure that personnel are informed of archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and to ensure that personnel understand the importance of not disturbing archaeological resources and of avoidance and nonharassment of wildlife resources. The program also 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 activities. The program also shall include presentations and information about all pertinent lease-sale stipulations and information to lessees provisions.

The program shall be attended at least once a year by all personnel involved in on-site 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.

Purpose of Stipulation No. 2: The purpose of this potential stipulation, which addresses the concerns of residents expressed during the scoping process 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 would also 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.

Similar programs were implemented for construction of the trans-Alaska pipeline and have been specified in the Notices of Sale for Lease Sales 55 (Eastern Gulf of Alaska), 57 (Norton Sound), 60 (Lower Cook Inlet-Shelikof Strait), 70 (St. George Basin), 71 (Diapir Field), 83 (Navarin Basin), 87 (Diapir Field), and 92 (North Aleutian Basin).

Effectiveness of Stipulation No. 2: This measure provides positive mitigating effects in that it would make all personnel involved in petroleum-industry activities aware of the unique environmental, social, and cultural values of North Slope Inupiat residents and their environment. There is concern that uninformed workers and subcontractors could unknowingly 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 level of effects identified in Section IV.

Stipulation No. 3--Protection of Biological Resources

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

Based on any surveys that the RSFO may require of the lessee or on other information available to the RSFO on special biological resources, the RSFO may require the lessee to: (1) relocate the site of operations; (2) establish to the satisfaction of the RSFO, on the basis of a site-specific survey, either that such operation 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 RSFO, 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 RSFO and make every reasonable effort to preserve and protect the biological resource from damage until the RSFO 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 RSFO 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 RSFO provides written directions to the lessee with regard to permissible actions.

Purpose of Stipulation No. 3: Important biological populations and habitats in addition to those already identified in the Information to Lessees on Areas of Special Biological Sensitivity (see below) 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 disturbances to 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. 3: 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, although kelp-bed communities are known to occur in the northeastern Chukchi Sea, extensive surveys for them have not been made; and, at present, only two have been reported. This stipulation could result in the identification and protection of kelp-bed communities. By regulating the siting of drilling and construction activities, MAJOR effects on kelp beds could be avoided. Avoidance of such effects could also provide some local benefits to invertebrates, fishes, birds, and marine mammals. 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 250.34. Stipulation No. 3 is not likely to change the overall effect levels of the proposal on biological resources, although local reductions in habitat effects or effects on specific, vulnerable populations may occur.

Stipulation No. 4--Transportation of Hydrocarbons

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 the Regional Technical Working Group or other similar advisory groups with participation 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.

Purpose of Stipulation No. 4: 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 and (2) pipelines must be designed and constructed to withstand the hazardous conditions that may be encountered in the sale area. 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. Pipeline safety is regulated by the Department of Transportation through Title 49 CFR, Part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, and through 49 CFR, Part 195, Transportation of Hazardous Liquids by Pipeline.

Effectiveness of Stipulation No. 4: This stipulation is not expected to significantly reduce the overall effect levels of the proposal on the resources analyzed in Section IV.

Stipulation No. 5--Seasonal Drilling Restriction for Protection of Bowhead Whales From Potential Effects of Oil Spills

Exploratory drilling, testing, and other downhole exploratory activities will be prohibited during the spring bowhead whale migration period generally from April 1 through May 31 in the Spring Migration Area. The precise dates will be set each season by the Regional Supervisor, Field Operations (RSFO), based on available information concerning the presence of bowhead whales in the area. The RSFO may determine that continued operations are necessary to prevent a loss of well control or to ensure human safety. This stipulation will remain in effect until termination or modification by the Department of the Interior, after conferring with the State of Alaska and the North Slope Borough, and in consultation with the National Marine Fisheries Service. This stipulation applies to the following blocks for the dates indicated:

Spring Migration Area
April 1 to May 31

Official Protraction Diagram	Blocks Included
NR 2-6	728, 729, 771-773, 814-817, 856-861, 899-905, 941-949, 985-994, 1029-1038
NR 2-8	17-26, 61-70, 105-114, 150-158, 194-202, 238-246, 282-290, 326-334, 370-378, 414-422, 458-466, 502-510, 546-554, 590-598, 634-642
NR 3-4	243, 244, 284-288, 327-332, 370-376, 412-420, 454-464, 497-508, 539-552, 581-596, 624-640, 667-683, 710-726, 753-769, 796-812, 839-856, 882-899, 925-943, 969-986
NR 3-5	25, 26, 68-70, 111-114, 154-158, 197-202, 240-246, 282-290, 324-334, 367-378, 409-422, 451-466, 493-510, 535-554, 578-598, 620-642, 662-686, 706-730, 750-774, 794-818, 838-862, 882-906, 926-950, 969-994, 1013-1038
NR 3-6	1-18, 45-61, 89-104, 133-148, 177-191, 221-235, 265-279, 309-323, 353-366, 397-410, 441-454, 485-498, 529-542, 573-586, 617-630, 661-674, 705-718, 749-761, 793-804, 837-848, 881-891, 925-934, 969-977, 1013-1020
NR 3-7	2-27, 46-71, 90-104, 134-148, 178-192, 222-236, 266-280, 310-324, 354-368, 398-412, 442-455, 486-499, 530-542, 574-584, 618-627
NR 3-8	1-6
NR 4-3	12-24, 54-68, 96-110, 137-152, 179-195, 221-238, 265-281, 309-324, 353-367, 397-410, 441-454, 485-497, 529-539, 573-582, 617, 619-624
NR 4-4	1-11, 45, 47-54, 92-97

Purpose of Stipulation No. 5: This stipulation could protect endangered bowhead whales from the risk of oil spills during their spring migration through the sale area during exploratory drilling. Cessation of drilling would also benefit the subsistence harvest of bowheads through a reduction in the risk of oil spills as well as in the level of noise produced. During the peak migration period, exploratory drilling, testing, and other downhole exploratory activities would be prohibited in those blocks that are part of important migratory areas and from which the oil-spill-risk analysis indicates oil spills would have a significant likelihood of contacting bowhead whale habitat. The actual closure dates would float, recognizing that the whales may reach the areas before or after the specified dates. The bowhead whale-studies effort is continuing and may provide new information to allow further refinement, modification, or replacement of this proposed measure.

Effectiveness of Stipulation No. 5: The seasonal prohibition on exploratory drilling in the presence of bowhead whales could eliminate the risk (a low probability) that a major spill from exploration-drilling activities could occur when bowhead whales were present in the vicinity of an exploration-drilling unit. For Sale 109, this measure would extend generally from April 1 through May 31, representing the peak bowhead whale-migration period for the Spring Migration Area. If an oil spill occurred within the spring lead system during the bowhead migration (a low probability), some bowhead whales may contact spilled oil and experience baleen fouling, inhalation of toxic vapors, ingestion of oil or oil-contaminated prey, and irritation of sensitive tissues. A portion of those whales exposed to spilled oil may die or suffer respiratory distress. A prolonged spill into a major spring lead at the time of a bowhead migratory pulse could result in the exposure of a major portion of the bowhead whale population to spilled oil and the aforementioned effects, or might result in a delay in the migration if bowheads refused to migrate through the spilled oil. Also, it is likely that bowheads would attempt to avoid closely approaching exploratory-drilling units located within the spring lead system. If exploratory-drilling units are located within the spring lead system, the spring bowhead migration may or may not be able to occur normally, without delay or displacement, depending upon the location of drilling units in relation to spring leads being used by migrating bowheads. In the most likely case, MINOR effects on the bowhead population are expected as a result of oil spills and noise disturbance. Greater effects are possible, although less likely. Implementation of Stipulation No. 5 would greatly reduce the potential for noise and oil-spill effects in the spring lead system during the exploration period and would virtually eliminate the possible occurrence of greater than MINOR effects. However, even if Stipulation No. 5 is adopted, it is anticipated that noise and oil-spill effects could occur from exploration activities that would occur in areas through which bowhead whales migrate during the fall. Interaction with these activities by migrating bowheads would be expected to continue to result in MINOR effects on the bowhead whale population.

This stipulation would also affect the bowhead whale subsistence harvest. The projected scenario anticipates the use of two drillships and two bottom-founded units for exploration in the Sale 109 area. Drillships would not likely be in place until the open-water season occurs--after the whale-migration and whaling season has ended. The only exploration activities that would be of concern during the whale migration and the subsistence harvest would be from the two bottom-founded units that would be in place year-round. If a bottom- founded unit were placed in the vicinity of the whale-harvest area, noise from the drilling units and support vessels could interfere with the whale harvest. If an oil spill occurred during the whaling season, this could cause whalers to move their camps or suspend their whaling activities until the spill had been cleaned up and dissipated. During the years when bad weather and poor ice conditions occur, the whaling season can be as short as a couple of weeks. A spill that occurred during that period could cause a loss of the year's harvest, although such a spill is not likely to occur. As described above, implementation of Stipulation No. 5 would greatly reduce the risk of an oil spill or noise occurring during the whale migration, which also would reduce potential effects from exploration activities on the subsistence harvest in Barrow, Wainwright, or Point Hope from MODERATE to MINOR. While the fall migration could still be affected by exploration activities, these activities would not affect the subsistence harvest of bowheads--because Barrow is the only community in or near the sale area that harvests bowheads in the fall in an area to the west of Barrow, outside of the sale area.

Stipulation No. 6--Industry Site-Specific Bowhead Whale Monitoring Program

Lessees shall conduct a site-specific monitoring program during exploratory drilling activities to determine when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these activities. The lessee shall provide its proposed monitoring plan to the Regional Supervisor, Field Operations (RSFO), for review and approval no later than 60 days prior to commencement of drilling activities. Information obtained from this site-specific monitoring program shall be provided to the RSFO in accordance with the approved monitoring plan. This stipulation will remain in effect until termination or modification by the Department of the Interior after consultation with the National Marine Fisheries Service.

This stipulation applies to the following blocks for the following time period:

Spring Migration Area
April 1 to May 31

Official Protraction Diagram	Blocks Included
NR 2-6	728, 729, 771-773, 814-817, 856-861, 899-905, 941-949, 985-994, 1029-1038
NR 2-8	17-26, 61-70, 105-114, 150-158, 194-202, 238-246, 282-290, 326-334, 370-378, 414-422, 458-466, 502-510, 546-554, 590-598, 634-642
NR 3-4	243, 244, 284-288, 327-332, 370-376, 412-420, 454-464, 497-508, 539-552, 581-596, 624-640, 667-683, 710-726, 753-769, 796-812, 839-856, 882-899, 925-943, 969-986
NR 3-5	25, 26, 68-70, 111-114, 154-158, 197-202, 240-246, 282-290, 324-334, 367-378, 409-422, 451-466, 493-510, 535-554, 578-598, 620-642, 662-686, 706-730, 750-774, 794-818, 838-862, 882-906, 926-950, 969-994, 1013-1038

NR 3-6	1-18, 45-61, 89-104, 133-148, 177-191, 221-235, 265-279, 309-323, 353-366, 397-410, 441-454, 485-498, 529-542, 573-586, 617-630, 661-674, 705-718, 749-761, 793-804, 837-848, 881-891, 925-934, 969-977, 1013-1020
NR 3-7	2-27, 46-71, 90-104, 134-148, 178-192, 222-236, 266-280, 310-324, 354-368, 398-412, 442-455, 486-499, 530-542, 574-584, 618-627
NR 3-8	1-6
NR 4-3	12-24, 54-68, 96-110, 137-152, 179-195, 221-238, 265-281, 309-324, 353-367, 397-410, 441-454, 485-497, 529-539, 573-582, 617, 619-624
NR 4-4	1-11, 45, 47-54, 92-97

Purpose of Stipulation No. 6: This stipulation requires the lessee to conduct site-specific monitoring during exploratory-drilling activities occurring within the bowhead whale spring-migration period to determine when whales are present and any behavioral disturbances due to the activities.

Effectiveness of Stipulation No. 6: This stipulation, in conjunction with ITL No. 5 (Information on Endangered Whales and MMS Monitoring Program), addresses the NMFS's Conservation Recommendation No. 3 in the Sale 109 Biological Opinion and will help protect endangered bowhead whales during their spring migration from significant adverse effects due to exploratory activities. Should the information obtained from the MMS' or the lessees' monitoring programs indicate that there is a threat of serious, irreparable, or immediate harm to the species, the RSFO will require the lessee to suspend operations causing such effects, in accordance with 30 CFR 250.12. The provisions of this stipulation and the ITL will minimize the likelihood of disrupting whale migration, feeding, or socialization.

It is likely that some endangered whales would interact with the activity associated with exploratory-drilling units. It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. Some effects on endangered whales can be expected. If this measure is adopted, the overall effect level is expected to be the same as for the proposal--MINOR.

The subsistence harvest of whales also could be affected if Stipulation No. 6 is adopted; the monitoring program would provide more information on industrial effects on the bowhead whale, which ultimately could be beneficial to the whale harvest. In the event that the RSFO suspends exploration activities whenever whales are subject to a threat of serious, irreparable, or immediate harm to the species, the suspension also would be beneficial to the bowhead subsistence harvest. While the RSFO has the authority to suspend exploration activities, there could be disturbances that would interfere with whaling and thus cause an effect on the subsistence harvest--and yet not cause a threat to the species. Although Stipulation No. 6 would be beneficial to whale research and might slightly reduce the effect on the bowhead harvest, the effect of exploration activities would remain MODERATE in Barrow, Wainwright, and Point Hope.

b. Potential Information to Lessees: 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 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.

The following ITL's are proposed for Chukchi Sea Sale 109:

No. 1 - Information on Bird and Marine Mammal Protection
No. 2 - Information on Areas of Special Biological Sensitivity
No. 3 - Information on Protection of Endangered Whales
No. 4 - Information on Endangered Whales
No. 5 - Information on Endangered Whales and MMS Monitoring Program
No. 6 - Information on Development- and Production-Phase Consultation With NMFS to Avoid Jeopardy to Bowhead Whales
No. 7 - Information on the Arctic Peregrine Falcon
No. 8 - Information on the Chukchi Sea Biological Task Force
No. 9 - Information on Subsistence Whaling and Other Subsistence Activities
No.10 - Information on Coastal Zone Management

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, among others, the provisions of the Marine Mammal Protection Act (MMPA) of 1972, as amended; the Endangered Species Act (ESA) of 1973, as amended; and 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. With respect to endangered species, disturbance could be determined to constitute a "taking" situation in violation of the ESA. Under the ESA the term "take" has been defined to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Incidental takings of depleted marine mammals are only allowed when the statutory requirements of the MMPA and the ESA are met and Letters of Authorization (as contained in Section 101(a)(5) of the MMPA and Section 7(b)(4)(C) of the ESA) are obtained from the National Marine Fisheries Service (NMFS). Activities that are likely to "take" depleted marine mammals will be subject to these regulatory requirements. Violations under these acts and treaties may be reported to the NMFS or the U.S. Fish and Wildlife Service (FWS), as appropriate.

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 locating and identifying major wildlife-concentration areas in the lease area are available from the Regional Supervisor, Field Operations (RSFO). Lessees are also encouraged to confer with the FWS and the NMFS in planning transportation routes between support bases and leaseholdings.

Behavioral disturbance of most birds and mammals found in or near the lease area would be unlikely if aircraft and vessels maintained at least a 1-mile horizontal distance from and aircraft maintained at least a 1,500-foot 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-foot 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 disturbance of wildlife, particularly at known concentration areas. The Chukchi Sea is an important habitat for endangered and nonendangered marine mammals, marine birds, and waterfowl.

Effectiveness of ITL No. 1: The Chukchi Sea area is an important habitat for endangered and nonendangered marine mammals and marine birds. Of particular concern are: (1) bowhead whale populations that migrate through the Chukchi Sea from April through June and September through November; (2) gray whales that spend the summer feeding in the area (June through October); (3) other endangered whale species (fin and humpback) that occasionally occur in the sale area during the summer; (4) large groups of Pacific walrus hauled out along the pack-ice front; (5) large numbers of bearded and ringed seals occurring throughout the sale area, especially along the ice front; (6) concentrations of spotted seals hauled out along the barrier islands of Kasegaluk Lagoon and Icy Cape; (7) polar bears that sometimes congregate along the coast near Cape Lisburne, Icy Cape, and Point Franklin; (8) large seabird colonies at Capes Lisburne and Thompson; (9) waterfowl and shorebird concentrations at Kasegaluk Lagoon and Peard Bay; and (10) other areas identified in ITL No. 2 as areas of special biological sensitivity.

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 (30 years). It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. If this measure is adopted, effects on whales, walruses, seals, and seabirds are expected to be the same as for the proposal--MINOR.

ITL No. 2--Information on Areas of Special Biological Sensitivity

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, or other biological resources. Identified areas of special biological sensitivity include the spring lead system from April through July, the area from Icy Cape to the northern boundary of the sale area east of 162°W. longitude, Peard Bay, Kasegaluk Lagoon, and the open water within 12 miles of the major bird colonies at Cape Lisburne and Cape Thompson. These areas are among areas of special biological sensitivity to be considered in the oil-spill-contingency plan section of Alaska OCS Order No. 7. Lessees are advised that they have the primary responsibility for identifying these areas in their oil-spill-contingency plans and for providing specific protective measures. Additional areas of special biological sensitivity may be identified during review of exploration plans and development and production plans.

Consideration should be given in oil-spill-contingency plans as to whether use of dispersants is an appropriate defense in the vicinity of an area of special biological 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 birds, marine mammals, fishes, and other biological resources from oil spills in those areas that have been identified by Federal and State agencies and public-interest groups as important to the continued well-being of the biological resources.

Effectiveness of ITL No. 2: Consideration in oil-spill contingency plans of the identified areas of special biological sensitivity would 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 may reduce oil-spill effects on some coastal-wetland habitats of birds and reduce the chance of caribou encountering oil along the coast; but the overall level of effects on caribou and marine and coastal birds--as well as effects on pinnipeds, polar bears, and beluga whales--would not be reduced by this ITL. However, any local reduction of the effects on birds, marine mammals, and fishes should also reduce any adverse effects on subsistence-hunting activities. With the ITL in place, Peard Bay and Kasegaluk Lagoon would be considered during oil-spill-contingency planning. This would lessen the chance of oil reaching these areas and reduce the probability of a MODERATE effect on fish resources in these sensitive areas. Potential effects on kelp-bed communities in nearshore waters might be ameliorated by this ITL. The area within a 3-mile radius of Point Belcher is an important feeding area for gray whale cow/calf pairs. Identification of this area in the oil-spill-contingency plan will focus the need for more protection in this area, which will decrease the potential of a gray whale/oil-spill interaction. Overall, if this measure is adopted and observed, the effect of sale-related activities on the biological resources of the area would remain the same as for the proposal--MODERATE on fishes, and MINOR on lower-trophic-level organisms; marine and coastal birds; pinnipeds, polar bears, and beluga whales; gray whales; and caribou.

ITL No. 3--Information on Protection of Endangered Whales

> Lessees are advised that the Regional Supervisor, Field Operations (RSFO), has the authority and intends to limit or suspend oil and gas drilling activities on any lease whenever endangered whales are present and near enough to be subject to probable oil-spill risks or noise disturbance that would be likely to result in a threat of serious, irreparable, or immediate harm to these species. Exploratory drilling, testing, and other downhole activities may be prohibited whenever these whales are in the vicinity of the drilling operation. Such prohibition would continue until it is determined that the whales are outside of the zone of probable influence or are no longer subject to likely risk of oil spills or noise disturbance, unless the RSFO determines that continued operations are necessary to prevent a loss of well control or to ensure human safety. Bowhead whales are most likely to be in the sale area generally from April 1 through May 31 and from September 15 through November 15, gray whales from June 1 through October 31.
>
> To determine if bowhead or gray whales are in the vicinity of exploratory operations, the lessee may be required to conduct a suitable monitoring program concurrent with exploratory operations on the lease. The RSFO will consult with the National Marine Fisheries Service on the need for and design of the monitoring program and in determining the zones of influence around the exploratory operations.

Purpose of ITL No. 3: This ITL is designed to prevent the potential effects of activities associated with this sale from jeopardizing the continued existence of endangered whales or from otherwise adversely affecting them.

Effectiveness of ITL No. 3: Virtually the entire western arctic bowhead population migrates through the sale area during the spring and fall months. The spring migration is concentrated in the nearshore lead system whereas the fall migration appears rather widely dispersed across the sale area. A significant proportion of the gray whale population feeds primarily in coastal portions of the sale area during the summer and fall periods. Fin and humpback whales occasionally occur in the sale area in low numbers during the summer months.

Due to the advisory nature of this measure, it is likely that some endangered whales would interact with the activity associated with exploratory-drilling units. It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. If this measure is adopted, some effects on endangered whales can still be expected, and the overall effect level is expected to be the same as for the proposal--MINOR.

The subsistence harvest of bowhead whales also could be affected by ITL No. 3. Bowhead whales are the only endangered whales harvested in the Sale 109 area. In the event that the RSFO suspends exploration activities whenever whales are subject to a threat of serious, irreparable, or immediate harm to the species, the suspension also would be beneficial to the bowhead subsistence harvest. While the RSFO has the authority to suspend exploration activities, there could be disturbances that would interfere with whaling and thus cause an effect on the subsistence harvest--and yet not cause a threat to the species. The monitoring program would provide more information on the industrial effects on the bowhead whale population, which ultimately would be beneficial to the whale harvest. Although ITL No. 3 might slightly reduce the effects on the bowhead harvest, the effect of exploration activities would remain MODERATE in Barrow, Wainwright, and Point Hope.

ITL No. 4--Information on Endangered Whales

> Lessees are advised that the Regional Supervisor, Field Operations, has the authority and intends to limit or suspend any noise-producing operations, including preliminary activities, as defined under 30 CFR 250.34-1(a)(1), on a lease whenever endangered whales are near enough to be subject to noise disturbance from offshore oil and gas activities that would be likely to result in a threat of serious, irreparable, or immediate harm to the species.
>
> A Notice to Lessees (NTL) (similar to NTL No. 86-2 for the Beaufort Sea), which specifies performance standards for preliminary activities in the Chukchi Sea, will be issued prior to this sale.

Purpose of ITL No. 4: The purpose of this measure is to reduce the risk of endangered whales being adversely affected by any noise-producing activities, including geophysical-seismic surveys associated with OCS operations in the Chukchi Sea area.

Effectiveness of ITL No. 4: Due to the advisory nature of this measure, it is likely that some endangered whales would interact with the activity associated with platforms over the life of the field (30 years). It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. If this measure is adopted, some effects on endangered whales can still be expected, and the overall effect level is expected to be the same as for the proposal--MINOR.

The subsistence harvest of bowhead whales also could be affected by ITL No. 4. Bowhead whales are the only endangered whales harvested in the Sale 109 area. In the event that the RSFO suspends noise-producing activities whenever whales are subject to a threat of serious, irreparable, or immediate harm to the species, the suspension also would be of benefit to the bowhead subsistence harvest. While the RSFO has the authority to suspend noise-producing activities, there could be disturbances that would interfere with whaling and thus cause an effect on the subsistence harvest--and yet not cause a threat to the species. Although ITL No. 4 might slightly reduce the effects on the bowhead harvest, the effects of the proposal on the Wainwright bowhead whale harvest would remain MAJOR.

ITL No. 5--Information on Endangered Whales and MMS Monitoring Program

> Lessees are advised that the Minerals Management Service (MMS) intends to continue its areawide endangered whale-monitoring program in the Chukchi Sea during exploration activities. The program will gather information on whale distribution and abundance patterns and

will provide the Regional Supervisor, Field Operations (RSFO), with additional assistance in determining the extent, if any, of adverse effects to the species.

Lessees are further advised that the RSFO has the authority and intends to limit or suspend any operations, including preliminary activities, as defined under 30 CFR 250.34-1(a)(1), on a lease whenever bowhead whales are subject to a threat of serious, irreparable, or immediate harm to the species. Should the information obtained from MMS' or lessees' monitoring programs indicate that there is a threat of serious, irreparable, or immediate harm to the species, the RSFO will require the lessee to suspend operations causing such effects, in accordance with 30 CFR 250.12. Any suspensions may be terminated at any time when the RSFO determines that circumstances which justified the ordering of suspension no longer exist. A Notice to Lessees (NTL) (similar to NTL No. 86-2 for the Beaufort Sea), which specifies performance standards for preliminary activities in the Chukchi Sea, will be issued prior to this sale.

Incidental takings of depleted marine mammals are only allowed when the statutory requirements of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) are met and Letters of Authorization (as contained in Section 101(a)(5) of the MMPA and Section 7(b)(4)(C) of the ESA) are obtained from the National Marine Fisheries Service. Activities that are likely to "take" depleted marine mammals will be subject to these regulatory requirements.

Purpose of ITL No. 5: The purpose of this measure is to prevent serious, irreparable, or immediate harm to the species by reducing the risk of bowheads being adversely affected by oil and gas exploration activities within the proposed sale area.

Effectiveness of ITL No. 5: The ITL, in conjunction with Stipulation No. 6 on the industry monitoring program, satisfies the NMFS' Conservation Recommendation No. 3 in the Biological Opinion and will help protect bowhead whales during migration from significant adverse effects due to exploratory activities. If the monitoring programs indicate a threat of adverse effects, the RSFO will require the lessee to limit or suspend operations causing such effects, in accordance with 30 CFR 250.12.

It is likely that some endangered whales would interact with the activity associated with exploratory-drilling units. It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. If this measure is adopted, some effects on endangered whales can be expected, and the overall effect level is expected to be the same as for the proposal--MINOR.

The subsistence harvest of bowhead whales also could be affected by ITL No. 5. Bowhead whales are the only endangered whales harvested in the Sale 109 area. In the event that the RSFO suspends exploration activities whenever whales are subject to a threat of serious, irreparable, or immediate harm to the species, the suspension also would be beneficial to the bowhead subsistence harvest. While the RSFO has the authority to suspend exploration activities, there could be disturbances that would interfere with whaling and thus cause an effect on the subsistence harvest--and yet not cause a threat to the species. The monitoring program would provide more information on the industrial effects on the whale population, which ultimately would be beneficial to the whale harvest. Although ITL No. 5 might slightly reduce the effects on the bowhead harvest, the effect of exploration activities would remain MODERATE in Barrow, Wainwright, and Point Hope.

ITL No: 6--Information on Development- and Production-Phase Consultation With the NMFS to Avoid Jeopardy to Bowhead Whales

> The Minerals Management Service (MMS) has been advised by the National Marine Fisheries Service (NMFS) that, based on currently available information and technology, the NMFS believes that development and production activities in the spring lead system used by bowhead whales along the Chukchi Sea coast would likely jeopardize the continued existence of the bowhead whale population. The NMFS has advised that they will reconsider this conclusion when new information, technology, and/or measures become available or are proposed that would effectively eliminate or otherwise mitigate this potential jeopardy situation. Lessees are advised that specific options, alternatives, and/or mitigating measures may be developed for production and development activities during the MMS consultation with the NMFS as new information or technology is developed for specific development plans.

Purpose of ITL No. 6: The ITL addresses the NMFS' concern under their Incremental Step Consultation in the Sale 109 Biological Opinion that, based on current available information and technology, development and production within the spring lead system would likely jeopardize the continued existence of the bowhead whale population. The lessees are advised that consultation will be conducted with the NMFS before development and production will be allowed within the spring lead system, and that specific options and alternatives to protect the bowhead whale may be developed as a result of new information and technology.

Effectiveness of ITL No. 6: ITL No. 5 (Information on Endangered Whales and MMS Monitoring Program), along with Stipulation No. 6 (Industry Site-Specific Bowhead Whale-Monitoring Program), will provide additional biological information over at least the next 5 years (minimum time before development). This additional information, along with any advances in technology, will aid both the NMFS and the MMS in developing alternatives to prevent a jeopardy situation during future consultation, especially consultations concerning development and production within the identified spring lead system. While this ITL will assist in preventing a jeopardy situation, the overall effect level of sale-related activities on the bowhead whale population is expected to be the same as for the proposal--MINOR.

ITL No. 7--Information on the Arctic Peregrine Falcon

> Lessees are advised that the arctic peregrine falcon (Falco peregrinus tundrius) is listed as threatened by the U.S. Department of the Interior and is protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Peregrines are generally present in Alaska from mid-April to mid-September and are most disturbed by human activities in the vicinity of nest sites. The conduct of OCS exploration or development and production activities will not conflict with arctic peregrine falcons if onshore facilities are located away from known nest sites. The lessee should contact the U.S. Fish and Wildlife Service (FWS) for information on locations of known nest sites of peregrine falcons. Aircraft should maintain at least a 1-mile horizontal and 1,500-foot vertical distance from known or potential peregrine nest sites to avoid conflict.

Lessees are advised that the FWS will review exploration plans and development and production plans submitted by lessees to the Minerals Management Service (MMS). The FWS review may determine that certain restrictions could apply to further protect arctic peregrine falcon habitats. Lessees and affected operators should establish regular communication with the MMS and the FWS. Human safety should take precedence at all times over these recommendations.

Purpose of ITL No. 7: The purpose of this measure is to prevent noise or human disturbance from OCS exploration activities from adversely affecting peregrine falcons adjacent to the sale area. This protection is accomplished by advising the lessees of (1) minimum distances that aircraft should maintain from known or potential peregrine nest sites and (2) the role of the FWS in reviewing exploration plans and development and production plans and determining what restrictions, if any, may be applied.

Effectiveness of ITL No. 7: Compliance by lessees with the recommendations described in this ITL should decrease the adverse effects of aircraft traffic on peregrines. Likewise, it is believed that noise-disturbance effects from onshore facilities could be eliminated if such facilities are located away from known nest sites. However, the proposed onshore pipeline may not avoid all peregrine nest sites. Consequently, effects of sale-related activities under this ITL would be MINOR, the same as under the proposal.

ITL No. 8--Information on the Chukchi Sea Biological Task Force

In the enforcement of the Protection of Biological Resources stipulation, the Regional Supervisor, Field Operations (RSFO), will consider recommendations from the Chukchi Sea Biological Task Force (BTF) composed of designated representatives of the Minerals Management Service, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Environmental Protection Agency. Personnel from the State of Alaska and local communities are invited and encouraged to participate in the proceedings of the BTF. The RSFO will consult with the Chukchi Sea BTF on the conduct of biological surveys by lessees and the appropriate course of action after surveys have been conducted.

Purpose of ITL No. 8: The purpose of this ITL is to establish a formal means of advising the RSFO about matters regarding enforcement of the Protection of Biological Resources stipulation. The recommendations of the Chukchi Sea BTF should provide for better decisionmaking concerning biological resources and increased protection of these resources from possible adverse effects.

Effectiveness of ITL No. 8: Biological task forces have proven helpful in providing technical guidance to the RSFO on decisions concerning many Alaskan OCS lease sales. The BTF for Sale 109 in the Chukchi Sea should be no exception. Although effects levels of the proposal on biological resources would be reduced by this ITL, the overall level of effects would remain the same.

ITL No. 9--Information on Subsistence Whaling and Other Subsistence Activities

> Federal and State laws recognize subsistence as a priority use of wildlife resources. Lessees are therefore advised that operations should be conducted so as to avoid unnecessary interference with subsistence harvests.
>
> Lessees are advised that the coastal area of the entire Chukchi Sea sale area out to 20 miles from shore is used extensively for whaling and other subsistence activities by the residents of Barrow, Wainwright, Point Lay, and Point Hope. Spring whaling is particularly sensitive to disturbance and takes place during the period from April to June.
>
> Lessees are encouraged to consult with local communities and regional organizations, including the Alaska Eskimo Whaling Commission and local whaling captains, to develop a program of exploration and development that minimizes disturbance of these critically significant subsistence activities.

Purpose of ITL No. 9: The activities and attitudes that surround subsistence form the core of Native culture in the Chukchi Sea area. Local concerns about effects on subsistence are a major scoping issue. The intent of this ITL is to encourage lessees to conduct themselves in a responsible manner with regard to Native subsistence needs and thus avoid adverse effects on local subsistence harvests and cultural values.

Effectiveness of ITL No. 9: Lessee awareness of, and sensitivity to, Inupiat subsistence whaling and other subsistence activities could reduce adverse effects on local subsistence harvests and sociocultural systems, but not enough to reduce the MAJOR effects on subsistence-harvest patterns or the MODERATE effects on sociocultural systems.

ITL No. 10--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, the Northwest Arctic Borough (previously the Northwest Alaska Native Association [NANA] Coastal Resource Service Area) and the North Slope Borough (NSB) have developed local coastal management programs. The Northwest Arctic Borough Coastal Management Program (CMP) and the NSB CMP have been adopted by the Alaska

Coastal Policy Council and will become part of the ACMP if approved by the U.S. Department of Commerce. The NSB and Northwest Arctic Borough CMP's contain more specific policies related to transportation corridors; energy-facility siting; geologic hazards; and protection of subsistence areas and resources, habitats, and historic and prehistoric resources.

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. 10: The purpose of this ITL is to inform lessees of pertinent 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 those of the ACMP.

Effectiveness of ITL No. 10: This ITL could help to alleviate potential conflicts with both land use regulations and coastal management policies by alerting lessees that Alaska has an approved CMP that may be amended by the North Slope Borough and Northwest Arctic Borough district programs. Policies included in the ACMP are designed to prevent or to mitigate environmental and social problems that may be associated with development. Conformance with these policies would help to alleviate effects, especially on caribou and subsistence-harvest patterns noted in Sections IV.B.8 and IV.B.10. Several other stipulations and ITL's complement the objectives of the State's coastal management policies. The conclusions for land use and coastal management reached in this EIS are expected to remain MAJOR because the development creating the conflict would be the same. However, if the ITL were adopted, the process of obtaining final approval of projects could be substantially eased.

I. Summary and Comparison of Effects of Alternatives

Table II-14 presents a summary and comparison of potential effects for Alternatives I, IV, V, VI, and the cumulative case. The summaries presented are in tabular form to allow the reader to compare alternatives. Please see the analyses in Section IV for more in-depth discussion of the topics summarized in Table II-14. Terms that indicate levels of effect (i.e., NEGLIGIBLE, MINOR, MODERATE, MAJOR) are defined in Table S-2 (also located in the front of this EIS).

TABLE II-14. SUMMARY AND COMPARISON OF EFFECTS OF THE PROPOSAL, CUMULATIVE CASE, AND THE ALTERNATIVES

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
Air Quality	
The DOI exemption levels could be exceeded from typical offshore operations--a MINOR effect with regard to standards. The quantities of acid pollutants that would be emitted by Sale 109 activities are insufficient to pose a risk of acidification to the tundra ecosystem. Sulfur-dioxide emissions could cause short-term depression of photosynthetic rates in sensitive vegetation--a MINOR effect. Accidental emissions from blowouts, spills, or in situ burning of spills are expected to have MINOR effects on air quality.	Production emissions, particularly from Sale 109, are expected to cause MINOR effects on onshore air quality with regard to standards. Accidental emissions would also occur, but these would persist for short periods and are expected to have a MINOR effect on air quality. Sulfur-dioxide emissions could cause short-term depression of photosynthetic rates in sensitive vegetation--a MINOR effect.
Water Quality	
Oil spills of 1,000 barrels or greater would temporarily and locally increase water-column hydrocarbon concentrations. Although a spill of 100,000 barrels or greater is extremely unlikely, such a spill could temporarily degrade water quality over several hundred square kilometers, resulting in a MODERATE effect on water quality. The seven spills of 1,000 barrels or greater anticipated over the production life of the field could result in detectable, frequent, but short-term, oil contamination of pack ice over long distances--a MODERATE effect on water quality. Deliberate discharges are regulated by the EPA such that any effects on water quality must be extremely local; water-quality criteria cannot be exceeded at greater than a 100-meter distance from the discharge point. Discharge of formation waters (rather than their reinjection into the seafloor) would result in long-term pollution in the vicinity of the oil field--a MINOR effect on water quality. Long-term, or regional, effects are unlikely under the proposal. Construction activities and permitted drilling discharges are likely to result in local short- and long-term degradation of water quality. The effect of proposed Sale 109 on water quality is expected to be MODERATE.	Under the cumulative case, seven spills of 1,000 barrels or greater are assumed to occur and contact the Sale 109 area. Such spills would contaminate pack ice for an entire winter over long distances and would have a MODERATE effect. Other agents--smaller spills, dredging, construction, or removal projects--and deliberate discharges would locally degrade water quality and would have no more than a MINOR effect on water quality. The overall cumulative effect on water quality would be MODERATE. Cumulative development in the vicinity of the Sale 109 area could, several times, result in winter-long contamination of pack ice and could have a MODERATE effect on water quality. Other agents would have relatively little effect on water quality, and the overall cumulative effect is expected to remain MODERATE.
Lower-Trophic-Level Organisms	
Marine plants and invertebrates of greatest concern because of their abundance or trophic relationships are: (1) benthic epifauna and infauna that serve as prey for numerous higher-order consumers such as marine mammals, fishes, birds, and other	Under the cumulative case, effects on marine plants and invertebrates are most likely to be MINOR; however, the occurrence of possible State oil-lease Sales 45, 58, and 60 in the Chukchi Sea

ALTERNATIVE IV	ALTERNATIVE V	ALTERNATIVE VI
Under Alternative IV, the magnitude and rates of air-pollutant emissions would be identical to those for the proposal. The shoreline north of Naokok Pass would be more protected from offshore emissions because such emissions would be at least 29 kilometers offshore. Because of potential development closer to shore, pollutant concentrations would likely be highest south of Naokok Pass rather than north of the pass. Emissions could still exceed exemption levels--a MINOR effect on air quality with regard to standards. Accidental emissions and permitted sulfur-dioxide emissions could still cause short-term, local environmental degradation--a MINOR effect.	Under Alternative V, the magnitude and rates of air-pollutant emissions would be identical to those for the proposal. The shoreline west of about Cape Sabine would be more protected from offshore emissions because such emissions would be at least 29 kilometers offshore. Pollutant concentrations would likely be highest immediately to the north of the suggested deferral area because exploration and development could occur 5 kilometers from shore. Emissions could still exceed exemption levels--a MINOR effect on air quality with regard to standards. Accidental emissions and permitted sulfur-dioxide emissions could still cause short-term, local environmental degradation--a MINOR effect.	Under Alternative VI, the magnitude and rates of air-pollutant emissions would be less than those for the proposal and would occur at least 41 kilometers from shore--the closest point of remaining blocks to shore. Emissions of nitrogen oxides during peak development would be 34-percent lower than estimated for the proposal and farther offshore. Pollutant concentrations would likely be highest along the more northern shoreline rather than in the south because the suggested coastal deferral area extends farther from the coast in the southern portion of the Sale 109 area. Emissions during development, but not during exploration, could exceed exemption levels--a MINOR effect on air quality with regard to standards. Accidental emissions and permitted sulfur-dioxide emissions could still cause short-term, local environmental degradation--a MINOR effect.
Effects associated with Alternative IV would be essentially the same as those discussed for the proposal. Oil spillage is estimated as proportionate to the number of exploration wells and the quantity of oil produced and transported; these parameters would not change under this alternative. Most importantly, most spillage within the area suggested for deferral is not from platform spillage, but is attributable to spills from pipelines that cross the suggested deferral area. Winter spills would still occur under this alternative, causing short-term contamination of the ice pack over long distances. Under Alternative IV, the short-term contamination of winter pack ice over long distances in the Sale 109 area would have a MODERATE effect on water quality. Thus, the effect of Alternative IV on water quality is expected to be MODERATE.	Effects associated with Alternative V would be essentially the same as those discussed for the proposal. Oil spillage is estimated as proportionate to the number of exploration wells and the quantity produced and transported; these parameters would not change under this alternative. However, Alternative V would eliminate the possibility of a spill occurring within the suggested deferral area. (The only pipelines in the area would transport oil produced in the potentially deferred area). Under Alternative V, winter spills would still occur elsewhere and cause short-term contamination of the ice pack over long distances. The short-term contamination of winter pack ice over long distances in the Sale 109 area would have a MODERATE effect on water quality. The effect of Alternative V on water quality is expected to be MODERATE.	Effects associated with Alternative VI would be slightly less than those discussed for the proposal. A most likely number of five or six spills of 1,000 barrels or greater is projected for this alternative. Platform spills and deliberate discharges would not occur in the deferred area. However, oil pipelines would still be built through the deferred area to shore; and pipeline spills are projected to occur in the deferred area. Winter spills would still occur under this alternative, causing short-term contamination of the ice pack over long distances. Under Alternative VI, the short-term contamination of winter pack ice over long distances in the Sale 109 area would have a MODERATE effect. The effect of Alternative VI on water quality is expected to be MODERATE.
Under Alternative IV, the effects on marine plants and invertebrates would be similar to those expected for the proposal, except the poten-	Alternative V would not alter the probability that an oil spill would occur and contact marine plants and invertebrates of	Under Alternative VI, there would be reductions in the number of platforms (by 2), the number of wells drilled (by 32), and the

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
invertebrates; (2) kelp beds; (3) planktonic and epontic communities, especially their linkage to other consumers; and (4) in particular, the dense planktonic community occurring off of Cape Lisburne that indirectly supports the huge colonies of seabirds nesting nearby. Oil spills are more likely to cause widespread negative effects on marine plants and invertebrates than are other activities associated with exploration, development, and production of oil resources. In general, oil spills are most likely to have MINOR effects on marine plants and invertebrates, since the distributions of most of these organisms are quite broad, and recolonization of affected areas is quite likely unless sediments become too contaminated. At greater risk to effects are benthic and epibenthic organisms living in shallow nearshore environments, where contact with oil could occur more easily. A very large spill that contaminated nearshore sediments could affect populations of benthic invertebrates, perhaps for years. However, the oil-spill-risk analysis indicates that nearshore areas are very unlikely to be affected by spilled oil. Oil-spill effects on planktonic and epontic communities are expected to be MINOR due to the limited area likely to be affected. Effects on these communities are not expected to be noticeably translated to higher trophic levels, although if a large spill occurred in the Cape Lisburne area during the open-water season, some seabirds could be affected for that year. Effects from other activities (seismic exploration, drilling discharges, construction activities) would be very localized. The effect of seismic exploration would be NEGLIGIBLE; the effects of drilling discharges and construction activities generally are expected to be MINOR. Kelp-bed communities in the Chukchi Sea are more vulnerable to effects from oil-related activities, since they are uncommon (only 2 have been reported) and are very restricted spatially. Because productivity and successful recruitment could be affected if a large or continuous oil spill occurred nearby, effects could be MODERATE. However, MINOR effects from oil spills on this community are most likely. The location of wells (as related to drilling discharges) and construction activities could also lead to more significant (larger) effects on kelp beds if these activities were located close to, or in the midst of, kelp beds. Drilling discharges that occurred too close (probably within 1,000 m) to kelp beds could lead to MODERATE effects, while construction that occurred within a bed could have a MAJOR effect. Drilling discharges and construction activities associated with Sale 109 are more likely to have a MINOR effect on kelp beds, since the kelp beds are located near the periphery of the sale area. The effect of proposed Sale 109 on lower-trophic-level organisms is most likely to be MINOR.	and environs would increase the probability that marine plants and invertebrates in nearshore and lagoonal environments would be affected. (These sales have been deferred from the current State 5-year lease schedule, but may be reinstated.) Kelp-bed communities are particularly vulnerable because of their apparent rarity and restricted distributions. Effects on these communities are more likely to be elevated in the cumulative case: effects are more likely to be MODERATE from oil spills and drilling discharges and MAJOR from construction activities. Cumulative effects on lower-trophic-level organisms are expected to be MINOR.
Fishes	
Oil spills pose the greatest threat to the fish resources of the Sale 109 area. In general, offshore oil spills are most likely to have a MINOR effect on fishes, since these organisms are mobile and often have broad distributions. Fishes concentrated in estuarine nearshore areas are more vulnerable to effects from offshore oil spills than are other fishes. Potentially vulnerable species include salmon, arctic cod, capelin, and rainbow smelts. Salmon smolts live in the nearshore area prior to moving to the open ocean. Arctic cod and capelins form large groups in estuarine areas during the open-water season and are thought to spawn only once. Rainbow smelts form aggregations at the mouths of spawning rivers in late winter. A MODERATE effect is possible for those species (e.g., salmon and possibly	When all other existing and proposed activities in this area are considered, the level of effect on fishes would not change from that of the proposal. The major activities considered include possible State and Federal offshore and onshore oil leasing. Activities on the NPR-A, and State sales along Kasegaluk Lagoon and from Icy Cape almost to Barrow, are the most likely additional activities to have an effect on fishes. (State sales in these areas have been deferred from the current State 5-year lease schedule, but may be reinstated.) The State sales are in the nearshore zone where oil spills, drilling discharges, and

tial for higher-order effects on kelp-bed communities would be reduced. Adverse effects on these organisms from drilling discharges, dredging, and construction activities would not occur in the deleted area. The removal of these activities substantially reduces the potential for MODERATE or MAJOR effects on kelp-bed communities. Potential oil-spill effects on marine plants and invertebrates of concern would be negligibly altered by this alternative and are most likely to be MINOR, the same as for the proposal. Thus, the effect of Alternative IV on lower-trophic-level organisms is expected to be MINOR.

greatest concern in the sale area, including the dense planktonic community occurring off of Cape Lisburne that indirectly supports huge colonies of nesting seabirds. However, deferral of this area would eliminate pipeline and platform spills from occurring within the deferred area. Under Alternative V, the most likely oil-spill effects on marine plants and invertebrates are considered to be MINOR. Adverse effects from drilling discharges, dredging, and construction activities would not occur within the deferred area; but effects from these activities are still most likely to be MINOR under this alternative. Thus, the effect of Alternative V on lower-trophic-level organisms is expected to be MINOR.

quantities of drilling fluids discharged. These reductions would decrease the extent of localized effects on marine plants and invertebrates, but the level of effect is expected to remain the same as for the proposal--MINOR. Potential risks to kelp beds and other organisms in more nearshore waters should be reduced because construction activities and drilling discharges would occur more distantly in offshore areas. The most likely number of oil spills of 1,000 barrels or greater would be reduced from seven for the proposal to five or six under Alternative VI. However, there is only a slight change in the probability that an oil spill would occur and contact areas of particular interest. This change would not alter the expected effects of oil on pelagic communities or marine plants and invertebrates in general; these effects are expected to remain MINOR. Thus, the effect of Alternative VI on lower-trophic-level organisms is expected to be MINOR.

Under Alternative IV, exploration and development activities would not occur within 32 to 48 kilometers of Kasegaluk Lagoon and Peard Bay. Concentrations of anadromous and marine fishes (adults, larvae, and eggs) occur in these nearshore areas and hence are vulnerable to adverse affects from oil-spills and drilling discharges. The decrease in drilling discharges and platform oil spills near these areas would decrease the possibil-

Under Alternative V, the area around Cape Lisburne and Cape Lewis would be deferred from exploration and development activity. This would decrease the probability of the Kukpuk River mouth and associated fish resources being affected by oil spills, drilling discharges, or construction activities. The rest of the Sale 109 area, however, would be offered for exploration and development. The development

Under Alternative VI, construction, drilling-effluent discharges, and platform oil spills would occur farther offshore and would be less likely to contact the nearshore area. Since the nearshore waters contain the highest densities of both anadromous and marine fishes during the open-water season, the potential effects from these activities on fishes would be reduced. The smaller number of oil spills

ALTERNATIVE I (The Proposal)

capelin) where the effect on a year-class of spawning adults or young could be felt for a number of years. A MODERATE effect is also possible if aggregated multi-aged assemblages are affected. The probability of an unweathered spill contacting estuarine areas during the summer is less than 0.5 percent, so a MODERATE effect is not likely. Although the probability of an oil spill contacting the nearshore area is higher during the winter, only Wrangel Island is likely to be affected. Oil contacting nearshore areas could have a MODERATE effect on rainbow smelts, but this is still not probable. Onshore spills could also affect fishes. A large spill from the projected onshore pipeline that contacted a major river system is likely to have a MODERATE effect on fishes by affecting overwintering and rearing habitat, sensitive lifestages, and/or concentrations of fishes. Anadromous fishes are more vulnerable to effects from onshore spills since most species spend the majority of the year in

freshwater and all age classes may be present in the winter. Since the Colville River harbors the most extensive overwintering areas of rivers feeding into the Alaskan Beaufort Sea, effects on fishes could be MAJOR if the Colville were contaminated by a large oil spill. Oil spills are likely to have an overall MODERATE effect on fishes; other oil-development activities are most likely to have MINOR effects on fishes. The effect of proposed Sale 109 on fishes is likely to be MODERATE.

CUMULATIVE EFFECTS

construction activities would be more likely to affect concentrations of various lifestages of fishes (adults, larvae, and eggs). Oil spills, however, remain the most likely event to affect fishes. With the increased activity under the cumulative case and the greater likelihood that oil spills would occur, there is an increased probability that important fish habitats would be contacted by oil. Therefore, the probability of both MODERATE and MAJOR effects would increase, although a MAJOR effect is still unlikely. The effect of activities other than oil spills would be MINOR. Cumulative effects on fishes are likely to be MODERATE.

Marine and Coastal Birds

ALTERNATIVE I (The Proposal)

The seven oil spills estimated to occur under the proposal may result in the loss of several hundred to several thousand sea ducks or seabirds in offshore waters over the 30-year life of the field. However, the chance of any of these spills contacting coastal concentrations of tens of thousands of birds is very low (less than 10%). Even if contact with coastal lagoons occurred, the oil would be highly weathered and would have little effect on sensitive habitats and populations. The loss of several thousand sea ducks and murres would represent MINOR effects because recruitment would replace lost individuals within less than one generation (1 or 2 years). Aircraft traffic (124-810 flights/ month) would be the primary source of noise and disturbance of seabirds, waterfowl, and shorebirds along the coast of the sale area. However, most air traffic from the proposal would fly directly from the shorebase at Point Belcher, or from Barrow or Wainwright, to the offshore platforms--not along the coast. Thus, aircraft disturbance of coastal concentrations of birds is likely to be infrequent and represent MINOR effects. Drillship-, icebreaker-, and supply-boat-traffic disturbance of birds would occur primarily offshore--away from coastal concentrations--and result in very brief, short-term diving and flight reactions by the birds, with NEGLIGIBLE effects.

Offshore installation of nine production platforms, trenching and laying of 400 kilometers of offshore pipeline, and construction of 640 kilometers of onshore pipeline and a haul road would temporarily (one season) disturb and displace some birds in local habitats near these facilities during construction activities (MINOR effects). Benthic environments very near the platforms and the offshore pipelines would be temporarily altered, while some onshore tundra habitats (25-30 hectares) at Point Belcher and along the onshore pipeline (estimated 64 km^2) would be altered or destroyed, representing a very small percentage of available habitat and MINOR effects. The effect of proposed Sale 109 on marine and coastal birds is expected to be MINOR.

CUMULATIVE EFFECTS

Bird habitats south of Cape Lisburne are at little or no oil-spill-contact risk from the proposal or from Canadian tankering. State oil-lease Sales 45, 58, and 60 in Hope Basin, Kasegaluk Lagoon, and Peard Bay, respectively, (although deferred from the current State 5-year lease schedule) could, if reinstated, have the most noticeable effects on birds because these sales would include coastal-concentration habitats of birds. Perhaps thousands to tens of thousands of birds could be killed as a result of oil spills over the life of these projects. The species likely to suffer high mortality rates (10,000 or more killed) from oil spills include common and thick-billed murres, oldsquaw, and eiders. If one or more spills--particularly from possible State Sales 58 and 60--contaminated coastal salt marshes, oldsquaw, eiders, brant, and other waterfowl could also suffer high losses. Oil spills probably would have no more than MODERATE effects on common species such as murres, oldsquaw, and common eiders because these birds are not likely to be exposed to many of these spills--which probably would occur during the winter season when most birds are absent from the area, and because recruitment of birds from unaffected parts of the regional populations is likely to replace lost individuals within one to a few generations.

The primary sources of cumulative noise and disturbance of marine and coastal birds are offshore air (124-810 round trips/month) and vessel traffic (perhaps over 100 vessels/year) and onshore motor-vehicle traffic (several hundred vehicles/day). The proposal--the primary source of offshore air traffic--would have NEGLIGIBLE effects on birds on their offshore feeding grounds but MINOR effects on colonial-nesting birds and

ALTERNATIVE IV	ALTERNATIVE V	ALTERNATIVE VI

ity of adverse effects on fishes. However, potential offshore oil spills could still kill some fishes and thus have a MINOR effect on affected populations. But, since the estimated oil resource is the same as for the proposal and this oil would be transported via pipelines through this area to Point Belcher, the risk from offshore oil spills would not decrease. Potential spills from the projected onshore pipeline would not be affected by this deferral alternative. Since the highest-order effects are likely to come from onshore pipeline spills, the likely effect of Alternative IV on fishes remains the same as for the proposal--MODERATE.

scenario is the same as for the proposal, since there are negligible oil resources within this deferred area. The overall effect of Alternative V on anadromous and marine fishes is likely to be MODERATE.

estimated under this alternative *decreases the probability of oil* contact with any of the nearshore areas. Potential spills from the projected onshore pipeline would not be affected by this deferral alternative. Since the highest-order effects are likely to come from onshore pipeline spills, the likely effect of Alternative VI on fishes remains the same as for the proposal--MODERATE.

This alternative would defer exploration within about 32 kilometers of Kasegaluk Lagoon and within about 48 kilometers of Peard Bay--important habitats of several thousand sea ducks, geese, and shorebirds. However, the chance of oil spills (seven for both this alternative and the proposal) contacting these habitats within 10 days of spill release is nil (during the open-water season) for both Alternative IV and the proposal. Potential oil spills occurring in blocks within Alternative IV or along the pipeline route could still kill several hundred or more sea birds or sea ducks, representing MINOR effects on bird populations. Noise and disturbance of birds along the coast of Kasegaluk Lagoon and Peard Bay could be reduced from MINOR to perhaps NEGLIGIBLE, but habitat-alteration effects from construction of the 640-kilometer onshore pipeline would be the same as for the proposal--MINOR. The overall effect of Alternative IV on marine and coastal birds is expected to be MINOR.

Alternative V would reduce the chances of oil spills occurring within 40 to 48 kilometers of the Cape Lisburne and Cape Lewis seabird colonies, where over 150,000 birds nest. Thus, potential oil-spill effects (loss of several thousand seabirds) on the Capes Lisburne and Lewis colonies could be greatly reduced under this alternative. However, noise and disturbance effects from aircraft traffic and habitat alteration (by the 640-km pipeline and support road) would still have MINOR effects on several thousand ducks, geese, and shorebirds that use coastal and tundra habitats north of Cape Lisburne and Ledyard Bay. The overall effect of Alternative V on marine and coastal birds is expected to be MINOR.

This alternative would reduce the chance of oil spills occurring within 41 to 113 kilometers of the coast near major concentrations of marine and coastal birds at Cape Lisburne, Kasegaluk Lagoon, and Peard Bay. However, these coastal bird habitats would still be at risk from spill contact due to the pipeline transportation of oil to Point Belcher (the landfall site assumed for Alternative VI as well as the proposal). Oil spills occurring on offshore lease blocks could still kill several hundred birds and have MINOR effects on bird populations. Under this alternative, noise and disturbance of several thousand birds could be reduced somewhat with aircraft traffic to only seven platforms, versus nine platforms under the proposal. However, marine and coastal birds would still be disturbed by aircraft traveling to the seven offshore platforms (MINOR effects, as for the proposal). Onshore transportation of oil through the 640-kilometer pipeline would be the same under this alternative as for the proposal; thus, habitat effects are expected to be the same as for the proposal--MINOR. The overall effect of Alternative VI on marine and coastal birds is expected to be MINOR.

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
	the coastal concentration of staging waterfowl and shorebirds if the helicopters passed near the seabird colonies and coastal lagoons during the open-water season. Most vessel traffic associated with the proposal and the Prudhoe Bay Sealift would remain offshore and not disturb concentrations of nesting and feeding birds. Cumulative vessel traffic is likely to have NEGLIGIBLE disturbance effects on birds. Most onshore air and ground traffic would be associated with NPR-A development, possible State Sale 53, the 640-kilometer oil pipeline/road associated with the proposal, and increased vehicle traffic from NSB communities. Noise and disturbance of tundra-nesting birds from onshore oil development would be greatest during construction activities (perhaps several hundred vehicles/day on the roads) and would subside after facilities are in place (perhaps less than 50 vehicles/day). These effects are likely to be MINOR for most bird populations occurring on the North Slope, but MODERATE effects on sensitive waterfowl species such as Pacific brant and snow geese are possible. Cumulative habitat loss from facility-construction activities (such as gravel mining and gravel facility-pad construction and road and pipeline construction), loss of habitat due to bird-population avoidance of habitat areas with high levels of noise and disturbance, and direct loss of birds from oil spills or habitat contamination are likely to have MODERATE effects on some bird populations such as murres, eiders, and oldsquaw. MAJOR effects (loss of several hundred thousand birds) on the murres and auklets of Little Diomede Island could occur if a major oil spill occurred in the Bering Strait during the fall, when over 1 million molting birds are rafting on the water (mortalities would be very high). MODERATE to MAJOR effects on snow geese and Pacific brant are possible from onshore oil development in the Teshekpuk Lake area of the NPR-A. Cumulative effects on marine and coastal birds are expected to be MODERATE.
Pinnipeds, Polar Bears, and Beluga Whales	
The seven oil spills estimated to occur under the proposal may contact several hundred to several thousand walruses; perhaps a few hundred ringed, bearded, and spotted seals; and a few polar bears and beluga whales in the migration corridor or drifting pack-ice front of the Chukchi Sea. Only highly stressed adult walruses and calves, stressed adult seals and very young seal pups, and a small number of polar bears are likely to die from direct or indirect effects of oil spills. These losses of walruses, seals, polar bears, and beluga whales would be replaced within one generation, representing MINOR effects. The seven oil spills may have some local long-term effects on the benthic prey of walruses and bearded seals; however, the amount of benthic habitat and prey affected is likely to be very small in comparison to the amount of benthic resources available in the Chukchi Sea. Therefore, effects on walruses and bearded seals from changes in the quality and quantity of food due to the seven oil spills are expected to be MINOR. Air traffic associated with the proposal (124-810 flights/month) could have some serious or lethal effects on walrus nursery	All six species of nonendangered marine mammals (ringed, spotted, and bearded seals; walruses; polar bears; and beluga whales) are likely to be exposed to more than one of the seven oil spills associated with cumulative oil development. However, these marine mammals are likely to suffer low mortality rates from oil-spill contact or habitat contamination. Only very young seal pups, young walrus calves, highly stressed adult seals, walruses, beluga whales, and a few polar bears (due to their sparse distribution and low density) are likely to die from oil-spill contact or habitat contamination. Cumulative air and vessel traffic associated with the proposal, the Prudhoe Bay Sealift, possible State oil-lease-sale activities (if State sales currently deferred from the State's 5-year lease schedule are reinstated), and the Red Dog Mine Project would include at least 124 to 810 round-

ALTERNATIVE IV	ALTERNATIVE V	ALTERNATIVE VI
Alternative IV would defer exploration within about 32 kilometers of Kasegaluk Lagoon--an important seasonal habitat of several thousand seals and a few thousand beluga whales, and within about 48 kilometers of Peard Bay--an important seasonal habitat of ringed and spotted seals. However, the chance of oil spills (7 for both this alternative and the proposal) contacting this habitat within 10 days of spill release is nil (during the open-water season), with less than a 10-percent chance of contact during the winter season for both Alternative IV and the proposal. Potential oil spills occurring within offshore blocks included in	Alternative V would reduce the chance of oil spills occurring within 40 to 48 kilometers of Cape Lisburne and the southwestern half of Ledyard Bay--coastal habitats with recent concentrations or fairly high densities of ringed seals and polar bears. Thus, oil spills and noise and disturbance effects associated with drillships in this area could be avoided. However, ringed seals, other ice seals, polar bears, and tens of thousands of walruses could still encounter potential oil spills from lease blocks north of Ledyard Bay within the migration corridor or the pack-ice front included in this alternative. These species could also be affected by traffic	Alternative VI could reduce the chance of oil spills contacting pinnipeds, polar bears, and beluga whales in the spring-migration corridor and their coastal habitats within about 41 to 113 kilometers of the coast. This alternative could slightly reduce aircraft noise and disturbance of hauled-out walruses and seals, with traffic going to seven production platforms rather than nine platforms under the proposal. However, potential oil spills (5 or 6 versus 7 under the proposal) could still contact several hundred or more seals, walruses, and some polar bears in the pack-ice front, resulting in MINOR effects on these species. Vessel

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
herds hauled out on the ice in the sale area. Disturbance from low-flying aircraft could result in injury or death to some walrus calves when adults stampede into the water in response to the presence of the aircraft. However, because the walrus herds are widely distributed along the ice front, only a small portion of the calf population is likely to be disturbed or injured. Noise and disturbance from marine vessels (drillships, icebreakers, supply boats, and barges) associated with the proposal could displace and temporarily interfere with the movements of some beluga whales, walruses, and seals near the vessels for perhaps a few hours up to perhaps a few days. However, vessel traffic from the proposal is not likely to block or significantly delay marine mammal migrations. Air- and vessel-traffic disturbance is expected to have MINOR effects on marine mammals. Construction activities (installation of 9 production platforms and the trenching and laying of 400 km of offshore pipelines) are likely to have local short-term disturbance effects on pinnipeds, polar bears, and beluga whales by displacing these marine mammals from platform and pipeline locations during construction for one season or 1 year, representing MINOR effects. The effect of proposed Sale 109 on pinnipeds, polar bears, and beluga whales is expected to be MINOR.	trip aircraft flights per month under the proposal; some icebreaker and drillship traffic (2-4 ships) during the spring; 15 to as many as 100 barges and a few to as many as 24 tugs; and 16 to 20 bulk-ore carriers and supply ships during the open-water season. The aircraft traffic could cause the death or injury of some walrus calves and the possible abandonment of a few seal pups by their mothers, but these losses are likely to have a MINOR effect on seal and walrus populations. Although vessel traffic--particularly active icebreakers--could temporarily interfere with or delay beluga whale migration, the level of icebreaker traffic is not likely to greatly delay beluga whale migration; thus, the effect is likely to be MINOR. Vessel-traffic disturbance of pinnipeds and polar bears would be very brief and probably would have NEGLIGIBLE effects on these species. Cumulative ground-vehicle and air traffic onshore or along the coast could temporarily displace ringed and spotted seals hauled out along the coast, particularly near development-support facilities such as the Point Belcher shorebase associated with the proposal; this effect is likely to be MINOR. The cumulative development of industrial facilities along the Chukchi Sea coast and the attendant increase in the presence of human refuse and galleyfood odors has a strong tendency to attract polar bears to these camps. Human/polar bear encounters are very likely to increase and result in an increased incidental take of polar bears to protect human life and property. At least in theory, this additive loss of polar bears, along with possible increases in the subsistence harvest, could have MODERATE effects on the polar bear population. However, conservation management of the polar bear population would hopefully prevent excessive loss of polar bears to the population. Thus, cumulative effects on polar bears are likely to be MINOR. The combined cumulative effects of oil spills, noise and disturbance, and habitat alteration through construction activities are expected to have MINOR effects on pinnipeds, polar bears, and beluga whales.
Endangered and Threatened Species As a result of an oil spill, some bowhead and gray whales may experience skin contact with oil, baleen fouling, localized reduction in food resources, ingestion of oil-contaminated prey items, bioaccumulations of hydrocarbons, and perhaps temporary displacement from migrating or feeding areas. Whales would be affected by noise-producing activities such as aircraft and vessel traffic and geophysical-seismic surveys, and structures such as drilling units and production platforms. Reactions are expected to be short-term and temporary in nature, consisting of movements away from the sound source. Whales swimming toward a sound source would probably deflect around the source at a range of several to over 10 kilometers. It is not anticipated that migration, feeding, or socializing activities would be precluded by OCS activities associated with Sale 109. There is a low probability that arctic peregrine falcons would	Cumulative effects could result from individually minor--but collectively significant--actions taking place over a period of time, or from individually significant actions occurring within a short period of time. Cumulative effects are defined in the CEQ regulations as "the impact on the environment which results from the incremental impact of the proposal when added to other past, present, and reasonably foreseeable future action regardless of what agency or person undertakes such other actions." Bowheads are more likely to be exposed to industrial activity for longer periods of time in the Sale 109 area than they would be in the Beaufort Sea Sale 97 or Navarin Basin Sale 107 areas. In

ALTERNATIVE IV	ALTERNATIVE V	ALTERNATIVE VI
this alternative or along the pipeline route could still contact several thousand walruses, several hundred ice seals, and some polar bears along the pack-ice front or migration corridor, resulting in MINOR effects (as under the proposal) on these species. Noise and disturbance of spotted and ringed seals and beluga whales near coastal habitats at Kasegaluk Lagoon and Peard Bay could be reduced from MINOR for the proposal to perhaps NEGLIGIBLE for Alternative IV; but habitat alteration and noise disturbance from icebreakers, drillships, and supply boats in the offshore blocks included under this alternative could still have MINOR effects on pinnipeds, polar bears, and beluga whales. The overall effect of Alternative IV on pinnipeds, polar bears, and beluga whales is expected to be MINOR.	from icebreakers, drillships, barges, and air traffic to and from the coast and offshore platforms north of the deferred area. Thus, oil spills and noise and disturbance from air and vessel traffic could still have MINOR effects on these marine mammals. The overall effect of Alternative V on pinnipeds, polar bears, and beluga whales is expected to be MINOR.	traffic (icebreakers, supply boats, and drillships) in the offshore blocks and helicopter traffic to and from the seven platforms would still cause brief (MINOR) disturbance of beluga whales and pinnipeds. The overall effect of Alternative VI on pinnipeds, polar bears, and beluga whales is expected to be MINOR.
Potential noise-disturbance effects and oil-spill-contact risks from Alternative IV are expected to be similar to those of the proposal. The probability of an oil spill contacting endangered whale habitat would be related to the transportation (not drilling) of oil under this alternative. Noise disturbance from industrial activity, aircraft, and vessels would bisect the deferral area, where most gray whales are found. Endangered whales would still be affected by exploratory and production activities conducted beyond the deferral	The effect of Alternative V on endangered whales is expected to be similar to that of the proposal. There would be no reduction in oil-spill risk to whale-habitat areas, and industrial noise would be similar to that of the proposal. Effects on endangered whales found beyond the deferral area would be the same as for the proposal. The effect of Alternative V on endangered and threatened species is expected to be MINOR on bowhead and gray whales and arctic peregrine falcons and NEGLIGIBLE on fin and	Oil-spill risks and industrial noise would be slightly reduced within the deferral area, and the number of production platforms would decrease from nine to seven--thus reducing associated support traffic. Exploration drilling activities and production platforms would be eliminated from the bowhead whale spring-migration corridor and coastal areas heavily used for gray whale feeding. This would result in some decrease in noise-producing activities in the coastal areas, where most endangered whales have been observed.

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
contact spilled oil or be disturbed by onshore activities associated with the exploration phase of the sale. The effect of proposed Sale 109 on endangered and threatened species is expected to be MINOR on bowhead and gray whales and arctic peregrine falcons, and NEGLIGIBLE on fin and humpback whales.	the cumulative case, bowheads could be exposed to increased noise levels from support traffic associated with Sale 109 and traffic and ship transportation (supply barges and bulk-ore carriers) associated with the Red Dog Mine; and up to 30 potential oil spills of 1,000 barrels or greater could occur within the range of the bowhead whale during the projected exploration and development and production periods (over 30 years). The effects of several stimuli could be purely additive or, in a combination, could have synergistic effects that would lead to changes that are greater than the sum of changes due to individual stimuli or sources. Bowhead distribution in the Canadian summer-feeding area that overlaps the main industrial area has declined in sitings since 1980. Changes in prey distributions or increased noise disturbance have been hypothesized as factors in the bowhead movement away from previously used habitat areas in the industrial area. The combined cumulative effect of oil spills and noise on bowhead whales is expected to be MODERATE. The Sale 109 area is an important gray whale calf-rearing area, and effects associated with the proposal would have more long-term effects on the entire population than effects on them associated with most other sale areas. Cow/calf pairs are more likely to react to disturbing activities than other whale groupings. As many as 18 spills of 1,000 barrels or greater could occur from Federal offshore lease sales within the range of the gray whale in the Bering and Chukchi Seas during the projected exploration and development and production periods (over 30 years). Effects from increased acoustical disturbance associated with production activity, vessel traffic, aircraft operations, and seismic surveys could result in the abandonment of localized areas and changes in migration pathways and timing. The combined cumulative effect of oil spills and noise on gray whales is expected to be MODERATE. The Sale 109 area is the northern boundary of the range for both fin and humpback whales. Small numbers of these whales are regularly observed in the more pelagic areas where little OCS activity is expected. Therefore, the proposal is not expected to contribute significantly to cumulative factors that would affect fin and humpback whales; and the overall cumulative effect on these species is expected to be NEGLIGIBLE. The proposed pipeline and associated activities are factors most likely to affect arctic peregrine falcons on a cumulative basis. Noise-producing activities that disrupt nesting falcons could result in failed hatching. Peregrines nesting in the pipeline corridor near the Colville River crossing are at most risk. However, construction activities in the vicinity of peregrine nesting sites are expected to occur during the fall and winter seasons when falcons are not present, resulting in minimal effects on the regional population. Consequently, cumulative effects on arctic peregrine falcons are expected to be MINOR.

ALTERNATIVE IV

area. The effect of Alternative IV on endangered and threatened species is expected to be MINOR on gray and bowhead whales and arctic peregrine falcons and NEGLIGIBLE on fin and humpback whales.

ALTERNATIVE V

humpback whales.

ALTERNATIVE VI

Also, bowhead whales would not be exposed to noise and disturbance from exploration units or production platforms within their spring-migration corridor. Support traffic to drilling units and platforms outside the deferred area would still pass through the deferred area, and pipeline construction would still occur within the deferred area. Therefore, disturbance to endangered and threatened species from aircraft and vessel traffic and pipeline construction would remain under this alternative, although at somewhat lower activity levels. This reduction in disturbance would not change the overall effects of OCS activities on these species. Effects on endangered species beyond the deferred area would be similar to those described for the proposal.

Overall effects on endangered and threatened species would be reduced, but a low level of effect would remain. Consequently, the effect level is expected to remain the same as for the proposal. The effect of Alternative VI on endangered and threatened species is expected to be MINOR on gray and bowhead whales and arctic peregrine falcons and NEGLIGIBLE on fin and humpback whales.

TABLE II-14. SUMMARY AND COMPARISON OF EFFECTS OF THE PROPOSAL, CUMULATIVE CASE, AND THE ALTERNATIVES

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
	The overall cumulative effect is expected to be MODERATE on bowhead and gray whales, MINOR on arctic peregrine falcons, and NEGLIGIBLE on fin and humpback whales.
Caribou	
Under the proposal, onshore construction of a 640-kilometer onshore pipeline and support road from Point Belcher to the TAP and associated motor-vehicle traffic of several hundred vehicles per day during construction activities are the primary sources of disturbance and habitat effects on caribou of the Western Arctic herd. Although road traffic associated with the onshore pipeline would cause some motor-vehicle disturbance of caribou, particularly cows and calves during postcalving movements north of the calving range, the pipeline would not cross the calving range of the Western Arctic herd. Approximately 20 percent of the Western Arctic herd (the portion of the herd that winters on the North Slope) could also be temporarily disturbed by vehicle traffic on the support road during spring migration to the calving grounds south of the pipeline corridor. Vehicle traffic would cause flight reactions by some caribou and could delay movements across the corridor for perhaps a few hours, or no more than a few days. Disturbance of caribou would be most intense during the construction period, when motor-vehicle traffic is highest at perhaps 40 to 60 vehicles per hour, but would subside to perhaps 10 or fewer vehicles per hour after construction is complete. Following the construction phase, caribou are likely to return to crossing the pipeline corridor with little or no restriction of movements. Thus, disturbance of caribou from vehicle traffic associated with the proposal is expected to have a MINOR effect. Under the proposal, the onshore pipeline and support road would alter or destroy about 64 square kilometers of the Western Arctic herd's range habitat; and the Point Belcher service base would cover 25 to 30 hectares of range habitat near Point Belcher. These facilities represent less than 1 percent of the available range habitat of the Western Arctic herd--a NEGLIGIBLE habitat loss. The effect of proposed Sale 109 on caribou is expected to be MINOR.	Combined proposed and ongoing onshore oil and gas activities in the Prudhoe Bay, NPR-A, ANWR, and Canadian Mackenzie River Delta could have some long-term MODERATE disturbance/displacement effects on caribou herds if significant parts of the core calving areas of the Western Arctic, Central Arctic, Teshekpuk, or Porcupine caribou herds were avoided for the life of the projects and resulted in a reduction in caribou distribution or abundance. Depending upon the timing, extent, and specific location of oil development, and the duration (few hours to several years) and intensity (few vehicles and aircraft/day to several hundred/day) of the disturbance, effects on caribou could range from MINOR to MODERATE. Transportation facilities associated with Federal and State offshore oil activities alone would have MINOR cumulative disturbance and habitat effects on caribou because onshore development associated with offshore leases would generally be limited to small shorebases and would not affect caribou over large geographic areas. Onshore oil-field development on the NPR-A and the ANWR could affect caribou over larger geographic areas. Cumulative range-habitat loss from facility construction (such as gravel mining, construction of hundreds of kilometers of roads, pipelines, and drill pads) and caribou avoidance (cows with calves) of habitat areas with high levels of road and air traffic could have MODERATE effects on the distribution of one or more of the North Slope caribou herds. Cumulative effects on the distribution of one or more North Slope caribou herds are expected to be MODERATE.
Economy of the North Slope Borough	
Because of projected fiscal and resident-employment declines in the NSB, the economic effects of the proposal would have none of the typical growth-related, adverse consequences on the NSB government or residents. While most of the jobs in sale-related activities would be filled by commuters from outside the region, fiscal and employment conditions in the region would be improved. The effect of Sale 109 on resident employment would be less than 10 percent above employment without the sale after 1995, 20 percent greater after 2003, and 30 percent greater after 2010. Sale-related effects on Native and non-Native-resident employment would be slightly higher and slightly lower, respectively. However, the unemployment rate for Native residents would still reach 50 percent by 2005, with or without the sale. Economic benefits from new jobs, income, taxes, etc., that would result from Sale 109 are expected to occur after the level of petroleum activities on the North Slope (e.g., Prudhoe Bay) has begun to decline. This decline would not be reversed by the projected effects of the proposal. The effect of proposed Sale 109 on the economy of the NSB region is expected to be NEGLIGIBLE.	Cumulative-case projects would provide additional revenues to the NSB and additional employment opportunities for residents of the NSB. These economic benefits would be moderate because of the modest scale of resources considered for development. Cumulative effects on the economy of the NSB region are expected to be MINOR.

ALTERNATIVE IV	ALTERNATIVE V	ALTERNATIVE VI
Although Alternative IV would defer oil exploration within 32 kilometers of the Kasegaluk Lagoon barrier islands and within 48 kilometers of the Peard Bay barrier islands and spits used occasionally by caribou as insect-relief habitat, onshore development under this alternative would still include the 640-kilometer onshore pipeline and support road from Point Belcher to the TAP, which would cause MINOR disturbance and habitat-alteration effects on the Western Arctic caribou herd. The overall effect of Alternative IV on caribou is expected to be MINOR.	Alternative V would defer oil exploration within waters 32 to 48 kilometers from the coast of the southwestern half of Ledyard Bay, the coast of which is occasionally used by caribou for insect relief. However, onshore oil development under this alternative would still include the 640-kilometer onshore pipeline and support road to the TAP, and thus would have MINOR disturbance and habitat-alteration effects on the Western Arctic herd. The effect of Alternative V on caribou is expected to be MINOR.	Although Alternative VI would defer oil exploration within about 41 to 113 kilometers of coastal habitat used for insect relief by the Western Arctic herd, onshore oil development under this alternative would still include the 640-kilometer pipeline and road from Point Belcher to the TAP, resulting in MINOR disturbance and habitat-alteration effects on the Western Arctic caribou herd. The overall effect of Alternative VI on caribou is expected to be MINOR.
The revenue and employment effects of Alternative IV would be virtually identical to those of the proposal, because the resource estimates for this alternative are the same as those for the proposal. The effect of Alternative IV on the economy of the North Slope Borough is expected to be NEGLIGIBLE.	The employment effects of Alternative V are projected to be virtually identical to those of the proposal, because the resource estimates for this alternative are the same as those for the proposal. The effect of Alternative V on the economy of the North Slope Borough region is expected to be NEGLIGIBLE.	The effect of Alternative VI on the economy would be only slightly less than that of the proposal, because the resource estimate for this alternative is only 16 percent less than that for the proposal. The number of production platforms installed and operated would be reduced by over 20 percent, and the number of production wells drilled would be reduced by over 15 percent. Therefore, the economic effect of Alternative VI would probably be about 90 percent as great as the effect indicated for the proposal. The effect of Alternative VI on the NSB region is expected to be NEGLIGIBLE.

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS

Subsistence-Harvest Patterns

Barrow utilizes the Peard Bay area for a portion of its subsistence activities. Effects from Sale 109 on Barrow's subsistence-harvest patterns outside the Peard Bay area are not likely to be more than MINOR. In Peard Bay, MODERATE effects from oil spills could occur on Barrow's walrus subsistence harvest. Oil spills from the pipeline from Point Belcher to the TAP would have MODERATE effects on Barrow's subsistence-fish harvest. The effect of proposed Sale 109 on Barrow's subsistence-harvest patterns is expected to be MODERATE.

The Wainwright subsistence-harvest patterns are expected to receive the most effects due to the high probability of oil spills and the proximity of the subsistence-harvest area to the Peard Bay area, the shorebase at Point Belcher, and the pipeline to the TAP, where noise, traffic, and construction activities would be concentrated. Noise and traffic disturbance resulting from the proposal are likely to disrupt and eliminate the bowhead whale harvest in Wainwright for more than 1 year. The effect of proposed Sale 109 on Wainwright's subsistence-harvest patterns is expected to be MAJOR.

The Point Lay subsistence-harvest-resource area also has high oil-spill risks. Noise and traffic disturbance associated with the proposal may also affect Point Lay's subsistence-harvest patterns; however, the distance from Point Lay to Point Belcher eliminates the possibility of any effects from construction activities. If an oil spill or noise or traffic disturbance occurred during Point Lay's beluga harvest, MODERATE effects would occur. The effect of proposed Sale 109 on Point Lay's subsistence-harvest patterns is expected to be MODERATE.

Point Hope's subsistence-harvest area is distant enough from the area of intense activity under the proposal that subsistence-harvest patterns are not likely to be affected. Point Hope is too distant from Peard Bay to be affected by noise from construction activities. However, noise and traffic from vessels passing through the area could cause disturbance during the bowhead whaling season and disrupt Point Hope's whale harvest. The effect of proposed Sale 109 on Point Hope's subsistence-harvest patterns is expected to be MODERATE.

Atqasuk harvests marine resources in conjunction with the Barrow harvests; thus, the MODERATE effects on Barrow's walrus harvest would also affect Atqasuk's walrus harvest. Noise and traffic disturbance associated with the presence of the pipeline, as well as disturbance associated with the construction of the pipeline from Point Belcher to the TAP, could cause some effects on Atqasuk's caribou harvests; however, these effects would be short-term and temporary for less than a year and caribou would remain available to Atqasuk hunters. MINOR effects on caribou subsistence harvests would be expected in Atqasuk and in Barrow, Wainwright, and Nuiqsut. Onshore oil spills from the pipeline are expected to have MODERATE effects on Atqasuk's subsistence-fish harvest. The effect of proposed Sale 109 on Atqasuk's subsistence-harvest patterns is expected to be MODERATE. With the exception of its caribou-harvest area, Nuiqsut's subsistence-harvest area lies outside of the Sale 109 area. No more than MINOR effects on all resources except fish are expected on Nuiqsut's subsistence-harvest patterns. The proposed pipeline from Point Belcher to the TAP would cross four branches of the Colville River; thus, effects on Nuiqsut's subsistence-fish harvest are expected to be MAJOR as a result of expected onshore-pipeline spills.

The effect of proposed Sale 109 on subsistence-harvest patterns is expected to be MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

Effects on Barrow's subsistence harvests would be increased to MAJOR in the cumulative case because of increased noise and traffic disturbance in the Barrow bowhead whale subsistence-harvest area. Cumulative-case effects on Wainwright's subsistence-harvest patterns would remain MAJOR due to noise and traffic disturbance and construction activities in the Peard Bay area that would affect Wainwright's bowhead harvest. Effects on Point Lay's subsistence-harvest patterns would increase to MAJOR due to effects from oil spills and noise and traffic disturbance from possible State lease sales in the Chukchi Sea. (State sales in the Chukchi Sea have been deferred from the State's 5-year lease schedule, but may be reinstated.) Effects would not increase and would remain MODERATE in the Point Hope cumulative case because of the absence of activity in the area other than Sale 109. Effects on Point Hope's bowhead whale harvest are expected to remain MODERATE due to noise and traffic disturbance. Effects on Atqasuk's subsistence harvests also would increase from MODERATE to MAJOR in the cumulative case because of construction activities and increased pipeline and associated road traffic from Federal and possible State lease sales and possible development of ANWR. This activity is expected to cause MAJOR effects on caribou harvests.

The cumulative effects on subsistence-harvest patterns are expected to be MAJOR in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut, and MODERATE in Point Hope.

ALTERNATIVE IV

Alternative IV would eliminate a portion of Barrow's seal, walrus, fish, and bird subsistence-hunting areas from the proposed Sale 109 area; all of Wainwright's coastal-hunting areas; and the Kasegaluk Lagoon portion of Point Lay's coastal-hunting area. Deferral of this area would not alter the effects of oil spills or reduce effects from construction of the shorebase facilities at Point Belcher and the pipeline corridor from Point Belcher to the TAP, or reduce effects from the presence of the pipeline. However, it would reduce noise and disturbance from exploration, development, and production activities. Effect levels on Point Lay's beluga harvest due to noise and traffic disturbance would be reduced from MODERATE to MINOR under this alternative. However, the overall effect on Point Lay's harvest would remain MODERATE because oil-spill effects on walrus would not be reduced. Effects on Wainwright's harvest also would remain MAJOR because the effects of noise and traffic disturbance and construction activities at Point Belcher would not be reduced. Effects on Barrow's and Atqasuk's harvests also would remain MODERATE because the offshore oil-spill effects on walrus and onshore oil-spill risk to fish would not be reduced. Effects on Point Hope's harvest would remain MODERATE because noise and traffic disturbance would not alter under this alternative. Effects on Nuiqsut's harvests would remain MAJOR because effects on fish from onshore-pipeline oil spills would not be reduced. The effect of Alternative IV on subsistence-harvest patterns is expected to be MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

ALTERNATIVE V

Alternative V would remove from possible leasing Point Hope's subsistence-harvest areas, from Point Hope around Cape Lisburne to Cape Sabine. This deferral would reduce noise and disturbance from exploration, development, and production activities in the Point Hope subsistence-harvest area; but oil-spill effects would not change. The subsistence-harvest pattern that would receive more than NEGLIGIBLE effects under the proposal is the bowhead whale harvest, which is expected to experience MODERATE effects due to noise and traffic disturbance. Although noise and traffic disturbances would be reduced under this alternative, effects on Point Hope's bowhead harvest would remain MODERATE. Other subsistence-harvest areas in the Sale 109 area would not be affected by this alternative because they are too distant from the deferred area. As for the proposal, effects in Wainwright and Nuiqsut would remain MAJOR; effects in Barrow, Point Lay, and Atqasuk would remain MODERATE. The effect of Alternative V on subsistence-harvest patterns is expected to be MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

ALTERNATIVE VI

Alternative VI would remove from possible leasing the subsistence-harvest areas for Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk. Oil-spill effects would be reduced, but not significantly enough to alter effect levels. This deferral would remove the possibility of exploration, development, and production occurring within the subsistence-hunting areas in the Sale 109 region, which would decrease noise and disturbance associated with these activities within the deferred area. However, deferral of this area would not alter effects from construction of the shorebase facilities at Point Belcher and the pipeline from Point Belcher to the TAP, reduce effects from the presence of the pipeline, or reduce effects from onshore pipeline oil spills. However, Alternative VI would reduce noise and disturbance from exploration, development, and production activities in the Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk subsistence-harvest areas. Effect levels on Point Lay's beluga harvest due to noise and traffic disturbance would be reduced from MODERATE to MINOR under this alternative. However, the overall effect on Point Lay's subsistence-harvest patterns would remain MODERATE because the oil-spill effects on walrus would not be reduced. Under this alternative, effects on Wainwright would remain MAJOR because effects from noise and traffic disturbance and construction activities at Point Belcher would not be reduced. Effects on Barrow and Atqasuk also would remain MODERATE because the offshore oil-spill effects on walrus and onshore oil-spill effects on fish would not be reduced. Effects on Point Hope would not be reduced because noise and traffic disturbance would not be reduced under this alternative. Effects on Nuiqsut would remain MAJOR because effects on caribou from pipeline construction and its presence would not be reduced and effects of offshore oil spills on fish harvests in the Colville River would not be reduced. The effect of Alternative VI on subsistence-harvest patterns is expected to be MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

TABLE II-14. SUMMARY AND COMPARISON OF EFFECTS OF THE PROPOSAL, CUMULATIVE CASE, AND THE ALTERNATIVES

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
Sociocultural Systems	
Effects on the sociocultural systems of communities near the Sale 109 area would occur as a result of industrial activities, changes in population and employment, and effects on subsistence-harvest patterns. Barrow and Wainwright are the communities that would be most affected by the proposed sale due to their proximity to the shorebase facilities at Point Belcher and their use as air-support bases. Increases in population and employment are expected to affect primarily Wainwright and Barrow. MAJOR and MODERATE effects are also expected on three of Wainwright's subsistence harvests. MODERATE effects are expected on Wainwright's sociocultural systems. Although Barrow is in proximity to proposed onshore industrial activities and population and employment changes are expected in Barrow, these changes would not be more significant than current population and employment changes in Barrow. MODERATE effects are expected on only one of Barrow's subsistence harvests. MINOR effects are expected on Barrow's sociocultural system. Point Lay, Point Hope, Atqasuk, and Nuiqsut are too distant from onshore industrial activities for these activities to directly affect their sociocultural systems. These communities also are not expected to experience direct population and employment increases as a result of the proposed sale. These communities may experience some indirect increases in population and employment, but the increase is not expected to be significant. MODERATE effects are expected on two primary subsistence-harvest patterns in Point Lay, while MODERATE effects are expected on one to two subsistence-harvest patterns in Point Hope and Atqasuk. MAJOR effects are expected on Nuiqsut's subsistence-harvest patterns. Point Lay, Point Hope, and Atqasuk would experience MINOR effects and Nuiqsut would experience NEGLIGIBLE effects on sociocultural systems. The effect of the proposed sale on sociocultural systems is expected to be MODERATE.	Cumulative-case activities would increase employment and population in the communities affected by Sale 109 as well as increase NSB revenues. Cumulative effects on subsistence-harvest patterns as a result of all projects and activities in the North Slope region would be MAJOR. In the cumulative case, MAJOR effects of displacement of sociocultural systems are possible from offshore oil development in the Beaufort Sea. Sale 109 is not expected to increase the level of MAJOR effects from Beaufort Sea lease sales. Cumulative effects on sociocultural systems are expected to be MAJOR.
Archaeological Resources	
Numerous onshore archaeological resources and nearshore shipwrecks exist in the Sale 109 area, particularly in the vicinity of Point Belcher, Point Hope, and Icy Cape. Because of extensive ice gouging in most nearshore areas, the chance is very low that archaeological resources and shipwrecks exist in this area. There is a possibility that shipwrecks may have survived because they are more recent than prehistoric resources. However, offshore archaeological resources, particularly at depths below 38 meters west of Icy Cape, may not have escaped ice gouging in the Pleistocene age; but this is uncertain. Activities associated with the proposal--such as construction and maintenance of pipelines and the shorebase at Point Belcher and oil-spill-cleanup activities resulting from a spill--could damage archaeological resources, if they exist. The effect of proposed Sale 109 on archaeological resources is expected to be MINOR.	The cumulative effects on offshore archaeological resources would result from exploration, development, and production activities occurring at the same time as those for the proposal. However, exploration and development activities in the NPR-A are expected to be low. Little activity that would damage archaeological resources is expected to occur from possible State oil-lease sales. No oil discoveries have been made which would be cumulative with the effects of the proposal. No oil discoveries have been made by the Arctic Slope Regional Corporation. Future Federal oil and gas exploration and development activities are not expected to damage archaeological resources. No Canadian shipping of oil through the area is expected to occur prior to 1990. Therefore, cumulative effects are expected to be MINOR.

ALTERNATIVE IV	ALTERNATIVE V	ALTERNATIVE VI
Onshore industrial activities and population and employment projections would not alter under Alternative IV because the resource estimates for this alternative are the same as those for the proposal. This deferral alternative also would not alter effects on subsistence-harvest patterns. The effect of Alternative IV on sociocultural systems is expected to be MODERATE.	Onshore industrial activities and population and employment projections would not alter under Alternative V because the resource estimates for this alternative are the same as those for the proposal. This deferral alternative also would not alter effects on subsistence-harvest patterns. The overall effect of Alternative V on sociocultural systems is expected to be MODERATE.	Onshore industrial activities and population and employment projections would not alter under Alternative VI because the resource estimate for this alternative is only 16 percent less than that of the proposal. Deferral of this alternative also would not alter effects on subsistence-harvest patterns. The effect of Alternative VI on sociocultural systems is expected to be MODERATE.
Under Alternative IV, leasing activity would be reduced somewhat in the deferral area. But since the shorebase and pipeline landfall would still be located at Point Belcher and many archaeological resources exist there and some of these may be disturbed, the effect of Alternative IV on archaeological resources is still expected to be MINOR.	Under Alternative V, leasing activity would be reduced somewhat in the deferred area. But, since the shorebase and pipeline landfall would still be located at Point Belcher and many archaeological resources exist there and some of these would be disturbed, the effect of Alternative V on archaeological resources is still expected to be MINOR.	Under Alternative VI, leasing activity would be reduced somewhat in the deferred area. But, since the shorebase and pipeline landfall would still be located at Point Belcher and many archaeological resources exist there and some of these would be disturbed, the effect of Alternative VI on archaeological resources is still expected to be MINOR.

ALTERNATIVE I (The Proposal)	CUMULATIVE EFFECTS
Land Use Plans and Coastal Management Programs	
Major changes in land use would result from development associated with Sale 109. Onshore facilities and the Sale 109 pipeline corridor would be constructed in areas currently used only for subsistence hunting. The onshore facility would be a highly incompatible use of land given the importance of Point Belcher for subsistence whaling. Interfering with the subsistence hunting of bowhead whales also would be contrary to NSB Land Management Regulations. Because Point Belcher has traditionally been the launching site for whaling crews, potential also exists for conflicts with the policies protecting the cultural resources of the area. The assumed pipeline corridor would conform to most NSB Land Management Regulations and Alaska Coastal Management Program (ACMP) policies; however, the access by Wainwright residents to the North American road system and vice versa via the Sale 109 pipeline corridor to the Dalton Highway may generate additional problems and benefits that would need to be assessed if the road became public. Last, potential conflict with the air- and water-quality standards would need to be resolved. MAJOR conflicts are expected between the activities associated with proposed Sale 109 and land use, the NSB Land Management Regulations, and the ACMP.	Potential policy conflicts would be more frequent and pervasive in the cumulative case. Along the Chukchi Sea coast, the areas most sensitive to development are included in possible future State lease sales. Moreover, effects in the NSB would be compounded by those in the Northwest Arctic Borough region and in Canada. Conflicts would arise from the siting and construction of shorebases, pipelines and associated roads, and support activities. Potential conflicts of developments included in the cumulative case with land use and land and coastal management regulations are expected to remain MAJOR.

ALTERNATIVE IV

Alternative IV would defer drilling activities and feeder pipelines in the vicinity of Kasegaluk Lagoon and Peard Bay but would not change the basic assumptions for infrastructure, production, and transportation. Potential effects on kelp-bed communities and bird and marine mammal populations that use Peard Bay and Kasegaluk Lagoon would be reduced; however, the reductions would not be adequate to reduce the overall levels of effects on these resources. For these reasons, the potential conflicts with land use and land and coastal management policies are expected to remain MAJOR.

ALTERNATIVE V

Deferring the southern portion of the Sale 109 area near Point Hope and Cape Lisburne reinforces the assumptions used for the proposal, whereby the pipeline landfall and shorebase would be located near Point Belcher. Because these facilities would create a major effect on land use and would conflict with NSB Land Management Regulations and ACMP policies, the effect of Alternative V on land use plans and land and coastal management policies are expected to be MAJOR.

ALTERNATIVE VI

Although the scenario remains the same for Alternative VI as for the proposal, deferring the coastal portion of the sale area reduces many of the negative effects identified under the proposal. Potential risks are reduced on kelp beds and other organisms in the more nearshore waters, including fish, marine mammals, and birds. However, effects levels on these resources would remain the same as for the proposal. Therefore, although fewer effects would need to be mitigated, conflicts with existing land use and management policies under Alternative VI would remain MAJOR. The effect of Alternative VI on land use plans and land and coastal management policies are expected to be MAJOR.

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. Physical Considerations

1. Geology:

a. Physiography: The continental shelf within the proposed Sale 109 area is broad and relatively flat (Fig. III-1). Water depths within the sale area are generally greater than 10 meters (m); shallower depths may occur on Blossom Shoals (about 8 m) and in Ledyard Bay (about 6 m). More than 80 percent of the shelf lies between the 30- and 60-meter isobaths (Grantz et al., 1982b). In the extreme northwest and northeast, a very small part of the sale area lies at depths greater than 60 meters, but the maximum depth is approximately 80 meters.

Several bathymetric highs lie within or are contiguous to the sale area. The western flank of Hanna Shoal, which rises above the surrounding seafloor to a height of approximately 20 meters below sea level, is located in the northeastern part of the sale area. The lower part of the eastern flank of Herald Shoal is located in the west-central part of the sale area. A well-developed, spit-like shoal defined by the 30-meter isobath extends northwest from Point Hope for about 20 kilometers (Toimil, 1978). Widths on the spit range from 2 to 4 kilometers. Blossom Shoals is a series of sand ridges that extend 12 to 16 kilometers from Icy Cape; the ridges trend parallel to the shoreline.

The major bathymetric low of the northeastern Chukchi Sea continental shelf is the Barrow Sea Valley (Fig. III-1); although it is not part of the sale area, this sea valley affects oceanographic circulation and sea-ice zonation within and adjacent to the sale area. The Barrow Sea Valley begins north of Wainwright and trends in a northeasterly direction parallel to the Alaskan coast.

b. Petroleum Provinces: The petroleum provinces (Fig. III-2) into which the Sale 109 area has been divided are based on the classification used by Grantz et al. (1982b) to describe the geological framework and hydrocarbon potential of this area. The geologic ages and names of stratigraphic formations of the sale area are shown in Figure III-3. The names of stratigraphic formations containing known petroleum hydrocarbons are also shown in this figure. The petroleum potential of the provinces was estimated from seismic profiling, thermal history, and known occurrences of hydrocarbons and onshore geology in the adjacent National Petroleum Reserve-Alaska (NPR-A) area (Grantz et al., 1982b). No wells have been drilled in the proposed Sale 109 area.

The areas with the highest hydrocarbon potential are the provinces in the northeastern and western parts of the sale area--the Barrow Arch, Arctic Platform, Chukchi Platform, and North Chukchi Basin (Cooke, 1985). Both structural and stratigraphic traps are present in the sale area. In the Hanna Trough, North Chukchi Basin, and Hope Basin, structural traps predominate, whereas in the Barrow Arch and Chukchi Platform provinces, stratigraphic traps predominate. The most prospective reservoirs are expected to be found in the rocks of the Lisburne Group, the Sadlerochit Group, the Shublik Formation, and the Sag River Formation; oil is produced from all of these stratigraphic units at Prudhoe Bay. Based on their high-organic-carbon content and high percentage of oil-pronekeregon, the best potential source rocks are the Shublik Formation, the Kingak Shale, the Pebble Shale, and the Torok Formation.

c. Other Geological and Environmental Considerations:

(1) Marine Sediments: Only a relatively thin layer of unconsolidated sediment overlies the bedrock throughout much of the Chukchi Sea continental shelf; the thickness of this layer averages about 2 to 5 meters (Grantz et al., 1982b). Exposed bedrock is frequently found in areas where the water depth is greater than 30 meters. Along the coast between Icy Cape and Point Franklin, sediment thickness increases from 1 or 2 meters in water depths of about 24 meters, to 15 meters on the shoals off Icy Cape and 12 meters landward of the Barrier Islands (Phillips, 1983). On the open shelf, the paleochannels and paleovalleys that have been cut into the bedrock contain thick accumulations of sediments (Phillips, 1983) ("paleo:" a combining form meaning old, ancient). The paleochannel of the Kuk River extends west of Wainwright and is filled with sediments that range in thickness between 18 and 23 meters; large paleovalleys that have also been identified north of Herald Shoal contain up to 50 meters of fill. The distribution of gravel, sand, and mud (silt- and clay-size particles) in the surficial sediments of the Sale 109 area is shown in Figures III-4 and III-5.

Gravel is found in the nearshore region (1) between Point Hope and Point Lay, (2) between Icy Cape and Wainwright, (3) east of Point Franklin, and (4) on the Barrier Islands (Phillips, 1983). Gravel deposits have also been identified on Herald Shoal. The paleochannels and paleovalleys may also contain gravel deposits (Grantz et al., 1982b). In waters shallower than 15 meters, extensive biological communities that are dominated by kelp beds have been observed east of Point Franklin and south of Wainwright (Phillips, 1983). The surficial gravel deposits indicate areas of active currents and subsequent seafloor erosion.

Accumulations of sand-size sediments occur in many parts of the Sale 109 area. Movement of sediment particles along the seafloor produces ridges and sand wave fields that provide some indication of the predominant current speed and direction. Current-produced features have been observed (1) in the sediments of the nearshore region at depths less than 10 meters, (2) as extensive northeast-migrating sand-wave fields on the seafloor beneath the Alaska Coastal Current, and (3) on sand ridges off Icy Cape (Phillips, 1983).

The small-scale (less than 30 centimeters high) bedforms of the nearshore region form discontinuous patches separated by gravel on the seafloor. These bedforms were probably formed by the sediment that was transported shoreward by shoaling waves under storm conditions.

Northeast migrating sand-wave fields have been identified west of Point Lay, west and north of Icy Cape, north of Wainwright, and north of Point Franklin (Phillips, 1983). These sand waves are thought to be actively migrating because of a decrease or absence of ice-gouge preservation within the fields. The asymmetric sand waves obtain heights of about 0.5 meters. The areal extent of the sand-wave fields is poorly defined but could be expected to occur within the region underlying the Alaska Coastal Current.

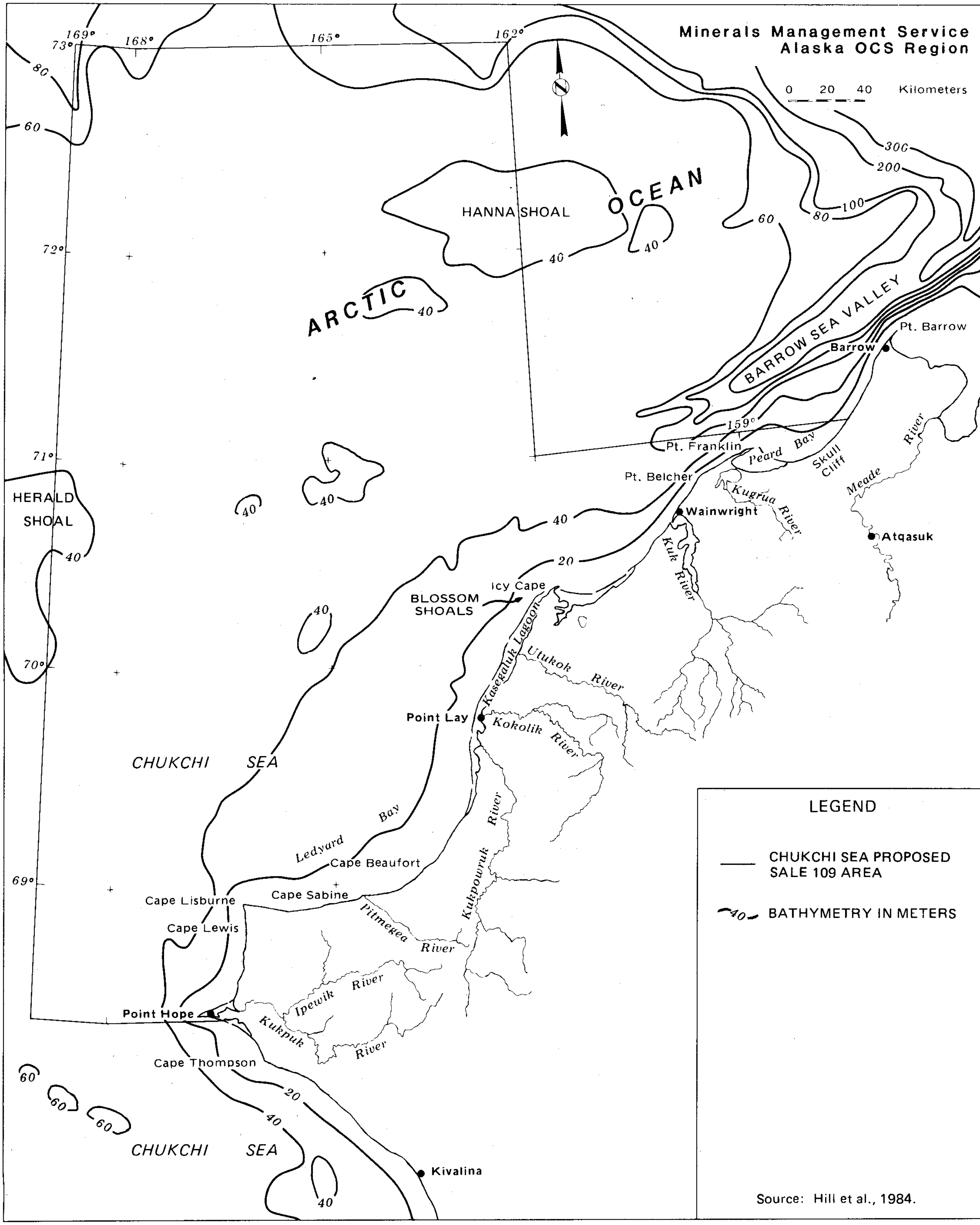


FIGURE III-1. CHUKCHI SEA BATHYMETRY

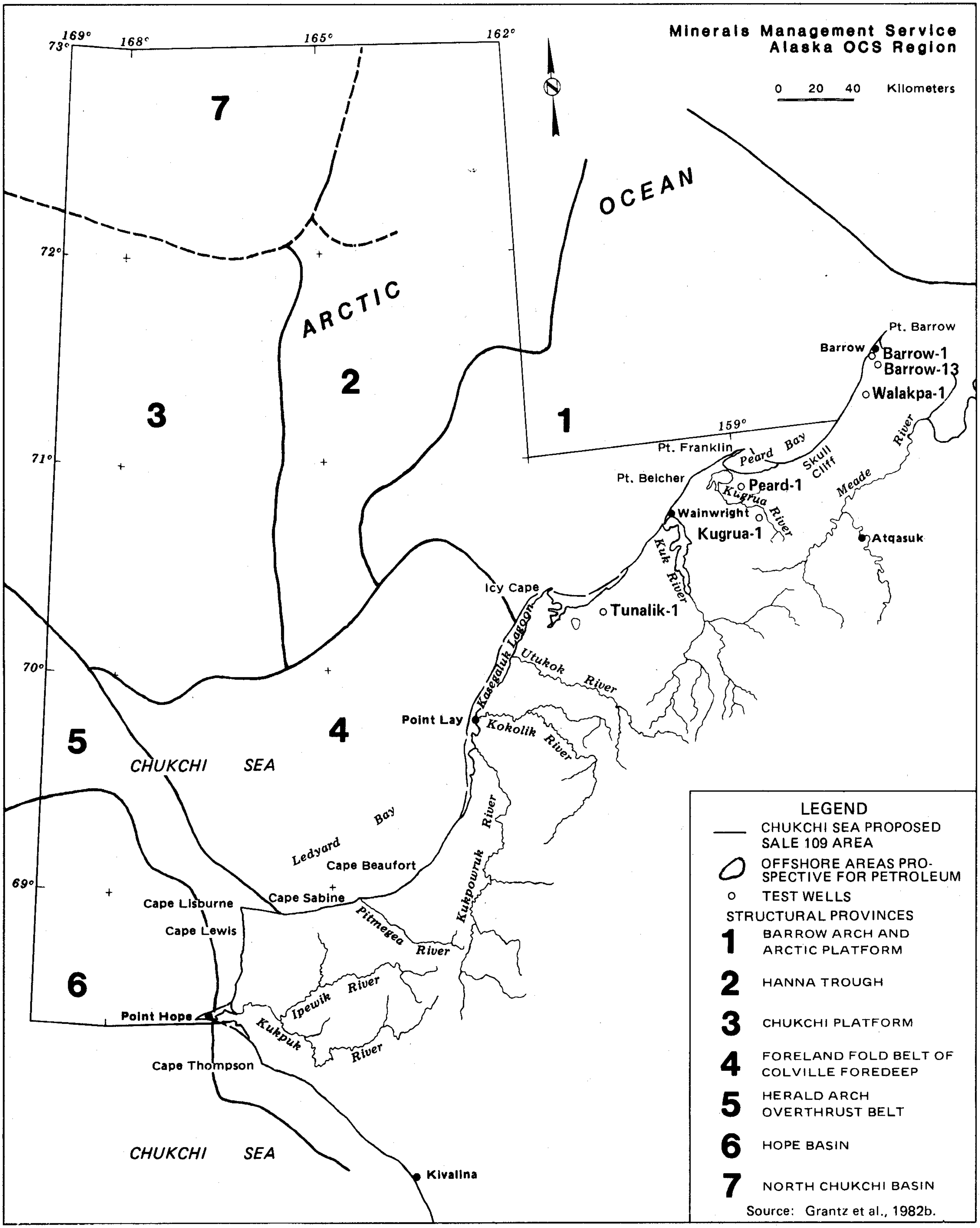


FIGURE III–2. STRUCTURAL PROVINCES AND OFFSHORE AREAS PROSPECTIVE FOR PETROLEUM IN THE CHUKCHI SEA

	STRATIGRAPHIC UNIT	AGE	GEOLOGIC TIME SEQUENCE
	Colville Group	Upper Cretaceous	
● ○	Nanushuk Group		Brookian Sequence
+ ○	Torok Formation	Lower Cretaceous	
● ○	"Pebble Shale Unit"		
+ ○	Kingak Shale	Lower Cretaceous/ Jurassic	
●	Sag River Sandstone	Triassic	Ellesmerian Sequence
● ○	Shublik Formation		
○	Sadlerochit Group	Triassic/ Permian	
	Lisburne Group	Carboniferous/ Permian	
	"Argillite"	Pre-Devonian	Franklinian Sequence

LEGEND

● Oil pools or strong shows in test wells and seeps

○ Gas pools or strong shows in test wells and seeps

\+ Oil staining in test wells

Source: Grantz et al., 1982b.

FIGURE III–3. GENERALIZED STRATIGRAPHIC COLUMN BENEATH THE ARCTIC COASTAL PLAIN OF NORTHWESTERN ALASKA SHOWING POSITION OF OIL AND GAS POOLS, STRONG SHOWS OF OIL AND GAS, AND OIL STAINING ENCOUNTERED IN TEST WELLS AND SEEPS

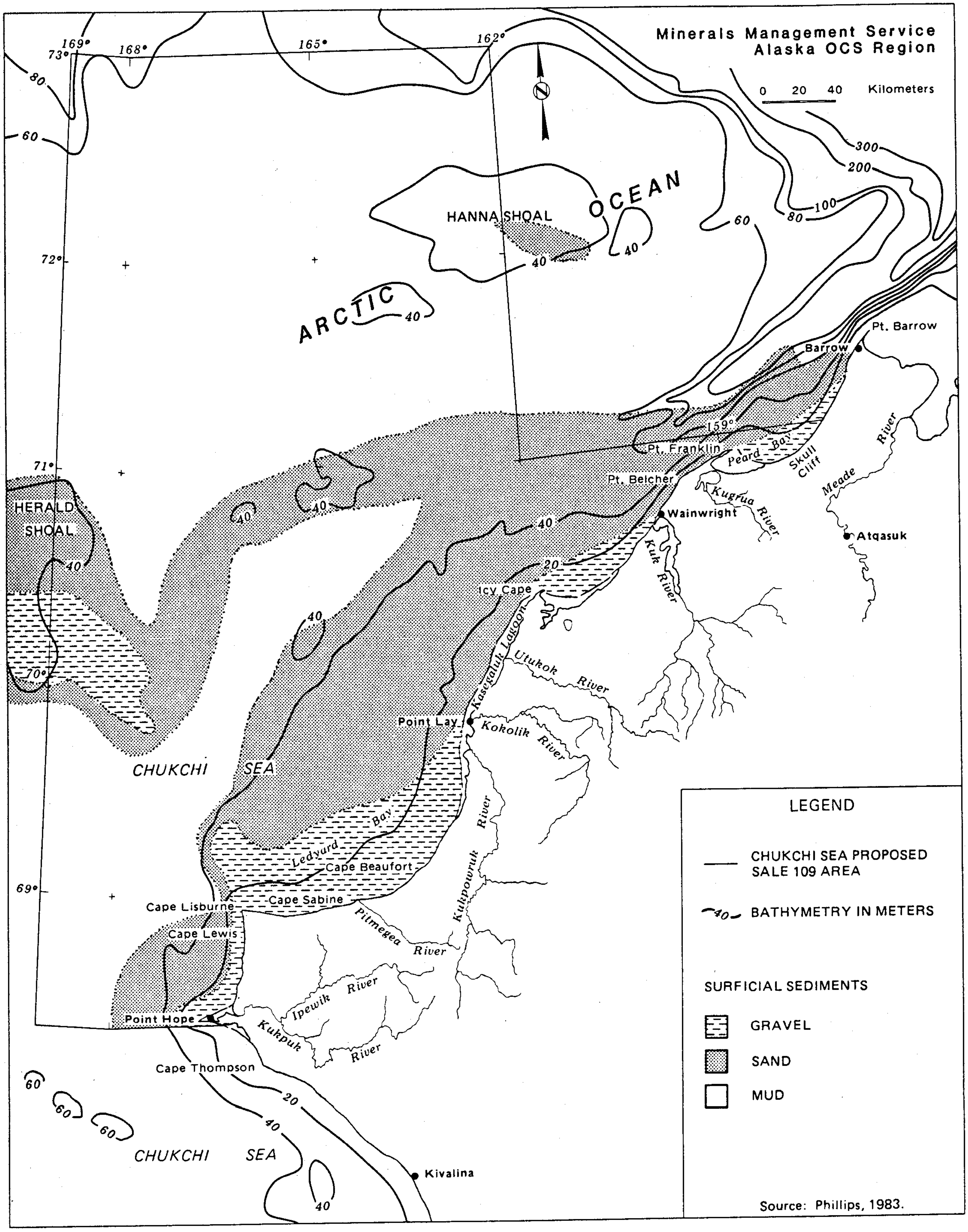


FIGURE III–4. DISTRIBUTION OF SURFICIAL SEDIMENTS WITHIN THE CHUKCHI SEA

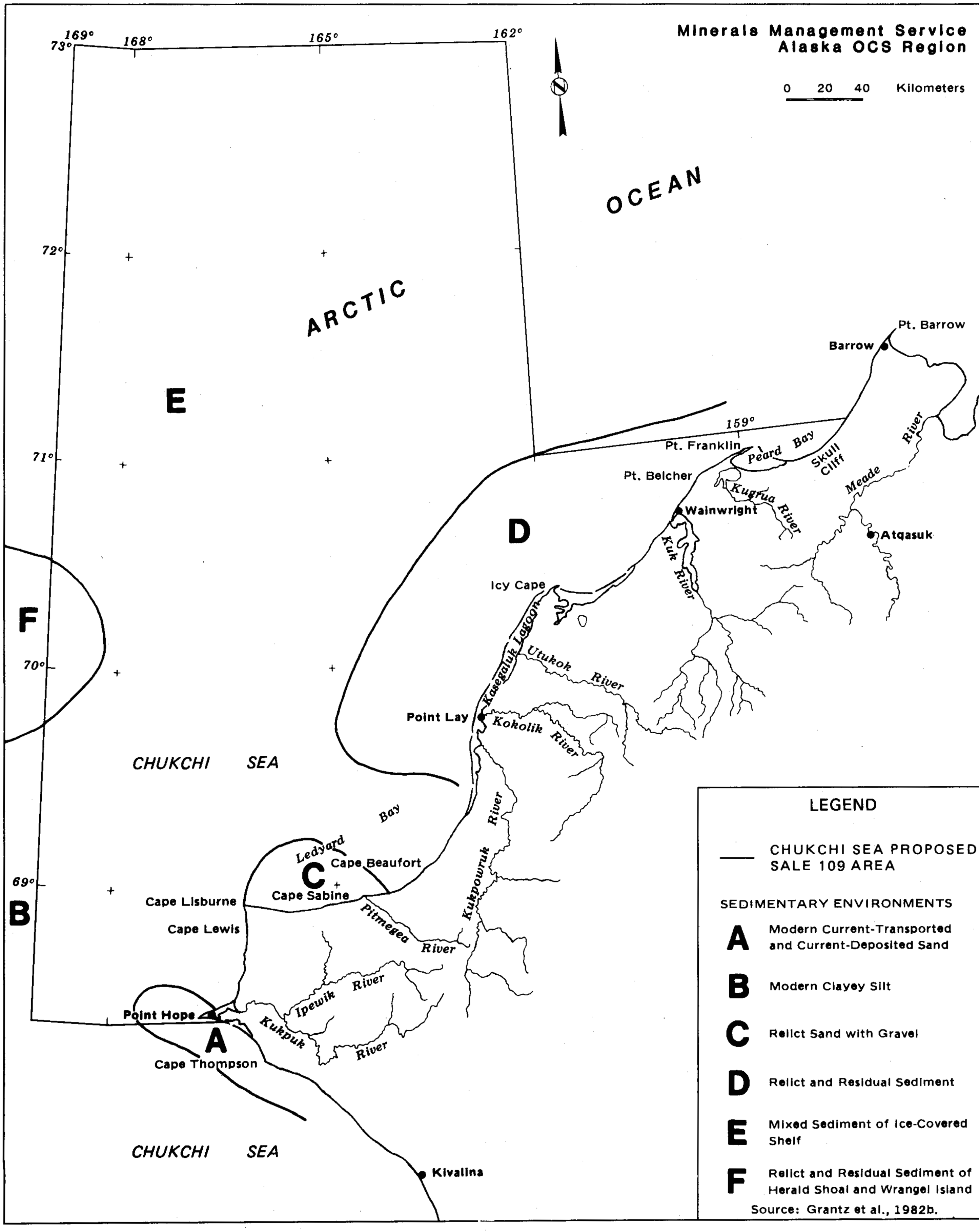


FIGURE III–5. SEDIMENTARY ENVIRONMENTS OF THE CHUKCHI SEA

The discontinuous, linear sand ridges located directly off Icy Cape are covered by large-scale, up-to-1-meter-high sand waves. Seismic profiles indicate that the ridges are migrating to the northwest and that they decrease in height in an offshore direction (Phillips, 1983). The migration rate of the sand ridges is unknown.

Broad, low-amplitude, northeast-trending sand ridges are also found beneath the Alaska Coastal Current on the seafloor between Icy Cape and Cape Lisburne (Phillips, 1983). These linear ridges are probably formed by a combination of ice groundings and sand-wave migration. The migration rate and direction of these ridges is presently unknown.

Mud is generally found in the deeper parts of the shelf and is also abundant in protected bays and lagoons along the coast (Phillips, 1983).

(2) Permafrost: The presence and distribution of perennial and seasonal permafrost in the Sale 109 area is presently unknown (Grantz et al., 1982b). Subsea permafrost is a relict feature formed during periods of major glaciation when sea level was lowered and a large part of the shelf was exposed to subfreezing temperatures for long periods of time. When the glaciers melted and sea level rose, the ice-bonded sediments were exposed to warmer, saline water that caused the permafrost to slowly degrade.

In the nearshore region, ice-bonded sediments are more likely to be found in those areas where coastal erosion is rapid. However, nearshore permafrost may be less common in the Chukchi Sea than it is in the Beaufort Sea because the rates of coastal erosion are generally lower in the Chukchi (Harper, 1978). Seismic data collected north of Icy Cape in water depths of 5 meters indicate that ice-bonded material may be present, but there are no drill holes in the area to confirm this (Rogers and Morack, 1982). The onshore part of the coastal area from Point Hope to Barrow is underlain by a thick layer of permafrost (Ferrians, 1965).

Seismic studies of permafrost in the Alaskan Beaufort Sea indicate the presence of reflecting horizons at depths that range from about 100 to 1,900 meters. However, most of the horizons occur within relatively narrow depth ranges at about 200, 500, and 800 meters below sea level (Sellman and Neave, 1982). These three horizon groupings are not continuous on all profiles, but they can be found repeatedly throughout the area. The 200-meter horizon may be the top of a thick slab of relict subsea permafrost. The 500-meter reflection coincides with the depth of permafrost on land in some parts of the area and may be the base of the permafrost layer. The source of the 800-meter horizon is unknown, but it may be related to some change in material types or the distribution of hydrates.

Farther offshore, the absence of thick layers of unconsolidated sediments and the widespread occurrence of consolidated bedrock at or near the seabed, limits the lateral and vertical extent of the ice-bonded sediments.

(3) Natural Gas Hydrates: In other areas, natural-gas hydrates have typically been found at depths of 200 to 300 meters below the surface (Lewbel, 1984). Seismic profiles to date have not shown any likely major area of gas hydrates.

(4) Shallow Gas: Accumulations of shallow gas in the sediments of the Sale 109 area have been delineated from interpretation of seismic-profiling records. Most of the shallow gas is probably of biogenic origin (formed by bacterial metabolism of organic matter in the sediment); but in some instances, the gas may be of thermogenic origin (gas that has migrated to the surface from hydrocarbon deposits in the underlying rocks).

(5) Earthquakes: Earthquake data recorded by the Worldwide Network and summarized by Meyers (1976) indicate that the Sale 109 area and the adjacent coastal area are regions of historically low seismic activity. However, earthquakes with magnitudes as great as 6.9 to 7.3 on the Richter Scale have been recorded in the southeastern Chukchi Sea and in Kotzebue Sound.

(6) Mudslides: Mudslides may be a potential hazard along the shelf break in the northern part of the Sale 109 area (Phillips, 1983). Most of the Beaufort Sea continental shelf seaward of the 50- to 60-meter isobaths and the upper part of the continental slope consists of a relatively thick mass of unconsolidated and poorly consolidated sediments that appear to be unstable and show a variety of features associated with the downslope movement of large, tubular sediment blocks (Grantz et al., 1982a). Some of these features have also been observed along the shelf break west of the Barrow Sea Valley (Grantz, Eittreim, and Whitney, 1981). Delineation of the features associated with the mass movement of unconsolidated and poorly consolidated sediments is based on high-resolution seismic data recorded across the shelf and slope at 15- to 30-kilometer intervals. However, because of the lack of publicly available high-resolution seismic data from the outer part of the continental shelf and upper parts of the slope in the sale area, the nature and hazard potential of the unconsolidated sediments along the shelf break cannot be evaluated at the present time (Phillips, 1983).

(7) Coastal Area and Erosion: The onshore coastal zone between Point Hope and Point Barrow consists largely of narrow beaches lying at the base of cliffs or bluffs composed of bedrock or ice-rich sediments (Hartwell, 1973). Between Point Hope and an area about 30 kilometers northeast of Cape Beaufort, the coast is part of the arctic foothills physiographic province and a nearly continuous line of steep, rocky cliffs facing the Chukchi Sea. The highest cliffs--246 meters above sea level--occur at Cape Lisburne. At Point Hope, a continuous series of crescent-shaped sand and gravel barrier islands enclose a broad river delta. North of the foothills province, the coast lies within the arctic coastal plain physiographic province, which is characterized by low relief, numerous thaw lakes, rivers and streams, and other features typical of arctic-permafrost terrain. In the southern part of this province, rocky cliffs 4 to 14 meters high overlook the sea. Kasegaluk Lagoon extends for about 200 kilometers along the Chukchi Sea coast from about 25 kilometers southwest of Wainwright. Low, gravelly sand barrier islands lie along the seaward side of the lagoon. Vegetation occurs sporadically on the barrier islands north of Icy Cape but becomes increasingly common on the islands south of the cape; this suggests that the barrier islands north of Icy Cape are frequently overtopped during storm surges and, therefore, are more dynamic than those south of the cape (Robilliard et al., 1985). North of Icy Cape, the coastal bluffs are composed of bedrock or ice-rich sediments with up to 12 meters of relief. The bluffs of ice-rich material are subject to thermal erosion in the summer and early fall, when the

interstitial ice melts and the fine-grained particles are eroded from the bluffs and carried away by the nearshore currents. Two large embayments--Peard and Kugrua Bays--and the Kuk River Inlet occur along the coastline between Kasegaluk Lagoon and Point Barrow. The shorelines of these embayments consist of rapidly eroding, low tundra cliffs (Robilliard et al., 1985)

Rates of coastal erosion between Icy Cape and Barrow range from less than 1 meter per year to 6 meters per year (erosion rates south of Icy Cape have not been measured).

2. Meteorology: The general climatic conditions along the Alaskan arctic coast are characterized by relatively strong winds, cold temperatures during the winter and summer, and small annual precipitation (Searby and Hunter, 1971).

During the winter, the general air-mass-circulation patterns over the northeastern part of the Chukchi Sea are dominated by semistable, high-atmospheric-pressure systems that may extend from eastern Siberia to the eastern Beaufort Sea (Barry, 1979). High-pressure systems, which force the air to flow in a spiral fashion toward areas of low pressure, produce strong easterly, northeasterly, and northerly winds in the northeastern Chukchi Sea. This winter regime also produces intense cold, low cloudiness, and light snow along the coast.

The centers of most of the eastward-moving western-Pacific storms, low-atmospheric-pressure systems that pass into the Bering Sea, remain south of 60°N. latitude. Low-pressure systems that occasionally move northeasterly through the Bering and Chukchi Seas into the Arctic basin bring unseasonably warm air to the region. Strong southeasterly winds are associated with low-pressure systems along the northwest coast of Alaska.

During the summer, the atmospheric-pressure patterns are more numerous and varied than the winter patterns (Barry, 1979). Western-Pacific low-pressure systems are more common north of 60°N. latitude. These systems move northeasterly through the Bering Sea into the Chukchi Sea, where they follow the northwestern Alaska coast. Low-pressure systems generally bring cloudy skies, frequent precipitation, and southwesterly winds. Low-pressure systems may also develop over northern Siberia (Reed and Kunkel, 1960).

Surface winds along the coast between Point Lay and Barrow blow most commonly from the east and northeast; at Cape Lisburne, winds from the east and southeast prevail (Brower, Diaz, and Prechtel, 1977). The velocity of coastal winds is usually within the range of 4 to 8 meters per second. Winds greater than 8 meters per second occur less than 4 percent of the time (Wise, Comiskey, and Becker, 1981). Sustained winds of 26 to 29 meters per second, with higher gusts, have been recorded (Wilson et al., 1982).

Along the Chukchi Sea coast north of Point Hope, the average summer temperature ranges from -2° to 12°C, the average winter temperature from -33° to -6°C; extreme temperatures range from -49° to 27°C (Selkregg, 1975). The average precipitation ranges from about 13 centimeters per year in the north to about 38 centimeters per year in the south.

Fog may be present in the Sale 109 area at anytime throughout the year (Brower, Diaz, and Prechtel, 1977). During the period when sea ice covers the Chukchi Sea, fog occurs about 10 percent of the time. However, during open-water periods, fog becomes more common. In May through September, fog may occur between 20 and 30 percent of the time.

3. Physical Oceanography: The oceanographic regime of the Chukchi Sea is influenced by the seasonal ice cover, the influx of water from the Bering Sea, the atmospheric-pressure system, and surface-water runoff.

The general direction of water movement through the Chukchi Sea is northerly from the Bering Strait into the Arctic Ocean (Coachman and Aagaard, 1981). The basic driving force may be related to a difference in the mean-sea-level elevation, which is thought to be about 1 meter higher in the Pacific Ocean than in the Arctic Ocean (Coachman and Aagaard, 1981). The water flowing through the Bering Strait is nutrient rich--carrying with it Pacific planktonic life forms--and defines a migratory pathway between the Pacific and Arctic Oceans for a variety of animals. This warmer water also causes the Chukchi Sea to become ice-free much earlier than it would otherwise and extends the ice-free season into the fall (Aagaard, 1986).

The major southerly flow reversals occur when strong northerly winds develop over the entire northern Bering Sea and force enough water off the northern Bering Shelf so that the sea level through the Bering Strait region slopes to the south. These strong northerly winds develop when (1) a strong, low-atmospheric-pressure system is centered some distance southeast of the Bering Strait (in the area from Bristol Bay to the northern part of the Gulf of Alaska); (2) a high-pressure system is located in Siberia at some distance west to west-northwest of the Bering Strait; and (3) the greatest pressure gradient is located over the strait and extends north-south across the Chukchi Sea and northern Bering Sea. The southerly flow of water through the Bering Strait is episodic, but there is some indication that it is more common in the fall/winter that in the spring/summer.

The estimated flow of water through the Bering Strait may have a mean range that varies (1) daily from 3.1 Sverdrup (Sv) northerly to 5.0 Sv southerly and (2) monthly from 0.0 to 0.5 Sv northerly in the winter to 1.0 to 2.0 Sv southerly in the summer; the mean annual northerly transport is approximately 0.8 ± 0.2 Sv (Coachman and Aagaard, 1981) ("Sverdrup:" a unit of volume transport equal to 1,000,000 cubic meters per second [m^3/sec]). In comparison, the mean monthly discharge of the Yukon River for May, as measured at Kaltag, is slightly more than 0.018 Sv (18,000 m^3/sec) (Roden, 1967).

In the spring and summer, the water on the Bering Sea shelf is diluted with freshwater runoff and heated from solar radiation and runoff. Water in the eastern Bering Sea receives a larger proportion of the runoff than does the water in the western Bering Sea. The discharge from the arctic rivers flowing into the Bering and Chukchi Seas is greatest between May/June and August, and the major discharge comes from the Yukon River (Coachman and Aagaard, 1981). The water flowing through the Bering Strait may be considered to consist of two watermasses that are distinguished primarily by salinity differences (Aagaard, 1984). The more saline water forms in the northern Bering Sea and flows northward through the western part of the Bering Strait. This watermass tends to flow parallel to the bathymetry and, near the latitude of Point Hope, it begins to flow northwesterly following the Hope Sea Valley to Herald Canyon and into the Arctic Ocean; thus, for the most part, this watermass would not flow through the Sale 109 area.

The other watermass that flows northward through the Bering Strait is called the Alaska Coastal Water. This watermass develops in the eastern Bering Sea and, following the bathymetry, flows through the eastern part of the Bering Strait and along the western coast of Alaska through the Chukchi Sea (Aagaard, 1986). The Alaska Coastal Water is warmer and remains distinct from the more saline watermass that flows through the western Bering Strait. North of Cape Lisburne, the Alaska Coastal Water forms a narrow, relatively fast-moving current that flows northeasterly in a direction approximately parallel to the 20-meter isobath (Paquette and Bourke, 1974); this current is the Alaska Coastal Current (Figs. III-6 and III-7). Alongshore-current velocities of 100 centimeters per second are not unusual (Aagaard, 1984). From Wainwright to Point Barrow, the coastal current flows parallel to the Barrow Sea Valley.

The warmer water from the Bering Sea becomes stratified some tens of kilometers north of the Bering Strait (Bourke, 1983). The upper layer is between 5 and 15 meters thick and is separated from the lower layer by a boundary (thermocline) where the temperature decreases 6° or 7°C within a meter. The temperature in the upper layer reaches 6° to 10°C by midsummer, and the salinities seldom exceed 31 parts per thousand (ppt). The lower layer is cooler and less saline. The relatively warm, northward-flowing Bering Sea water is the primary agent responsible for melting the ice.

In the spring, the area of interaction between the relatively warm Bering Sea water, the Chukchi Sea water, and the ice is marked by a band of loose ice floes that varies in width from 10 to about 100 kilometers, depending upon local winds and currents (Bourke, 1983). In the central and eastern Chukchi Sea, a narrow transition zone usually separates the warmer southern water from the cooler northern water (Paquette and Bourke, 1981). In the upper layer, a thermohaline front is generated when the melting sea ice sharply lowers the temperature and salinity of the impinging warm Bering Sea water. The surface water that lies close to and behind the ice edge is cold (-1.6° to -1.7°C), saline (32.8 to 33.6 ppt), and near the equilibrium freezing point. Only the upper 10 meters of the seawater that lies underneath the ice is diluted by the meltwater. In the lower layer, a second thermohaline front develops between the Chukchi Sea winter water and the Bering Sea water. Both fronts are close together when the current flows parallel to the ice edge, there is low to moderate lateral mixing. However, when the current impinges normally to the ice edge, the two fronts are widely separated and the lower front is generally well south of the ice edge. The characteristics of the ice edge are described in Section III.A.4.

The flow of the Alaska Coastal Current is variable and includes directional reverses that can persist for several weeks (Wilson et al., 1982; Aagaard, 1984); a large part of the flow variability is wind-driven. Thus, during the summer, the Alaska Coastal Water may be absent from some parts of the Chukchi Sea coastal area for a substantial period of time because of prolonged (southerly) flow reversal or offshore diversion (Aagaard, 1984).

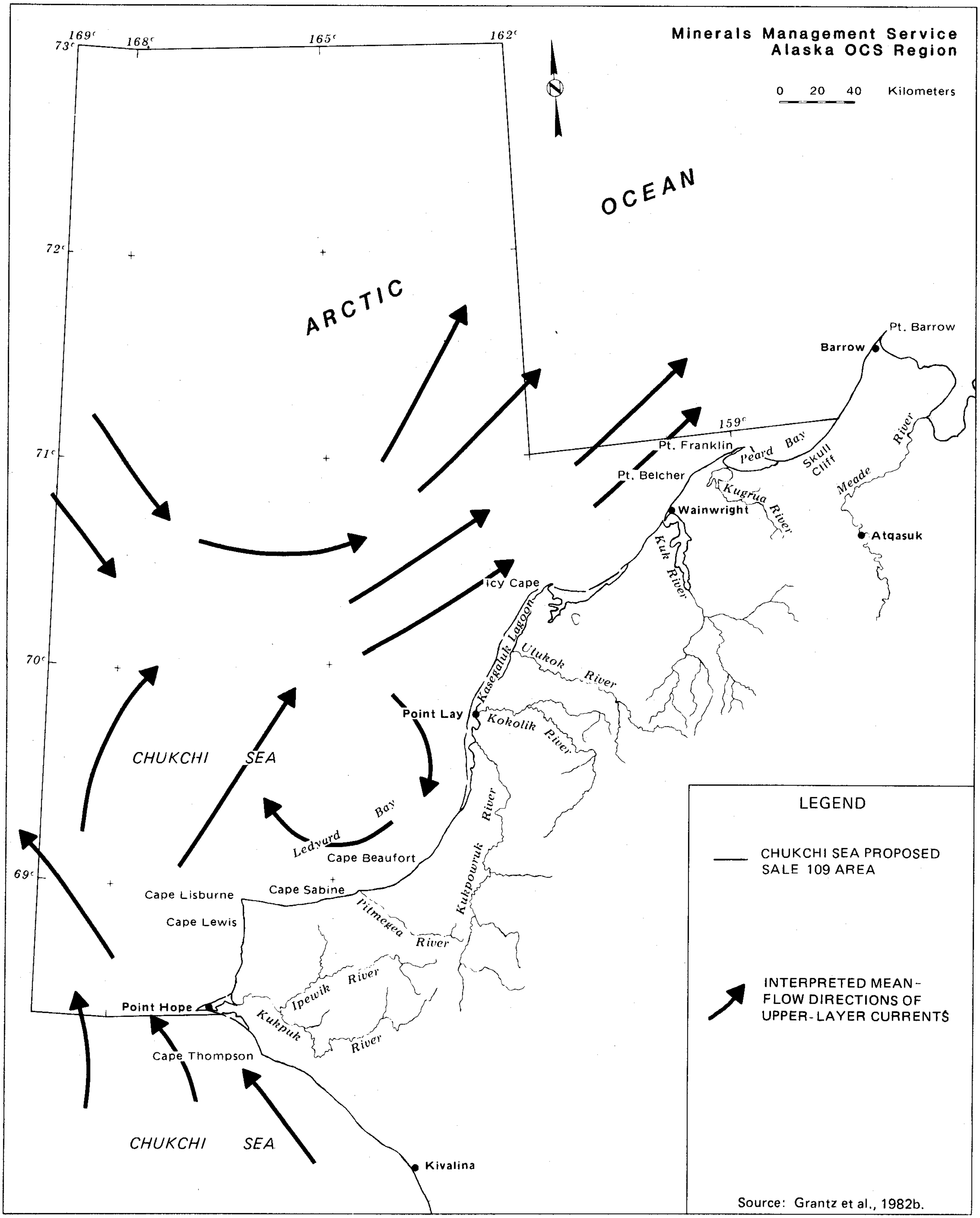


FIGURE III-6. UPPER-LAYER CURRENTS IN THE CHUKCHI SEA

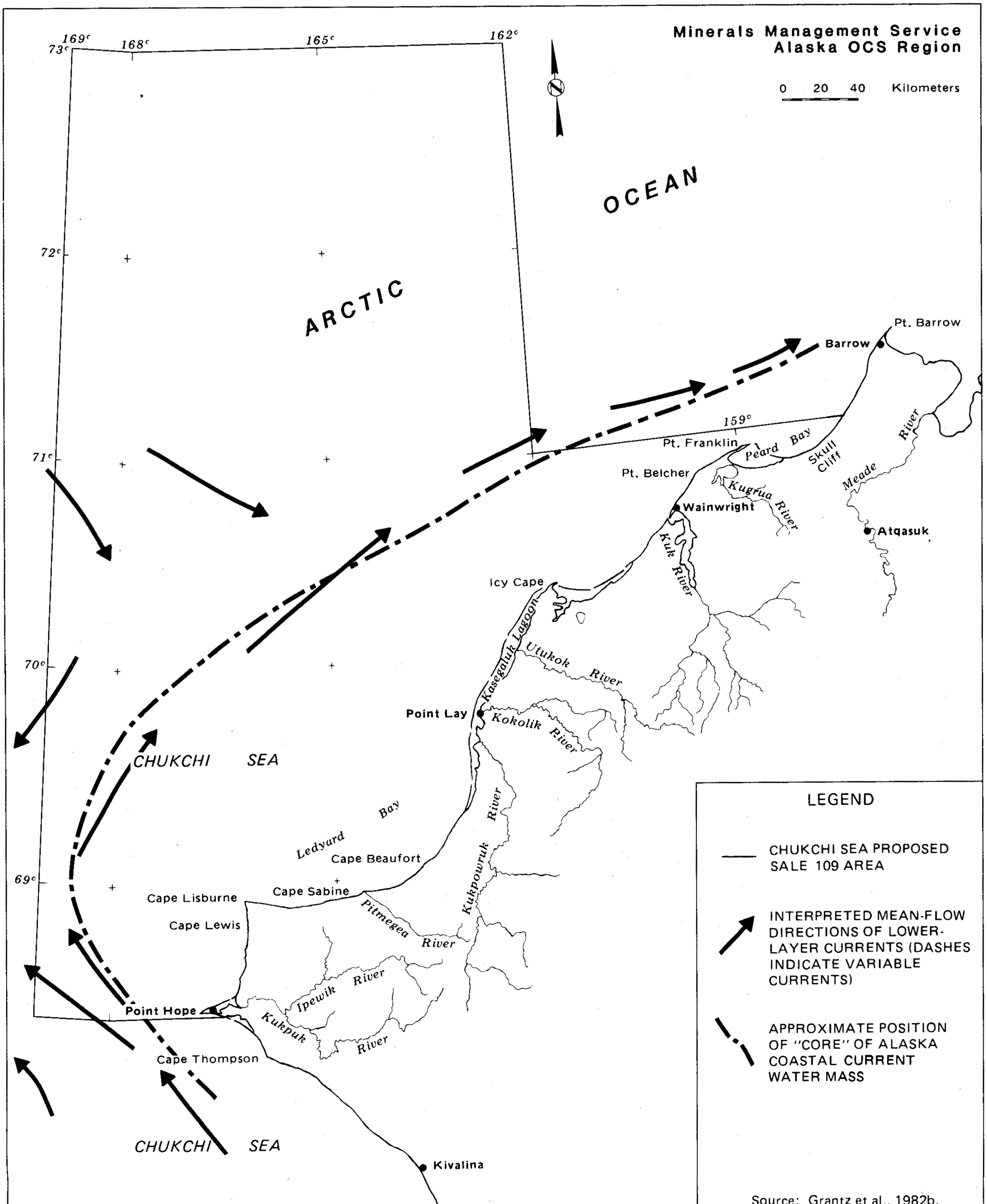


FIGURE III-7. LOWER-LAYER CURRENTS IN THE CHUKCHI SEA

Anticyclonic (clockwise) eddies that separate the nearshore circulation from the warm Alaska Coastal Current, during northeasterly flow, have been observed in the broad embayment between Cape Lisburne and Icy Cape (Fig. III-6) (Wiseman and Rouse, 1980) and off Icy Cape (Hufford, Thompson, and Farmer, 1977), and Peard Bay (Hachmeister and Vinelli, 1985).

During the open-water period, the onshore and offshore flow of surface waters in the nearshore region is controlled by the local wind fields (Hachmeister and Vinelli, 1985). Northeasterly winds promote upwelling that brings cooler bottom water into the nearshore area. Winds with an easterly component also shift the location of the Alaska Coastal Current offshore so that it is centered approximately 20 kilometers from the coast. Southwesterly winds establish a warm coastal jet in the nearshore region and remove the cooler bottom water. Winds with a westerly component shift the location of the warmer waters of the Alaska Coastal Current closer to the coast.

During the summer, when the pressure gradients between major atmospheric-pressure systems produce light- to calm-wind conditions along the coast, local surface winds that blow landward are set up by the thermal contrast between the colder, denser air over the water and the warmer, lighter air over the land (Kozo, 1983). These onshore sea breezes may attain velocities of 5 to 6 meters per second and last for 10 to 36 hours; the average duration is about 10 to 12 hours. These winds affect a zone seaward of the shoreline that is about 20 kilometers wide and push water and sea ice, if present, toward the coast.

The Barrow Sea Valley/Barrow Canyon provides a channel for water exchange between the shallow Chukchi Sea and the deeper waters of the Beaufort Sea and Arctic Ocean (Mountain, Coachman, and Aagaard, 1976). North of Point Barrow, the Alaska Coastal Current turns and flows southeasterly parallel to the coastline. This water has been traced as far east as 152°W. longitude in the deeper parts of the Beaufort Sea (about 150 km east-southeast of Point Barrow). At times, the flow of water in the Barrow Canyon is to the southwest from the Arctic Ocean into the Chukchi Sea (Mountain, Coachman, and Aagaard, 1976). Temperature and salinity measurements indicate that the water in the canyon during these reversals originated in the Arctic Ocean at depths of 150 to 300 meters. The occurrence of these reversals appears to be related to the same atmospheric-pressure conditions that cause a southerly flow of Chukchi Sea water through the Bering Strait.

Wind-generated waves are limited to the open-water period. Waves with heights of less than 1 meter and periods of less than 6 seconds are the most frequently observed (Brower, Diaz, and Prechtel, 1977). However, the potential for generating larger waves occurs near the end of the open-water season when storm frequencies are highest and there is more open water. Waves with heights greater than 6 meters have been observed, but they occur less than 1 percent of the time.

A storm surge is generally an increase in the level of the sea above the mean level, and is associated with atmospheric low-pressure (storm) systems. In general, storm-surge levels and wave heights are higher in the Chukchi Sea than in the Beaufort Sea because of the greater fetch over the open water that exists in summer and autumn (fetch is the open-water distance over which the wind blows). During the summer and fall months, storms usually result in winds from the southwest that move across the Chukchi Sea. Waves and currents generated by the storms may erode seafloor sediments and transport large quantities of the eroded material along the shelf. Storm surges occur along the entire Chukchi coast and can reach as high as 3 to 3.5 meters above normal sea level (Shapiro, 1975).

During storm surges, the coastal water flows through the passes that separate the barrier islands, washes over the low-lying islands, and mixes with the warmer freshwaters of Kasegaluk Lagoon (Wiseman and Rouse, 1980; Hayes and Nummedal, 1977). When the southwest winds subside and the sea level along the coast drops, the lagoon waters flow offshore and mix with the coastal waters. The coarse sediments and frequent washover events prevent stabilization of some of the barrier islands by tundra and vegetation.

Tides are small in the Chukchi Sea, and the range is generally less than 0.3 meters.

Current speeds of 20 to 30 centimeters per second are characteristic of the eastern Chukchi Sea (Mountain, Coachman, and Aagaard, 1976). Grantz et al. (1982b) noted reports of coastal-current velocities of 50 centimeters per second near Cape Lisburne, 51 to 87 centimeters per second south of Icy Cape, and 55 centimeters per second north of Wainwright; on occasion, velocities up to 200 centimeters per second have also been reported north of Wainwright.

The temperature and salinity properties of the winter water in the Chukchi Sea are acquired by cooling and sea-ice formation. This water forms a layer that is characterized by nearly vertical homogeneity. Sea ice covers the Chukchi Sea for most of the year. In the southern part, ice is present for nearly 8 months and remains south of 71°N. latitude for 10 or 11 months. Melting of ice in the Bering Strait begins in late June and--under the influence of northward-flowing warm water--proceeds to the north. The change from winter- to summer-oceanographic conditions occurs quite rapidly. In September, the ice reaches its maximum retreat somewhere between 72° and 75°N. latitude (Paquette and Bourke, 1981). Sea-ice conditions in the Sale 109 area are described in Section III.A.4.

During fall and winter, salt rejection during the formation of sea ice in the nearshore area increases the density of the underlying water and causes a seaward flow of the more dense water; this mechanism preferentially occurs along coasts with offshore winds, such as is frequently the case in the eastern Chukchi Sea during winter.

4. Sea Ice: In an average year, sea ice begins to form in the Sale 109 area in late September or early October; by mid-November or the beginning of December, almost all of the sale area is covered by ice (Webster, 1982; LaBelle et al., 1983; Stringer and Groves, 1985). The general seasonal characteristics of ice in the nearshore area are summarized in Table III-1; the timing of freezeup at several locations along the Chukchi Sea coast is shown in Table III-2. Polar pack ice begins to move southward in late September and, by mid-October, may be found near Barrow (Webster, 1982).

By about mid-May, the nearshore ice and thin ice begin to melt; by July, the pack ice in the sale area has begun to retreat northward (Tables III-1 and III-2). Even in September, when there is maximum open water, ice may be

Table III-1
Average Seasonal Landfast-Ice Regimes in the Chukchi Sea 1/

Ice Phase	Central Chukchi 2/ Sea Coast
New ice forms	Oct. 10
First continuous fast ice	Early Nov.
Extension/modification of fast ice	Nov./Dec. - Jan./Feb.
Stable ice sheet inside 15-meter isobath	Feb. - Apr./May
Rivers flood the fast ice	May 1
First melt pools	May 10
First openings and movement	June 10
Nearshore area largely free of fast ice	July 5

Source: Barry, 1979.

1/ These dates are based on available Landsat imagery for 1973-1977. An identifiable event may occur anywhere between the dates of available clear frames that bracket the latest date of recognized nonoccurrence and the earliest date of its identified occurrence; the average of these dates is used here.

2/ The ice may not achieve any prolonged local stability, given data ±7 to 10 days.

Table III-2
Ice-Breakup and -Freezeup Data for Points Along the Chukchi Sea Coast

	BREAKUP			FREEZEUP			Years
	Earliest	Latest	Average	Earliest	Latest	Average	of Data
Point Barrow	June 15	Aug. 22	July 22	Aug 31	Dec. 19	Oct. 3	31
Wainwright	June 7	July 26	June 29	Sept. 26	Oct. 9	Oct. 2	7
Point Lay	June 1	July 10	June 24	Oct. 12	Nov. 27	Nov. 4	4
Point Hope	May 30	July 8	June 20	Oct. 6	Dec. 19	Nov. 11	8

Source: LaBelle et al., 1983.

present in the northern part of the sale area (Stringer and Groves, 1985). The southern part of the planning area, south of 70°N. latitude, will be ice-free between the beginning of August and the end of October (Stringer and Groves, 1986); within this area, the ice will return once it has retreated in the spring and may retreat once it has formed in the fall less than 50 percent of the time. The relative locations of the ice edge during the time of maximum ice-free water in the Chukchi Sea are shown in Figure III-8 for the period 1972 through 1983.

a. Winter Conditions: Based on dynamic behavior and differences in the types of sea-ice features, the winter-sea-ice regime of the Sale 109 area can be divided into the landfast-ice zone, the stamukhi (shear or flaw) zone, and the pack-ice zone (Fig. III-9). The location of these zones varies spatially and temporally and is strongly influenced by the bathymetry and location of offshore shoals.

(1) Landfast-Ice Zone: By March or April, the landfast-ice zone extends from the shore out to water depths that may vary from 20 to 30 meters (Barry, 1979; Wilson et al., 1982). The width of this zone tends to be narrowest around exposed capes and headlands and widest in protected embayments and shoals (Mellor, 1981). North of Icy Cape, the thickness of the landfast ice ranges from 1.8 to 2.4 meters; south of the cape, normal winter-ice thickness ranges from 0.6 to 1.2 meters.

In the inner part of the landfast zone, the ice freezes to the seafloor; in the outer part, the ice floats. Movement of ice in the landfast zone is intermittent and may occur at anytime, but is more common during freezeup and breakup; ice motion is caused primarily by winds, and by currents. As a first approximation, wind-driven sea ice moves at a rate of about 3 percent of the windspeed. Extreme rates of ice movement--up to 2.3 meters per second--were reported in the Chukchi Sea off Barrow during a storm in December 1973 (Shapiro, 1975); the ice was about 0.6 meters thick, and the winds blew at about 26 meters per second, with gusts up to 52 meters per second.

The movement of ice toward the shore may result in pileups and rideups on the beaches and offshore islands. In the Beaufort Sea, where these phenomena have been studied more extensively, shore-ice pileups and rideups appear to be relatively frequent events. These nearshore and onshore pileups frequently extend up to 20 meters inland from the shoreline over both gentle and sloping terrain and up steep coastal bluffs (Kovacs, 1982). In April 1981, a large shore pileup that was 20 meters high at its peak was observed on Icy Cape. A summer storm subsequently smoothed over the beach and removed any traces that the pileup might have left in the sediments (Kovacs and Kovacs, 1982).

Ice rideups--where an entire ice sheet slides in a relatively unbroken manner over the ground surface for more than 50 meters--are not very frequent; rideups that extend more than 100 meters are relatively infrequent (Kovacs, 1982). Some of the low-lying barrier islands in the Beaufort Sea have been completely overridden by ice sheets as thick as 0.9 meters (Kovacs and Sodhi, 1979). Pileups and rideups may occur at any time of the year, but they are most frequent in the fall and spring.

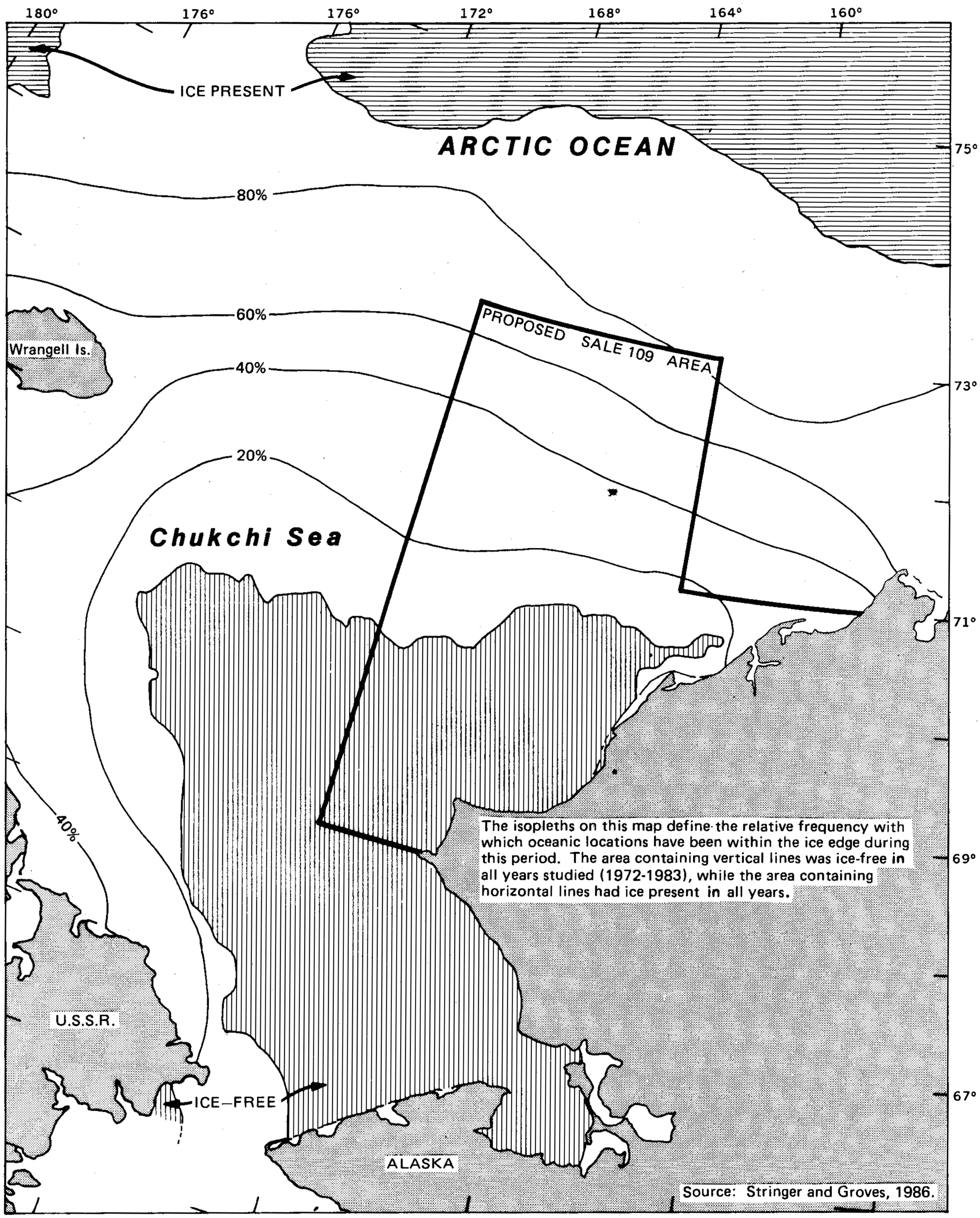


FIGURE III–8. CHUKCHI SEA ICE-EDGE FREQUENCY MAP FOR OCTOBER 5–11, 1972 to 1983

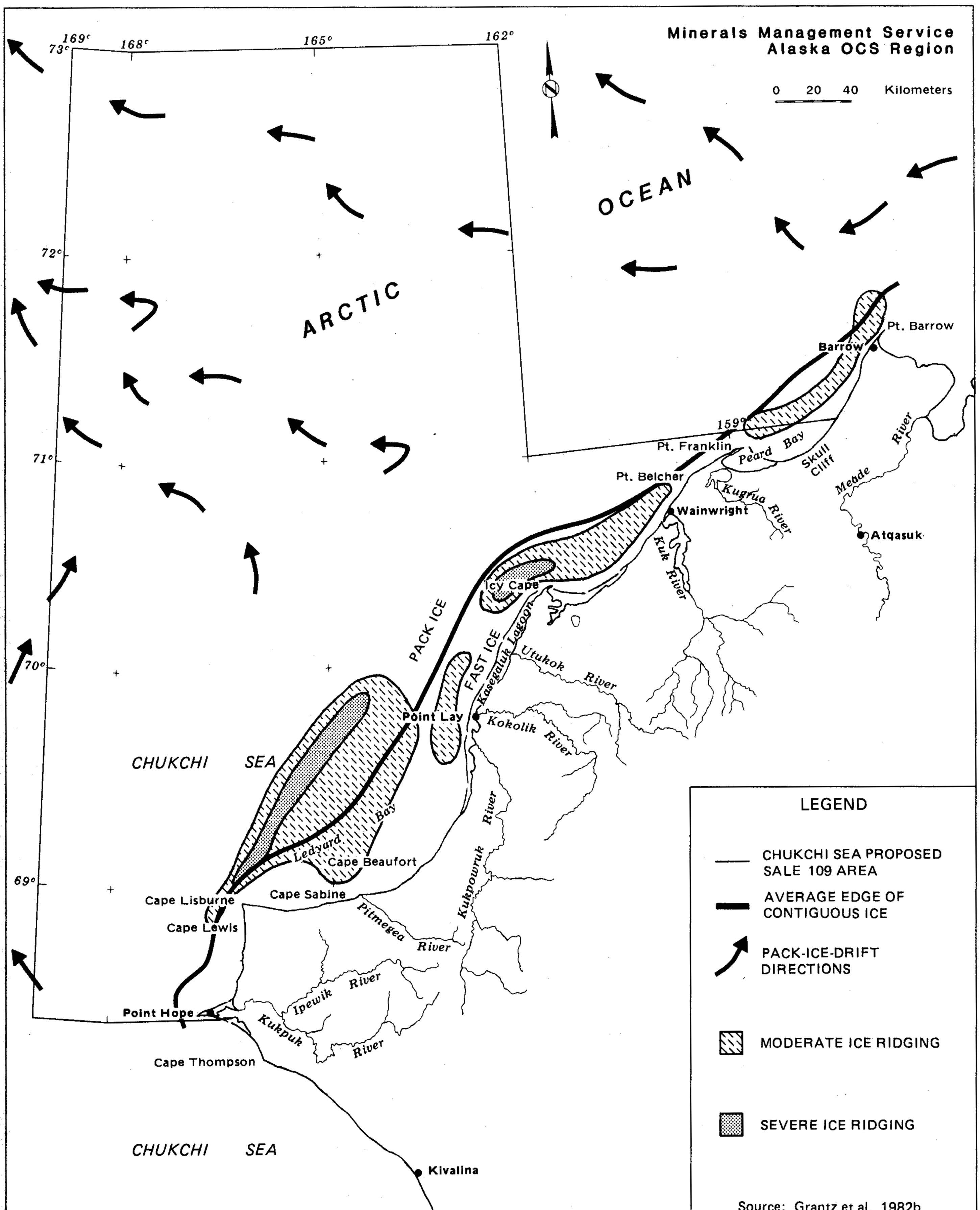


FIGURE III-9. COASTAL-ICE ZONATION, AREAS OF ICE RIDGING, AND DIRECTION OF PACK-ICE MOVEMENT IN THE CHUKCHI SEA

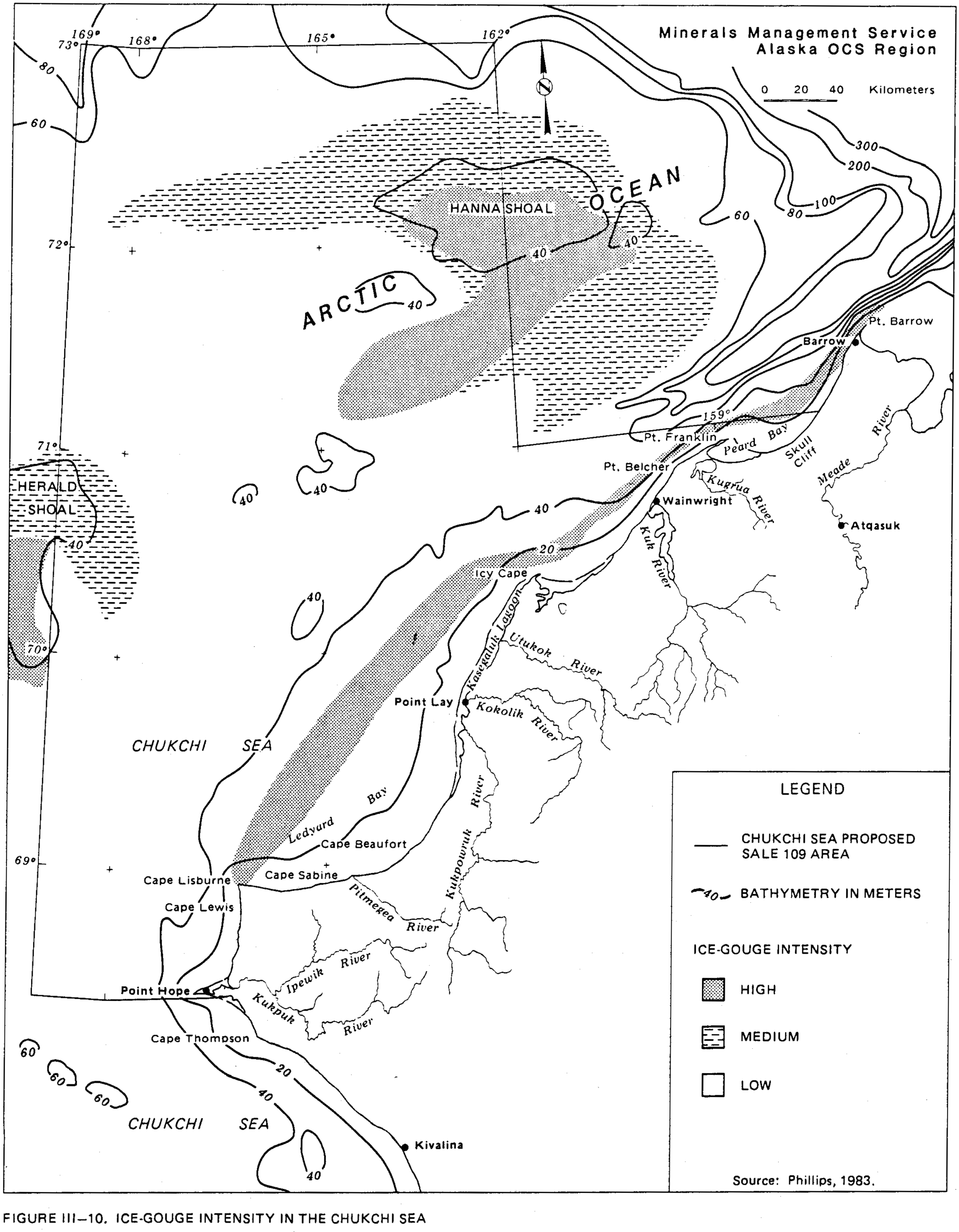


FIGURE III–10. ICE-GOUGE INTENSITY IN THE CHUKCHI SEA

(2) Stamukhi Zone: The ice zone that lies seaward of the landfast ice has been referred to as the stamukhi (shear or flaw) zone. This zone is a region of dynamic interaction between the relatively stable ice of the landfast-ice zone and the mobile ice of the pack-ice zone that results in the formation of ridges, leads, and polynyas (large areas of open water). In the Chukchi Sea, the region of most intense ridging occurs in waters that vary in depth from 15 to 40 meters deep (Fig. III-9); moderate ridging extends seaward and shoreward of these regions. Grounded ridges help to stabilize the seaward edge of the landfast-ice zone.

Ridges are formed by the differential movement of adjacent ice floes or sheets. If the movement is essentially normal to the boundary that separates the floes, a pressure ridge is formed. On the other hand, if the motion is essentially parallel to the boundary, a shear ridge is formed. Pressure ridges are sinuous, composed of blocks with dimensions related to the thickness of the ice being incorporated into the ridge at the time of movement, and may be associated with large (tens of meters) over- and underthrusting of interacting ice sheets. Extensive rafting usually occurs in the vicinity of pressure ridges, and ice thicknesses of 2 to 4 times the sheet thickness may be found within a few hundred meters of the ridge. Shear ridges are straighter, usually have one vertical side, and are composed of granulated-ice particles that range in size from a few centimeters in diameter up to rounded blocks that have dimensions comparable to the thickness in the ice that formed the ridge.

At depths shallower than 60 meters, linear depressions have been gouged into the seafloor by the keels of drifting ice masses. Ice-gouge densities in the sale area are shown in Figure III-10.

Along the coast, areas of high ice-gouge density include the steep slopes of the seafloor in the Barrow Sea Valley or ice-push-sediment ridges, the stamukhi zone, and the shoals adjacent to the capes (Phillips, 1983). The orientation of the gouges is usually parallel to the isobaths on the steep slopes and shoals, but in water less than 15 meters deep the orientation may be random. Between Point Barrow and Icy Cape, the maximum observed gouge-incision depth generally increases slightly from 2.4 meters at 12 meters of water depth to 2.8 meters at 24 meters of depth. Below 28 to 30 meters, the gouge-incision depth decreases with increasing depth; this decrease may reflect the thin sediment cover, about 1 to 2 meters, in waters deeper than 30 meters or the presence of bedrock at or near the surface, which would prevent gouges from forming. Reworking of sediments by currents in the stamukhi zone may also eliminate the traces of many ice gouges.

Contemporary ice gouging may be occurring in water at least 43 meters deep. In the central part of the Sale 109 area, beneath the Alaska Coastal Current in water depths of 43 to 45 meters, ice gouges were observed cutting across sand- ripple fields that may be active under present-day current regimes. The currents also transport the sediments that partially or completely fill in the gouges. The reoccurrence interval of ice gouging on the seafloor of the Chukchi Sea is unknown at this time.

The system of leads and polynyas that develops between the landfast- and pack-ice zones extends the length of the Chukchi coast from Point Hope to Barrow during the winter and spring (Stringer, 1982). Between February and

April, the average lead-system width is less than 1 kilometer (the extreme widths range from a few kilometers in February to 20 kilometers in April) and is open about 50 percent of the time. The overall behavior of the Chukchi Sea open-water system from late spring to early fall is summarized as follows: (1) during May and June, the average width is about 4 kilometers at the northern end but widens to about 58 kilometers at the southern end (there are, however, large variations in the width and the system is a more or less permanent feature); (2) through July and August, the average width increases dramatically (extreme widths of several hundred kilometers can occur), but the open-water system in the vicinity of Point Barrow and Wainwright may be closed; (3) September is the period of maximum open water, but the pack ice is occasionally held against the coast at Point Barrow; and (4) the freezeback process begins in October.

Anchor ice may be an important geologic agent in the sedimentary regime of the shallow Arctic seas (Reimnitz, Kempema, and Barnes, 1986). In the Beaufort Sea, anchor ice has been observed in waters shallower than 5 meters--other information suggests that it may form at depths out to about 15 to 20 meters.

Anchor ice is underwater ice formed in supercooled water. Frazil ice consists of small, disk-shaped crystals that form in turbulent, slightly supercooled water. When turbulence carries frazil ice to submerged, supercooled objects on the bottom, the frazil may adhere to the substrate (sediments)--forming anchor ice. Once anchor ice is formed, it may grow rapidly by free growth in the supercooled water or by trapping other frazil crystals from the water column. When dislodged, the buoyant force of the anchor ice generally transports some components of the substrate to the surface.

The short-lived nature of storm-generated anchor ice makes study of related sediment transport and bedform dynamics extremely difficult. Near the seabed, sediment movement with anchor ice during a storm probably is more important for overall sediment transport than is ice rafting on the sea surface (Reimnitz, Kempema, and Barnes, 1986).

(3) Pack-Ice Zone: The pack-ice zone lies seaward of the stamukhi zone and includes the following morphologically different sea-ice types: (1) first-year ice; (2) multiyear floes, ridges, and floebergs; and (3) ice islands. The first-year ice that forms in open-water fractures, leads, and polynyas varies in thickness from a few centimeters to more than a meter. The ice within a refrozen opening generally is thinner and weaker than the surrounding ice. Multiyear ice is simply defined as ice that has survived one or more melt seasons. Ice islands are tabular icebergs that have calved (broken away) from ice shelves on Ellesmere and Axel Heiberg Islands.

During the winter, the pack ice in the northern part of the Chukchi Sea generally moves in a westerly direction (Fig. III-9); however, there may be short-term perturbations from the basic trend due to the passage of low- and high-atmospheric-pressure systems across the arctic. Pack ice in the southern part of the Chukchi Sea is usually transported to the north or northwest. The movement of the pack ice during the spring and summer of 1977 and 1978 was determined from buoys deployed on and drifting with the pack ice (Pritchard, 1978; Colony, 1979). The data from the buoys showed that the direction of movement was generally to the northwest, but the ice drifted slightly toward the southwest in March.

Sea-ice-motion studies in the Chukchi Sea during 1981 to 1982 showed that the ice (1) in the central part of the sale area, more than 150 kilometers offshore, moved in a generally northwesterly direction and (2) from an area 50 to 100 kilometers offshore, showed both northeasterly and southwesterly directions of movement--the distances covered in either direction were up to 100 kilometers long during time periods of 3 to 10 days (Pritchard and Hanzlick, 1987). The velocities of the ice movement nearer the coast ranged from about 5 to 25 centimeters per second; ocean currents appeared to be more important than wind in determining the direction of ice movement. Ocean currents flowing parallel to the shoreline reached a maximum velocity of about 35 centimeters per second.

Strong, driving forces acting over a relatively long period of time will gradually move the sea ice southward in a band that is 100 or more kilometers wide and extends from the Bering Strait northward along the Alaskan coast past Point Barrow (Kovacs, Sodhi, and Cox, 1982). This band includes sea ice of the flaw-lead system along the northwestern Alaska coast. As the ice attempts to move through the Bering Strait, an arch (or ice bridge) is formed across the strait (Pritchard, Reimer, and Coon, 1979). If the combination of wind and current forces acting on the ice behind the blockage exceeds the strength of the arch, the arch will fail and the jammed-up ice will move rapidly into the Bering Sea; such an event is termed a breakout. Breakouts may occur about two to four times a season and last for several (2 to 4) days (Lewbel, 1984). A breakout event in January 1977 resulted in an estimated 62,000 square kilometers of Chukchi Sea ice flowing through the Bering Strait with a speed of about 4.1 kilometers per hour; in March 1978, approximately 64,000 square kilometers of ice moved through the strait at 2.8 kilometers per hour (Ahlnas and Wendler, 1979).

First-year floes off the Chukchi Sea coast have a thickness of about 1.2 to 1.5 meters (Barry, 1979). Multiyear floes are 3 to 5 meters thick. Large floes with diameters that range from 0.5 to 10 kilometers have been observed in the vicinity of the 30- to 40-meter isobaths between Barrow and Cape Lisburne (Dickins Engineering Consulting, 1979).

Sea ice that is thicker than 5 meters is common in the Arctic Ocean pack ice and generally believed to consist of pressure ridges and rubble fields that were formed by the deformation of thinner ice (Weeks and Mellor, 1983). The sizes of multiyear ridges are described principally in terms of sail height and, to a lesser extent, keel depth or ridge length. Based on a limited number of concurrent measurements, the ratio of sail height to keel depth is about 1:3.2 for floating ridges that are in equilibrium. To date, measurements of these parameters indicate that there are many low ridges and very few high ridges.

Seasonal and geographic variations in the ice roughness were determined from data obtained in 1976 during laser-profilometer flights in the northeastern part of the Chukchi Sea (Tucker, Weeks, and Frank, 1979). Seasonal variations in the ridge heights showed that average ridge heights in the fall and early winter (1.2 m), are lower than in late winter and early spring when the ice is thicker (1.5 m). Over 75 percent of the late-winter and early spring ridges were less than 2 meters high; several ridges were about 5 meters high. The average ridge density of about 3.6 ridges per kilometer was also greater in February and April than in August and December, when about 1.8 ridges per kilometer were observed.

As a result of melting and refreezing, multiyear ridges are stronger than first-year ridges. During the summer, the ice in the sail portion of the ridge melts and displaces the more saline water in the voids of the keel. When this meltwater freezes, it gives the ridges a strong core with no voids.

Ships operating in sea ice report that first-year ridges do not offer significant resistance beyond that needed to force the large volume of ice aside, but multiyear ridges are extremely difficult to break (Weeks, 1981).

Other thick masses of sea ice include floebergs and ice islands. Floebergs are hummock or rubble fields that are frozen together. They form principally in the zone between the drifting pack ice and the landfast ice (Toimil and Grantz, 1976).

Ice islands are large, tabular icebergs with areal sizes ranging up to 1,000 or more square kilometers and thicknesses up to 60 meters (Sackinger et al., 1985). They calve from the ice shelves located along the northern coasts of Ellesmere and Axel Heiberg Islands and drift into the Arctic Ocean where they slowly circulate in a clockwise direction for many years. During an observation period from 1963 through 1986, 1,053 square kilometers of ice were lost from the Ellesmere and Axel Heiberg ice shelves. The amount of ice lost in any year varied from zero to 569 square kilometers. The ice-shelf observations and ice-island sightings indicate that it may take 10 or more years for ice islands to reach locations to the east within the Beaufort Sea. Large ice islands have been observed only in the northern part of the Chukchi Sea.

Hanna Shoal is a site for the accumulation of ice features such as ice-island fragments or floebergs that have drafts greater than 25 meters (Toimil and Grantz, 1976). Recurrent groundings of ice islands or floebergs result in the seasonal growth of this field.

The northern, eastern, and southeastern flanks of Hanna Shoal are extensively gouged (Phillips, 1983). The ice-gouge densities reflect the pack-ice-drift patterns around the shoal. On the northern flank of Hanna Shoal out to a depth of about 48 meters, ice-gouge-incision depths seldom exceed 2 meters; but between the water depths of 48 to 52 meters, incision depths of 3 to 4 meters have been observed. Ice gouges are shallow and sparse beyond the 54-meter isobath. Shallow, solitary ice gouges have been found east of Hanna Shoal in water as deep as 64.5 meters and may be expected of equivalent water depths in the northernmost part of the Sale 109 area. Ice gouges also are abundant on Herald Shoal.

Within the central part of the Chukchi Sea shelf, the ice-gouge density appears to decrease to the south and with depth.

b. Summer Conditions: The edge of the retreating pack ice is quite variable. In midsummer, the Chukchi Sea pack ice is usually composed of a mixture of broken, eroded blocks and small floes. Depending upon the wind velocity, the concentration of ice at the edge may be less than one-eighth or greater than six-eighths. Winds or currents moving away from the ice tend to scatter individual floes and form a broad zone; winds and currents moving toward the ice compact the zone. However, even when individual pieces of sea ice are scattered, the edge tends to be well defined (Paquette and Bourke, 1981).

The shape of the ice edge is irregular and includes embayments of various sizes that are produced by the melting action of warm water. Some of the larger embayments appear to reoccur from year to year and in approximately the same places. One of the embayments occurs in the western Chukchi Sea between 170° and 175°W. longitude; another embayment is centered at about 168°W. longitude; and a third lies west to west-northwest of Point Barrow. These embayments are closely correlated with bathymetric troughs and support the concept that the flow of warm water from the Bering Sea is controlled, at least in part, by the bathymetry.

The general characteristics of sea-ice decay along the coast during the summer are as follows (Barry, 1979) (see Table III-2 for the timing): (1) over-ice flooding at the river mouths in spring, (2) meltpools forming on the ice surface, (3) openings in previously continuous ice sheets, (4) movements in previously immobile nearshore ice, and (5) nearshore areas largely free of fast ice. Because there are no major rivers along the Chukchi Sea coast, nearshore over-ice flooding is not a dominant component of the sea-ice-decay process.

5. Air Quality: The only major local source of industrial emissions existing in arctic Alaska is the Prudhoe Bay/Kuparuk complex. Even in the vicinity of this complex, air quality has consistently been much better than necessary to meet Federal ambient standards. Existing air-quality concentrations for Prudhoe Bay for 1979 to 1980 are shown in Table III-3 with the relevant National standards. In the table, Drill Site 9 is to the east and usually upwind of major Prudhoe Bay-emission sources, while Well Pad A is to the west and usually downwind. Downwind concentrations show increases in nitrogen dioxide, carbon monoxide, sulfur dioxide, total suspended particulates, and nonmethane hydrocarbons, indicating appreciable emissions of these chemicals. Because northeast, east, and southeast winds predominate over southwest, west, and northwest winds only 30 percent of the time (54% versus 24%), these recorded concentration differences would have been roughly threefold greater if they were a true upwind/downwind measurement. Thus, the Prudhoe Bay/Kuparuk complex is increasing downwind air concentrations by 43 percent for nitrogen dioxide, 70 percent for sulfur dioxide, 86 percent for carbon monoxide, and 210 percent for total suspended particulates.

Even with the high level of oil and gas activity at Prudhoe Bay and Kuparuk, the North Slope generally has what is considered good air quality. In summer and fall, regional pollutant levels are extremely low, in some cases similar to those of the Antarctic. However, in winter and spring, pollutants are transported across the North Pole from industrial Europe and Asia to arctic Alaska (Rahn, 1982). Pollutant sulfate in the air in Barrow--that in excess of natural background levels--then averages 1.5 micrograms per cubic meter. The concentration of vanadium--a combustion product of fossil fuels--then averages up to twentyfold of background levels in air and snowpack. Concentrations of aerosol haze at Barrow during winter and spring are similar to those at major cities in the continental U.S. (see Fig. III-11) but considerably higher than levels south of the Brooks Range at Fairbanks. Preliminary

Table III-3
Measured Pollutant Levels (micrograms per cubic meter)
at Prudhoe Bay, Alaska, from April 1979 through March 1980

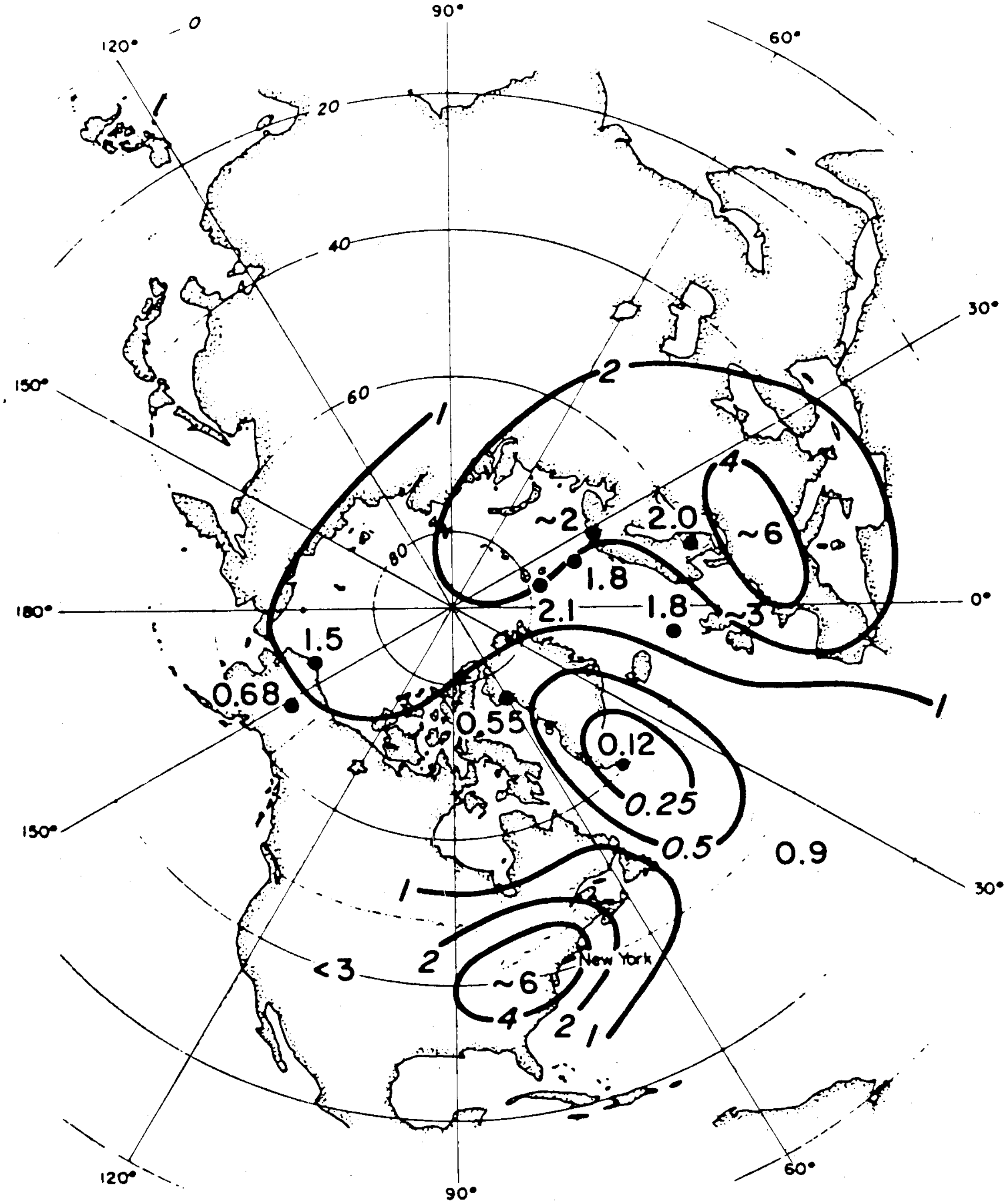
Pollutant	Monitor Location		National Ambient Air Quality Standards	
	Drill Site 9	Well Pad A	Primary	Secondary
Nitrogen Dioxide				
1-Hour Maximum	84.0	125.0	--	--
Annual Arith. Mean	3.5	4.0	100	100
Ozone				
1-Hour Maximum 1/	113.0	113.0	235	235
Annual Arith. Mean	51.0	47.5	--	--
Carbon Monoxide				
1-Hour Maximum 2/	3,430.0	3,120.0	40,000	40,000
8-Hour Maximum 3/	946.0	856.0	10,000	10,000
Annual Arith. Mean	133.0	171.0	--	--
Sulfur Dioxide				
3-Hour Maximum 2/	13.0	25.3	--	1,300
24-Hour Maximum 2/	9.5	9.3	365	--
Annual Arith. Mean	0.4	0.5	80	--
Total Suspended Particulates				
24-Hour Maximum 2/	112.0	294.0	260	150
Annual Geo. Mean	6.7	11.4	75	60

Source: Radian Corporation, 1981.

1/ Ozone standard is attained if the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than one.

2/ Not to be exceeded more than once per year.

Note: -- Denotes no applicable standard.



SOURCE: Rahn, 1982.

FIGURE III–11. MEAN WINTER CONCENTRATIONS OF POLLUTANT SULPHATE (μg/m^3) IN SURFACE AEROSOL OF THE ARCTIC AND ITS ENVIRONS data indicate that this arctic haze is composed of sulfur-oxide aerosols, soot, and perchloroethylene and other hydrocarbon products of industry and fossil-fuel combustion (Rahn, 1982; Ocean Science News, 1983). Despite this seasonal long-distance transport of pollutants into the Arctic, regional air quality is still better than National standards.

6. Water Quality: The water quality of the Sale 109 area is pristine; there has been no industrial activity and most impurities occur at low levels. These impurities are introduced into the marine environment through river runoff, coastal erosion, and inflow from the Bering Sea. The rivers that flow into the sea remain relatively unpolluted by the activities of man.

a. Turbidity: Satellite imagery and analyses of suspended-particulate matter indicate that turbid waters are confined to nearshore lagoons, inlets, and breaks in offshore bars (Sharma, 1979). However, because of the absence of major rivers and lower rates of shoreline erosion along the Chukchi Sea coast, these nearshore waters should be clearer than the nearshore waters of the neighboring Beaufort Sea.

Offshore, in the southern portion of the sale area, suspended-particulate loads in the water column range between 1 and 5 parts per million (ppm). In the northern portion, surface concentrations are usually less than 1 ppm, with somewhat higher concentrations at depth.

b. Dissolved Oxygen: In general, oxygen concentrations are at or above saturation (Fleming and Heggarty, 1966). Because the cold temperature of the water increases solubility of oxygen, oxygen concentrations are high--about 8 to 11 milliliters (ml) per liter (Kinney et al., 1970). However, concentrations as low as 6 ml per liter have been found in the deeper waters offshore Point Hope.

c. Trace Metals: Trace-metal concentrations are low and show no indication of pollution (Table III-4). Concentrations within the sediment are similar to those for other coastal seas. Existing water concentrations of sampled trace metals are two orders of magnitude lower than those required by Federal-saltwater-quality criteria.

d. Hydrocarbons: Background hydrocarbon concentrations are also very low. In the water they average less than 1 part per billion (ppb) and appear to be mostly biogenic (Shaw, 1977; Katz and Cline, 1980). Pelagic tars were not present in the two surface tows (740 m^2 each) made in the OCSEAP program. A plume of low-molecular-weight hydrocarbons in deeper water (although still less than 1 ppb) extends toward Point Hope from the west. Cline et al. (1978) speculated on two possible sources for this plume: (1) hypothesized seeps along the Siberian Shelf or (2) an artifact of slower decomposition of biotic hydrocarbons in cold, less oxygenated water derived from the Siberian Shelf.

Concentrations of hydrocarbons in the sediment have not been measured, but would be expected to be at least as low as the (low) parts-per-million levels found in the more developed Beaufort and northern Bering Seas (see Proposed

Table III-4
Trace-Metal Concentrations in the Chukchi Sea Planning Area

	SEDIMENTS (ppm)		WATER (ppb)	
	Chukchi Sea Planning Area	Average World Coastal Ocean 1/	Total	EPA Total Saltwater Criteria 2/
Chromium	30-60 3/	100	--	50 4/
Mercury	0.017 5/	--	0.006-0.03 6/	0.025 4/
Lead	14 5/	20	--	5.6 4/
Zinc	25-125 3,5/	5-200	2.4 7/	86 8/
Cadmium	0.1 9/	0.2-3.0	--	9.3 4/
Barium	150-400 3/	250	--	--
Copper	13-35 3,5/	48	--	2.9 10/
Nickel	10-30 3/	55	--	7.1 11/
Vanadium	--	130	--	--

Sources: As indicated in the footnotes below.

1/ Beaufort Sea Sale 97 DEIS (USDOI, MMS, 1986).
2/ USEPA (1986).
3/ Sharma (1979).
4/ 4-hour average, not to be exceeded more than once in 3 years.
5/ Barnes and Leong (1971).
6/ Atlas (1978).
7/ Kinney et al. (1970).
8/ 4-day average (52 FR 6213).
9/ Burrell (1978)--extractable only.
10/ 1-hour average, not to be exceeded more than once in 3 years.
11/ 24-hour average, not to be exceeded.

Note: -- Denotes lack of data or standard.

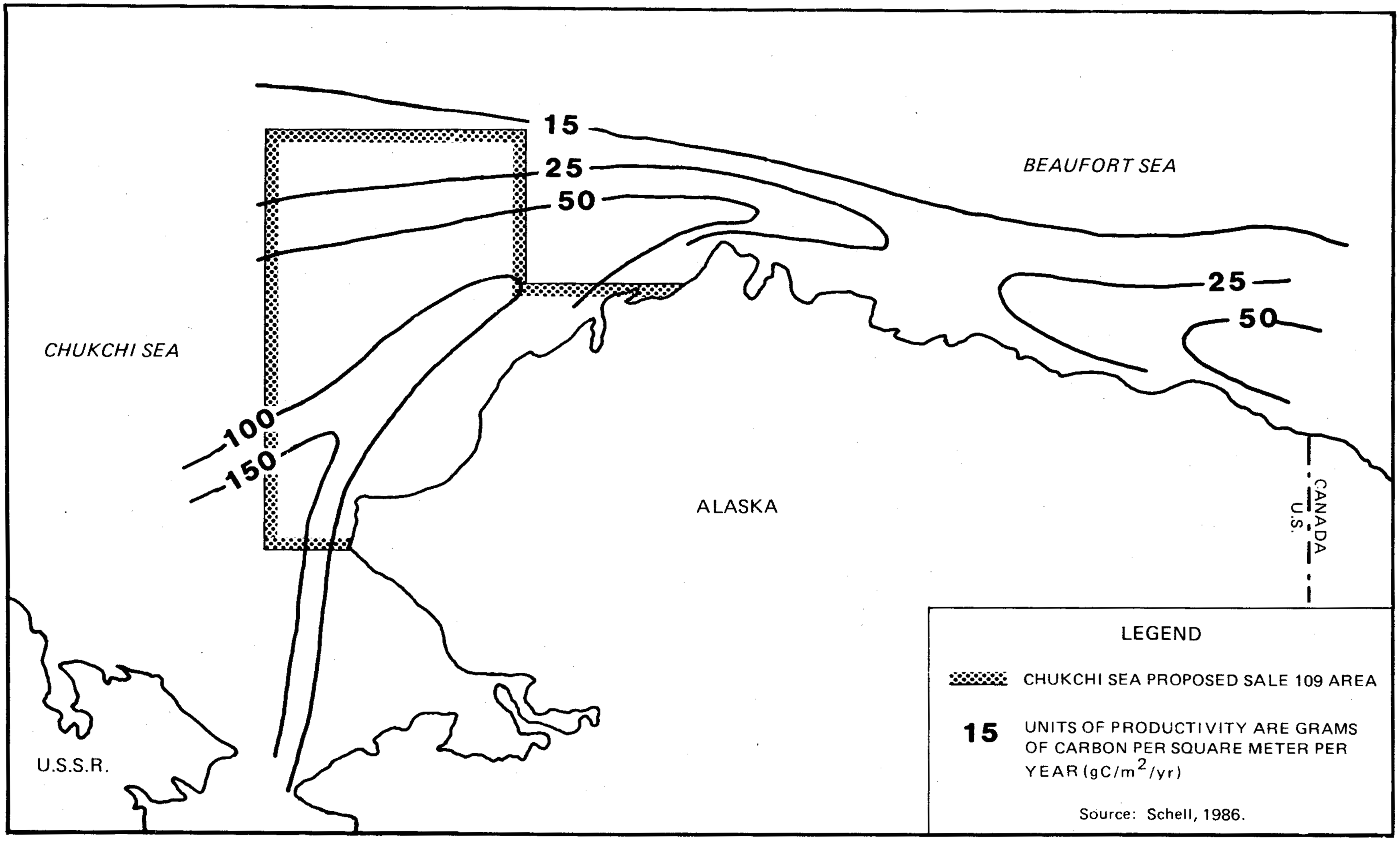


FIGURE III–12. CONTOURS OF ANNUAL PRIMARY PRODUCTION

Diapir Field Lease Offering [June 1984] FEIS [USDOI, MMS, 1984a]; Norton Basin Sale 100 FEIS [USDOI, MMS, 1985c]; and Beaufort Sea Sale 97 FEIS [USDOI, MMS, 1987a]).

B. Biological Resources:

1. Lower-Trophic-Level Organisms: Lower-trophic-level organisms in the proposed Chukchi Sea Sale 109 area can be categorized as pelagic (living in the water column), epontic (living on the underside of or in sea ice), or benthic (living on or in the sea bottom). The abundance and spatial and seasonal distribution of these organisms are strongly influenced by the physical environment. In particular, the currents moving north through the Bering Strait have a strong effect on primary production, in addition to transporting detritus and larval forms of invertebrates and fishes from the Bering Sea into the Chukchi Sea. Seasonal ice regimes also strongly influence the pattern and timing of productivity and the distribution patterns of higher-order consumers (e.g., walrus).

a. Pelagic Community: This section concerning the pelagic community concentrates on planktonic organisms that live in the water column (pelagic fishes are discussed in Sec. III.B.2). Planktonic organisms are those organisms occurring in the water column that are subject to the vagaries of the water's movements; they are unable to swim very effectively against currents. Two basic groups comprise the plankton: (1) phytoplankton, the primary producers or plants of the plankton; and (2) zooplankton, the animal component of the plankton.

Primary production, via the process of photosynthesis, is the formation of organic compounds (like carbohydrates), from inorganic carbon sources (e.g., carbon dioxide) using solar energy, and with chlorophyll as a catalyst. The entire food chain can be based on this process. In the southern Chukchi Sea, primary production is enhanced by the transport of upwelled nutrient-rich water from the Gulf of Anadyr in the northwestern Bering Sea through the Bering Strait and into the Chukchi Sea. The very high concentrations of phytoplankton supported by this water in the Bering Strait region have been estimated to fix 324 grams of carbon per square meter per year (g $C/m^2/yr$) over 2.12×10^4 square kilometers (Sambrotto, Goering, and McRoy, 1984). This is nearly twice the production of the southeastern Bering shelf and is higher than figures reported for any arctic area (Subba, Rao, and Platt, 1984). Initial data from the ISHTAR (Inner Shelf Transfer and Recycling in the Bering and Chukchi Seas) Project suggest that the various watermasses (Alaska Coastal Water, Bering Shelf Water, and Anadyr Water) entering the Chukchi Sea have distinct productivity regimes.

The intense productivity of the region near St. Lawrence Island and northward through the Bering Strait produces a great deal of organic matter, some of which supports a high zooplankton biomass, plus excess material which may, at least in part, be deposited in sediments of the Chukchi Sea. This enriched sediment supports a high biomass of benthic invertebrates (see Sec. III.B.1.c, Benthic Communities).

Patterns in annual primary productivity in the Chukchi Sea have been estimated by Schell (1986) (Fig. III-12). Primary productivity tends to decrease as one moves north from the Bering Strait. Light, as influenced by ice regimes, and nutrients are both important in determining levels of primary production. Hameedi (1978) found that nutrients (primarily nitrogen) were the major factor limiting primary production in the photic (lighted) zone of the Chukchi Sea during July. Light was not limiting at his stations during the summer. Hameedi also felt that sea-ice algae might contribute substantially to the total chlorophyll a content in the Chukchi Sea, although the residence time of these cells in the water column might not be long.

The phytoplankton species reported from the Chukchi and Beaufort Seas generally have widespread distributions in high latitudes (Carey, 1978). Most algal species predominate in either the open-water or epontic (under-ice) communities, with only one species, Nitzschia cylindrus, a major component of both epontic and pelagic habitats (Horner and Schrader, 1982). Long-chain diatoms such as Chaetoceros were found by English (1966) to be abundant components of phytoplankton samples in the Chukchi Sea.

Watermasses moving northward through the Bering Strait and into the Chukchi Sea transport not only nutrients and phytoplankton, but also zooplankton from the Bering Sea. Similar species of zooplankton are found in the Bering and Chukchi Seas (Stepanova, 1937; Johnson, 1953, 1956; Brodsky, 1957; English, 1966; Wing, 1974; Coyle, 1981). Differences in the species composition of nearshore- and more oceanic-zooplankton assemblages within the Chukchi are also similar to patterns observed in the Bering Sea (Brodsky, 1957). Samples from coastal environments generally had smaller volumes of zooplankton, with predominance by the copepods Eurytemora pacifica and Acartia clausi, and the cladoceran, Evadne nordmani. Offshore areas were characterized by copepods like Metridia lucens, Calanus plumchrus, and Eucalanus bungii (English, 1966). In sampling by Wing (1974), the hydromedusa, Aglantha digitale, was the predominant zooplankter, both in numbers and biomass. The second-most abundant zooplankters were calanoid copepods, although meroplankters (larval forms of benthic animals) equaled or exceeded copepods in numbers at half of the stations. The calanoid copepods had their highest densities off Cape Lisburne. Wing compared data from the most similar stations sampled by himself (in 1970) and Johnson (in 1947). Major differences (besides those that were apparently due to season of sampling) were: (1) calanoid copepods dominated the zooplankton in 1947, but not in 1970; (2) greater numbers of Aglantha, Clione (a pteropod), and crab larvae occurred in 1970; and (3) lesser numbers of Pseudocalanus were found in 1970. Coyle (1981) found calanoid copepods, mainly Pseudocalanus spp. and Oithonia similis, to predominate. However, he remarked that zooplankton abundances were much lower in the Chukchi Sea than in more southerly areas, and that the species represented were generally small, inefficient phytoplankton grazers that are poor sources of food for whales and other large consumers of zooplankton (in contrast to the large zooplankton found in the Beaufort Sea that are apparently efficient grazers and also are fed on extensively by bowhead whales).

Zooplankton samples in the Beaufort Sea have also included coelenterates, nematodes, annelids, mollusks, tunicates, decapod crustaceans, and barnacles. Numbers of these have been the larval forms of benthic organisms (meroplankton). The meroplankton can be an important component of the plankton in the Chukchi Sea, as compared to the Beaufort Sea (see Table III-5) (Johnson, 1956). Further data on meroplankton appear in Wing (1974).

Table III-5
Average Number of Bivalve and Barnacle Larvae (Meroplankton) per Station

Larval Type	1950 Chukchi Sea	1950 Western Beaufort Sea	1950 Eastern Beaufort Sea	1951 Chukchi Sea	1951 Western Beaufort Sea	1951 Eastern Beaufort Sea
Bivalves	160	10.4	6	3,192	492	15
Barnacles	2,532	45.1	6.86	9,576	1,478	52.68

Source: Johnson, 1956.

Wing and Barr (1977) sampled midwater invertebrates in offshore areas of the Chukchi Sea ranging from near Icy Cape to somewhat southwest of Cape Lisburne. They found 103 species of invertebrates, with amphipods comprising the most species (35), followed by decapod crustaceans with 14 species. Scyphozoans and hydrozoans contributed most to the volume of the catches. After the scyphozoans and hydrozoans were removed, euphausiids and mysids were the most abundant invertebrates and became the major contributors to the biomass.

b. Epontic Community: The epontic community in the Sale 109 area is an assemblage of plants, small invertebrates, and a group of fish (cryopelagic fish) that are distinctly associated with the undersurface of sea ice. The primary producers in this community are ice algae, which form a concentrated food source for a variety of animals, including amphipods, copepods, ciliates, various worms, and juvenile and adult fishes. The algae are dominated by diatoms and are present on the undersurface of the ice or within the bottom few centimeters. Ice-algal distribution tends to be patchy on both small and large scales.

In the Chukchi Sea, near Barrow, the ice-algal bloom and the spring bloom in the water column are clearly separated by species composition and time. The ice community is composed primarily of pennate diatoms (Horner and Alexander, 1972; Alexander, Horner, and Clasby, 1974), while the spring phytoplankton bloom consists primarily of centric diatoms (Horner, 1969). Only one diatom species, Nitzschia cylindrus, is abundant in both the ice and water-column communities. The ice-algal bloom usually occurs in April and May, although it sometimes extends into early June, while the phytoplankton bloom does not start until ice breakup is underway and light is available to the cells in the water column.

Although approximately 200 diatom species have been identified from arctic sea ice, only a few species predominate. Nitzschia frigida was usually found by Horner and Alexander (1972) to be the most abundant species at Barrow, but Meguro, Ito, and Fukushima (1966, 1967) apparently did not find it farther offshore. Navicula marina was also a prominent member of the community at Barrow and was often the most abundant species (Alexander, Horner, and Clasby, 1974).

Microalgae are found in sea ice as it forms in the fall, but the origin of the cells is not known (Horner and Schrader, 1982). One possibility is that those species that eventually thrive in the ice may be present in low numbers in the water column and may be incorporated into the ice as it forms (Horner and Schrader, 1982).

Light appears to be the major factor controlling the distribution, development, and production of the ice-algal assemblage. Productivity increases with increasing light. Attenuation of light by turbid ice (ice with incorporated sediments) or by snow cover can greatly reduce or eliminate the productivity of the ice algae (Alexander, Horner, and Clasby, 1974; Schell, 1980a,b; Horner and Schrader, 1982; Dunton, 1984).

Algal biomass in the spring bloom near Barrow showed a bimodal pattern, with an early peak during late April-early May, and a later maximum peak at the end of May-early June (Alexander, Horner, and Clasby, 1974). Primary-production levels near Barrow were 5 grams of carbon per square meter (g C/m^2) for the bloom period. In the eastern Chukchi Sea, Parrish (1987, unpublished data cited by Schell, 1987, oral comm.) has calculated a yearly estimate of 13 g C/m^2. This value is higher than estimates for the Chukchi Sea near Barrow and for the coastal Beaufort Sea (Alexander, Horner, and Clasby, 1974). Other sources of primary production include phytoplankton, benthic microalgae, and--in some areas--benthic macroalgae.

Although the contribution of ice algae to annual productivity may be relatively small, these cells may be an important source of food during early spring when food is presumably in short supply. It has been hypothesized that incomplete grazing of the ice algae and algae at the ice edge may allow a significant portion of the algal-cell population to remain intact. These cells may then serve as a direct food source or may enhance nutrient supplies in the benthic environment by sinking as detritus or living, photosynthetically active cells (Alexander and Chapman, 1981; Niebauer, Alexander, and Cooney, 1981).

c. Benthic Communities: The benthic communities in the Chukchi Sea can contain macroscopic algae (large seaweeds), benthic microalgae, and benthic invertebrates.

(1) Macroscopic Algae: Although systematic surveys for macroscopic algae, especially kelp beds, have not been undertaken in the northeastern Chukchi Sea, records from a variety of sources indicate the presence of at least two kelp beds along the nearshore coast. One first described by Mohr, Wilimovsky, and Dawson (1957) and confirmed by Phillips et al. (1982) is located about 20 kilometers northeast of Peard Bay, near Skull Cliff. Another was reported by Phillips and Reiss (1985) approximately 25 kilometers southwest of Wainwright in water depths of 11 to 13 meters. Even without detailed surveys, it appears that kelp beds are not frequently encountered in the Chukchi Sea. Mohr, Wilimovsky, and Dawson (1957) remarked that kelp were found at only one of 18 stations sampled by the Arctic Research Lab's LCM *William E. Ripley* as it traveled from Point Barrow to Wainwright; the one station where it found algae was near Skull Cliff. The predominant alga at this station was the kelp, *Phyllaria dermatodea*. Two other brown algae, *Laminaria saccharina* and *Desmarestia viridis*, were also abundant; and

seven species of red algae were sampled. Other macroscopic algae have been noted in Peard Bay, as drift algae, and when fouling anchors (see Truett, 1984).

Macroscopic-algal growth in nearshore areas of the Chukchi Sea is probably limited by the availability of appropriate substrates (rock, cobble, and gravel). The existent kelp beds and stands of green sea lettuce (Ulva) in Peard Bay are additional sources of primary production. Kelp beds provide a three-dimensional environment that, in some areas, increases the diversity of organisms living in an area. However, Mohr, Wilimovsky, and Dawson (1957) recorded that relatively few invertebrates (all polychaetous annelids and arthropods) were taken, plus six species of fishes in conjunction with the algae near Skull Cliff.

(2) Benthic Microalgae: Benthic-microalgal assemblages, consisting primarily of diatoms, have been studied in the Chukchi Sea in the nearshore area off Barrow (Matheke and Horner, 1974). The relationship of the species found in sediments with those found in the ice-algal assemblage is unclear, although some species occur in both assemblages. Primary productivity of the benthic microflora ranged from less than 0.5 milligrams C/m^2/hour in winter (when the sampling area was covered with ice), to almost 57.0 mg C/m^2/hour in August. This peak-productivity value was about eight times the peak value for ice-algal production and approximately twice that of the phytoplankton (Matheke and Horner, 1974). The productivity of these various assemblages peaked at different times: ice-algal productivity peaked in May, phytoplankton productivity peaked in the first half of June, and productivity of the benthic microalgae peaked during late July and August. In nearshore environments then, benthic microalgae may be a significant source of primary productivity.

(3) Benthic Invertebrates: The benthic-invertebrate fauna of the northeastern Chukchi Sea appears to contain components of both the Bering Sea biota and that of the Beaufort Sea. Currents flowing northward from the Bering Sea through the Bering Strait carry larval forms of some benthic invertebrates (meroplankton). With increasing distance from the Bering Strait, the influence of such transport should decrease, although only for those species that, once established in the Chukchi Sea, are unable to successfully reproduce. Although the benthic-invertebrate fauna of the southeastern Chukchi has been characterized as primarily boreal Pacific in nature, both Broad et al. (1978) and Kinney (1985) have noted the similarity of nearshore, littoral, and/or lagoonal invertebrates found in the northeastern Chukchi Sea to those of the Beaufort Sea. Kinney (1985) attributes this to the similarity of the major physical conditions in the northern Chukchi and Beaufort Seas, and to occasional current reversals along the coast that bring larvae and food from the Beaufort Sea.

The offshore benthos in the northeastern Chukchi Sea has not been extensively studied. Stoker (1981) examined benthic infauna in this region as part of a large study that extended from the southeastern Bering Sea to the northern Chukchi Sea. Even this study had only about 10 of its 176 quantitative sampling stations within the Sale 109 area (Figs. III-13 and III-14, and Table III-6). In his study, Stoker statistically compared the infaunal compositions

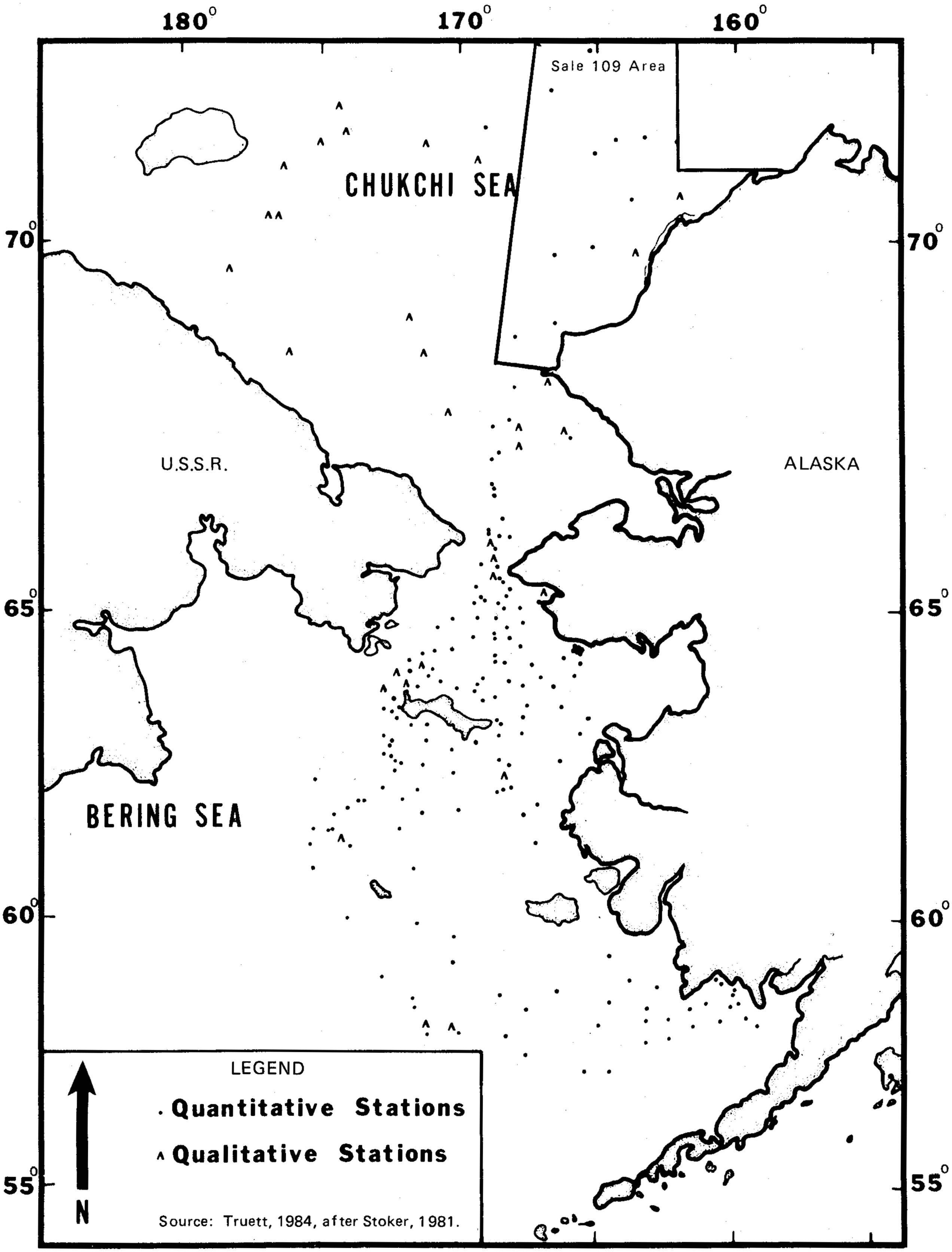


FIGURE III–13. INFAUNAL STATIONS SAMPLED BY STOKER

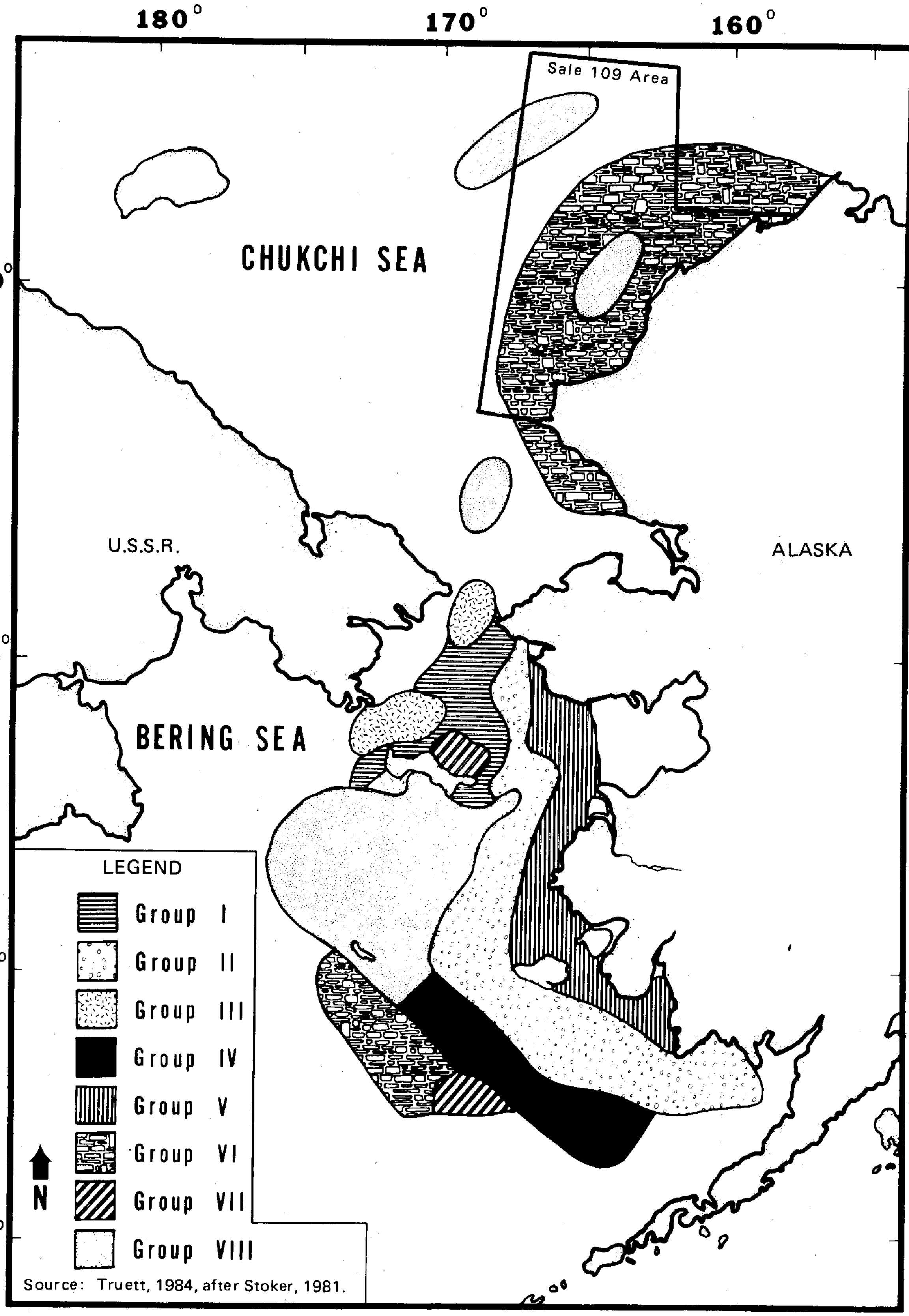


FIGURE III–14. PATTERNS OF SIMILARITY OF BENTHIC FAUNAL GROUPS

NOTE: The groups of benthic infauna are defined by similarity of dominant species as determined from bottom samples at various locations (see Fig. III-13 and Table III-6 of this EIS).

Table III-6
Descriptions of Benthic Faunal
Groups Shown in Figure III-14

Dominant Species	Common Name
CLUSTER GROUP I	
Ampelisca macrocephala	amphipod
Byblis gaimardi	amphipod
Ampelisca birulai	amphipod
Macoma calcarea	clam
Astarte borealis	clam
CLUSTER GROUP II	
Tellina lutea	clam
Echinarachnius parma	sand dollar
CLUSTER GROUP III	
Ophiura maculata	brittle star
Strongylocentrotus droebachiensis	sea urchin
Cistenides granulata	polychaete worm
CLUSTER GROUP IV	
Haploscoloplos elongatus	polychaete worm
Protomedeia fasciata	amphipod
Yoldia hyperborea	clam
CLUSTER GROUP V	
Serripes groenlandicus	bivalve - cockle
Myriochele heeri	polychaete worm
Sternaspis scutata	polychaete worm
Diamphiodia craterodmeta	brittle star
Gorgonocephalus caryi	basket star
CLUSTER GROUP VI	
Maldane sarsi	polychaete worm
Ophiura sarsi	brittle star
Golfingia margariticea	sipunculid - peanut worm
Astarte borealis	clam
CLUSTER GROUP VII	
Macoma calcarea	clam
Chone duneri	polychaete worm
CLUSTER GROUP VIII	
Macoma calcarea	clam
Nucula tenuis	clam
Yoldia hyperborea	clam
Pontoporeia femorata	amphipod

Source: Stoker, 1981.

of the stations, ranging in location from the southeastern Bering Sea to north of Point Barrow, and recognized the recurring pattern of eight major faunal assemblages (Fig. III-14 and Table III-6). Two of these species groupings occurred in the northeastern Chukchi Sea--Groups VI and VIII (Fig. III-14 and Table III-6). Group VI was predominated by the polychaete Maldane sarsi, the brittle star Ophiura sarsi, the sipunculid (peanut worm) Golfingia margariticea, and the bivalve Astarte borealis. The major species in Group VIII were the bivalves Macoma calcarea, Nucula tenuis, and Yoldia hyperborea, and the amphipod Pontoporeia femorata. Stoker felt that the type of sampling gear used did not adequately sample large, deep-burrowing bivalves in the genera Mya and Spisula. The major predators of the infauna, walruses and bearded seals, have diets containing higher percentages of burrowing bivalves than did Stoker's study (Lowry, Frost, and Burns, 1980a). In the case of bearded seals, diets were dominated by clams in the genera Spisula and Serripes. Walrus diets in the Chukchi Sea may be similar (Lowry, Frost, and Burns, 1980a).

Stoker also latitudinally compared the species diversity and biomass of samples. Within the Sale 109 region, biomass was far greater in the most southerly region; however, species diversity increased with increasing latitude. The differences in benthic standing stocks (biomass) on the Bering/Chukchi shelf were felt to be determined by levels of primary productivity, current structure and velocity (both affecting food availability), and predation by benthic-feeding fishes and marine mammals. Depth, sediment type, and latitude were viewed as being only coincidentally involved. In examining species distributions, sediment type was the environmental variable most directly correlated with distributions (Stoker, 1981).

The epifauna in offshore regions of the northeastern Chukchi Sea benthos has been investigated to varying extents by Wing and Barr (1977), Frost and Lowry (1983a), Sparks and Pereyra (1966), and Phillips and Reiss (1985a,b). In general, organisms seem to be broadly distributed, although they frequently seem to segregate by sediment type.

Ten of 36 stations sampled by Frost and Lowry (1983) occurred in the northeastern Chukchi Sea, with the remainder ranging eastward to the U.S./Canada demarcation line. The major break in epifaunal communities seemed to occur at about 154°W. longitude. West of this meridian, in areas with muddy substrates, brittle stars (usually Ophiura sarsi) predominated. Other associated species included soft corals (Eunephthya spp.) and sea cucumbers (Psolus sp. and Cucumaria sp.). Stations in this western area that had rocky substrates had different species compositions. Ophiura sarsi was also one of the species found by Stoker (1981) to predominate in the Chukchi Sea (Group VI, Fig. III-14). Echinoderms, primarily brittle stars and crinoids, were the most abundant invertebrates at 26 of 33 stations sampled by Frost and Lowry, usually comprising more than 75 percent of the total trawl biomass.

Sparks and Pereyra (1966) sampled primarily south of Point Hope, but found, in their samples to the north of that point, various echinoderms (starfish, echinoids, brittle stars, and sea cucumbers), gastropods, annelids, barnacles, decapod crustaceans, and tunicates to be relatively abundant.

Wing and Barr (1977) sampled the benthos at one station in the northeastern Chukchi Sea off Point Lay and found 3 species of gastropods, 4 bivalves, 2 mysids, 2 isopods, 12 amphipods, 9 decapod crustaceans, and 1 ascidian species.

Phillips (1986, oral comm.), found some association of invertebrate types with substrate and water depth. Depth of the substrate could also influence the survival of various organisms. In some gravel-dominated areas, live anemones and soft corals were found down to depths of 30 to 40 centimeters; in some places, a layer of dead barnacles was found buried in the gravel. The latter observation suggests that large-scale movements of gravel beds might be caused by storms. Wave forms in sandy substrates also suggest disturbance of the bottom by physical forces.

Feeding by gray whales and walruses could be correlated with different substrates, as evidenced by sidescan-sonar images of feeding traces (Phillips, 1986, oral comm.). Gray whales fed most intensively between Point Franklin and Wainwright, in areas of pebbly sand containing abundant amphipods. Walruses, on the other hand, fed intensively to depths of 58 meters at the edge of the pack ice north and west of Point Franklin. Substrates showing walrus traces were a finer sand with a mud veneer that contained some bivalves.

Although Phillips (1986, oral comm.) observed signs of ice gouging down to depths of 69 meters in the Chukchi Sea, the nearshore and littoral zones are much more likely to be seasonally disturbed by ice. In a study of the near-shore and littoral areas of the Beaufort and Chukchi Seas, Broad et al. (1978) concluded that the fauna of the Beaufort littoral and nearshore (0-20 m depths) and the northeastern Chukchi littoral (0-2 m depths) are similar in species, diversity, and biomass. Principal invertebrates sampled in the northeastern Chukchi littoral include oligochaete worms, isopods, mysids, amphipods, bivalves, priapulids, chironomid larvae, dipterans, and hermit crabs (Broad et al., 1978).

Investigation of the Peard Bay Lagoon by Kinney (1985) revealed that the predominant epibenthic species were the isopod Saduria entomon, the mysid Mysis litoralis plus many juvenile Mysis sp., and the amphipods Gammaracanthus loricatus, juvenile Gammarus sp., and Onisimus litoralis. The type and distribution of infaunal invertebrates appeared to be influenced by physical factors such as sediment composition, water depth, currents, etc. In the deeper, central section of Peard Bay, two species of bivalves predominated, while in the shallower surrounding areas such as the entrance to the more interior Kugrua Bay, several species of polychaetes predominated. The shallow center of Kugrua Bay was predominated by oligochaetes. Comparison of the faunas of the littoral and lagoonal environments of the northeastern Chukchi Sea with those of the Beaufort Sea, plus the occurrence of several arctic-zooplankton species just outside of Peard Bay, suggest that the predominant species in these areas are polar forms rather than boreal Pacific species.

d. Trophic Interactions: In a highly seasonal environment like that of the Chukchi Sea, extremes and patterns in the physical environment affect the interaction of organisms with the environment and interactions among organisms. In the Chukchi Sea, currents moving north through the Bering Strait have a strong effect on primary production in addition to transporting detritus and larval forms of invertebrates and fishes from the Bering Sea into the Chukchi Sea. Seasonal ice regimes also strongly influence the pattern and timing of productivity and the distribution patterns of higher-order consumers (e.g., walrus).

Dynamics within the pelagic community will be influenced most by transport of nutrients, productivity, and consumers from the Bering Sea, plus the seasonal retreat of ice and subsequent bloom of open-water phytoplankton. Other primary producers such as kelp, benthic microalgae, or ice-algae may be locally or temporally important sources of carbon (the ice algae providing a burst of production before the open-water phytoplankton bloom). Zooplankton in the Chukchi Sea are thought to be similar to those of the middle Bering Sea shelf in species composition and as small, inefficient grazers of phytoplankton. Thus, much of the local production, as well as plankton and detritus transported into the Chukchi Sea, may sink to the benthos and support the organisms there. It has been suggested that the epibenthic community is dependent on detritus (Stoker, 1981). Both the epifauna and infauna figure importantly in the diets of higher-order consumers (see Fig. III-15). The major predators of the infauna are walruses and bearded seals (Lowry, Frost, and Burns, 1980a), while the epifauna are of particular importance to bearded seals (shrimps, brachyuran crabs); ringed seals (amphipods, shrimps); gray whales (ampeliscid amphipods); and arctic cod (benthic amphipods, shrimps, mysids) (Lowry and Frost, 1981).

More generally speaking, epifauna are important prey of some marine mammals, marine and anadromous fishes, and birds. Fish--especially arctic cod but also saffron cod, sand lance, and sculpins--are important prey of other organisms, including marine mammals, birds, and other fishes. Swartz (1966) estimated that 25 million arctic cod may be consumed annually by seabirds at Cape Thompson. Changes in the abundance of these major fish prey may lead to fluctuations in the distribution and reproductive success of seabirds and marine mammals (Springer, Roseneau, and Johnson, 1979; Lowry, Frost, and Burns, 1980a). Springer et al. (1984) extended the correlation to interannual changes in water temperature and sea ice. Spatial variation in currents also can affect primary productivity and related food webs in an area. For example, the area near Cape Lisburne, where copepod abundance is very high and nesting birds forage extensively, may be an area of high primary productivity, resulting possibly from the formation of a front between Alaska Coastal Water and Arctic Ocean Water (Springer et al., 1984). Upwelling may occur in this region. Thus, physical-oceanographic parameters may affect primary productivity and its transport into the Chukchi Sea, which in turn may affect the abundance of fishes (and other prey of higher-order consumers), and finally may affect the abundance of birds or marine mammals.

2. Fishes: This discussion incorporates by reference the discussion of fishes contained in the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c) with augmentation by additional information, as cited. Overviews of the fish resources of the proposed Sale 109 area have been provided by Morris (1981a), Moulton and Bowden (1981), Craig (1984), and Maynard and Partch/Woodward-Clyde Consultants (1984). Craig and Skvorc (1982) provided an analysis of research on the fish resources of this region. Since these reviews, two more studies were completed in the northeastern Chukchi Sea (Fechhelm et al., 1984; Kinney, 1985); and a moderate amount of research was completed in the vicinity of Kotzebue

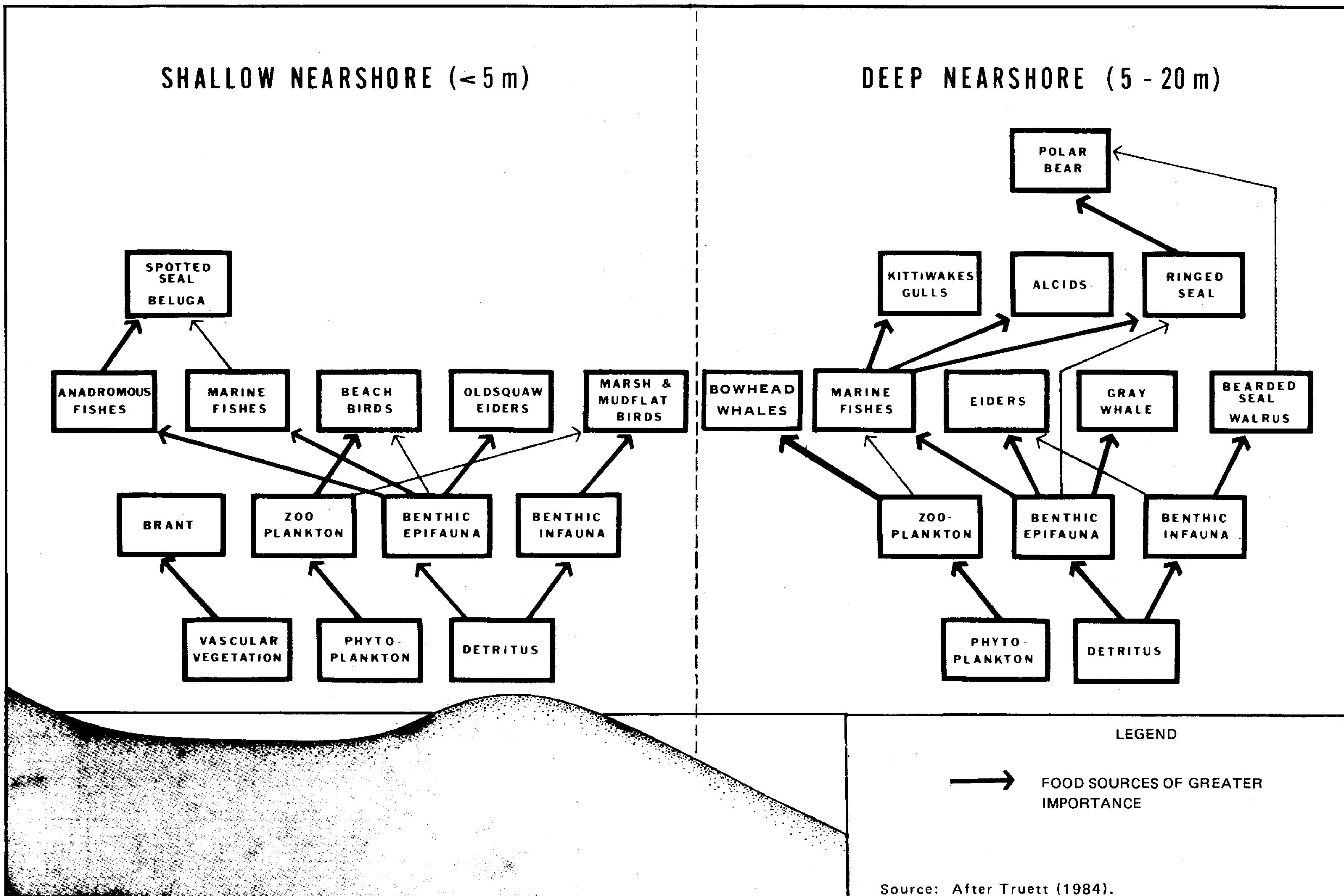


FIGURE III-15. SIMPLIFIED FOOD WEB OF THE CHUKCHI SEA COASTAL ECOSYSTEM.

Sound to the south and in the Beaufort Sea to the northeast. From this sampling, 72 species of fishes were reported for the northeastern Chukchi Sea. Studies in this area generally followed marine fishes because they appear to be more abundant than anadromous species. The populations of anadromous species tend to be small and widely distributed.

a. Anadromous Fishes: Twenty-five species of fishes were reported to occur in the freshwaters of the Chukchi Sea coast (Morrow, 1980). Thirteen of these species are anadromous and can be found in the open waters of offshore areas, estuaries, and freshwater systems during part of their life cycles. The anadromous fishes of the Chukchi Sea include Pacific salmon, arctic char (Dolly Varden), ciscoes, whitefishes, and rainbow smelt. Of the Pacific salmon species, only pink and chum salmon are found throughout the sale area; sockeye, coho, and king salmon are occasionally caught in coastal waters, but they generally reach their northern spawning boundary in the Point Hope/Point Lay coastal sector at Cape Lisburne. King salmon are infrequently taken by subsistence fishermen at Point Lay (Schneider and Bennett, 1979). As juveniles, some anadromous species undertake extensive migrations from freshwater to mature at sea in the offshore areas; as adults, they return to freshwater to spawn. Among this group are the arctic lamprey, the five salmon species (pink, chum, sockeye, king, and coho), and rainbow smelt (Maynard and Partch/Woodward-Clyde Consultants, 1984). The remainder of the anadromous species seasonally enter the brackish or offshore-marine environment in the summer and spend most of their lives in freshwater lakes and rivers. During the summer open-water season, anadromous species range throughout the Chukchi Sea in offshore coastal waters; brackish estuaries and river mouths; and freshwater rivers, streams, and lakes. Most of the anadromous-fish species spawn in the fall in lakes or streams.

A recent study by Craig and Skvorc (1982) on the status of existing fisheries information for the Chukchi Sea region recognized that limited research has been conducted on the anadromous fishes that inhabit the coastal streams and estuaries north of Point Hope. The available information is the result of a few brief reconnaissance surveys, and virtually all of the data on anadromous fishes were collected during the open-water season. Fechhelm et al. (1984) and Kinney (1985) studied fish in Kasegaluk Lagoon and Peard Bay as well as offshore during the open-water season, but few anadromous fishes were caught. In March 1983, no anadromous fish were caught under the ice in Peard Bay, Wainwright Inlet, or Ledyard Bay (Fechhelm et al., 1984). Much of the knowledge regarding species occurrence has been documented from subsistence harvests by coastal inhabitants. In the southeastern Chukchi Sea south of Point Hope, the knowledge of anadromous-fish populations, life-history information, and habitat use has been augmented by studies directed at commercial fish stocks and detailed investigations conducted during the 1960's for Project Chariot in the Cape Thompson area (Maynard and Partch/Woodward-Clyde Consultants, 1984). A number of studies that included anadromous fishes were conducted in relation to oil and gas activity in the Beaufort Sea (Craig and McCart, 1976; Bendock, 1977; Hablett, 1979; Craig and Haldorson, 1981; Gallaway et al., 1982; Schmidt, McMillan, and Gallaway, 1983; and Cannon and Hachmeister, 1986).

Craig (1984) summarized the importance of relatively warm and brackish nearshore waters to the dispersal and welfare of the anadromous fishes of the Beaufort Sea coast. Wolotira, Sample, and Morin (1977) characterized the anadromous fishes of the southeastern Chukchi Sea as using only estuarine and other nearshore marine environments. Recent studies indicate that there are physiological advantages, and probably requirements, for anadromous species to remain in these nearshore waters (Fechhelm and Gallaway, 1982). However, Craig and Skvorc (1982) caution that extrapolation of fisheries data from the Beaufort Sea or Norton Sound may not be valid because of differences in oceanography, fish populations, and presumed use of coastal habitats. When the catch per fyke-net-day in the Chukchi Sea is compared to the Beaufort Sea studies (Craig and Haldorson, 1981; Griffiths and Gallaway, 1982; Griffiths et al., 1983; Fechhelm et al., 1984; and Kinney, 1985), the virtual absence of anadromous fishes is the most prominent feature of the Chukchi Sea catches (Table III-7). Nearshore currents, or the discharge of freshwater from streams along the Chukchi Sea coast, may be inadequate to establish a narrow and significantly distinct body of warm, brackish water along the shoreline, except in enclosed areas such as Wainwright Inlet or Kasegaluk Lagoon. Anadromous fishes consequently may use offshore habitats, since the temperature and salinity gradients between nearshore and offshore are not great; or the fishes may congregate in the few protected coastal areas where waters are warmest and brackish (i.e., Kasegaluk Lagoon) (Craig, 1984). At this time, the importance of offshore-marine habitats to the anadromous-fish species of the Chukchi Sea has not been determined. In August and September of 1983, no rainbow smelt or salmon were caught with gill nets and otter trawls farther than 1.5 kilometers offshore. Fyke and gill nets at Point Lay caught 320 rainbow smelt, 34 pink salmon, 3 arctic char, 2 least cisco, 2 Bering cisco, and 1 chum salmon out of a total of 14,437 fish (Fechhelm et al., 1984). In Peard Bay, fyke nets caught 18 least cisco, 9 rainbow smelt, 3 Bering cisco, and 1 pink salmon out of a total of 11,896 fish (Kinney, 1985).

Rainbow smelt were the most common anadromous fish caught at Point Lay, but they were caught not far offshore. The smelt appeared to prefer the bottom of the water column, at least when traveling seaward. The presence of apparently young-of-the-year fish in August, the report of a sexually ripe female in mid-June, the lack of extensive coastal migrations by rainbow smelt, and an apparent postspawning gonadal recovery make it likely that the Kokolik, Utukok, and Kukpowruk Rivers are spawning sites for smelt. The rainbow smelt and pink salmon around Point Lay consumed from 65 to 75 percent fish--mostly arctic cod (Fechhelm et al., 1984).

Some investigators have suggested that the main rivers of the Chukchi coastline may be unsuitable for colonization by king, sockeye, and coho salmon because the juvenile lifestages of these species exhibit a marked intolerance to low water temperatures (Salonius, 1973; McLean and Delany, 1977). Pink and chum salmon have been able to colonize streams farther north because of their relative independence from the freshwater lifestages (i.e., outmigration to marine environments immediately after emergence from the stream gravel). The principal stocks of pink salmon are found in the Kugrua, Kuk, Utukok, Kokolik, Kukpowruk, Pitmegea, and Kukpuk Rivers. Although they may be small, chum salmon stocks are found in the Kugrua, Kuk, and Pitmegea Rivers (Craig, 1984). Craig and Skvorc (1982) speculated that the extremely low diversity and numbers of anadromous and resident freshwater fishes along the Chukchi coast may be related to the limited availability of suitable overwintering areas.

Table III-7
Fyke-Net-Catch Summary for Fish Species
Caught During Nearshore Summer Surveys in the Beaufort and Chukchi Seas[1/]

	Beaufort Sea								Chukchi Sea			
	Simpson Lagoon				Prudhoe Bay		Sagavanirktok Delta		Point Lay		Peard Bay	
	1977		1978		1981		1982		1983		1983	
Arctic cod	7.6	(6.5)[2/]	77.9	(1607.1)	49.2	(179.8)	27.9	(147.7)	39.0	(183.1)	69.5	(413.5)
Fourhorn sculpin	69.6	(59.1)	17.9	(369.3)	23.7	(86.4)	27.7	(146.9)	19.8	(93.0)	23.7	(140.8)
Arctic cisco	14.7	(12.5)	0.8	(16.5)	15.0	(54.7)	29.1	(154.4)	0.0	(0.0)	0.0	(0.0)
Least cisco	2.3	(1.9)	1.2	(24.8)	6.6	(24.0)	2.3	(12.5)	0.01	(0.07)	0.15	(0.9)
Arctic char	3.8	(3.2)	0.9	(18.6)	2.3	(8.5)	5.1	(27.8)	0.01	(0.1)	0.0	(0.0)
Broad whitefish	0.1	(0.8)	0.2	(3.1)	0.9	(3.1)	5.6	(29.7)	0.0	(0.0)	0.0	(0.0)
Others	1.9		1.1		2.3		2.3		41.2		6.65	

Sources: Craig and Haldorson, 1981 (Simpson Lagoon); Griffiths and Gallaway, 1982 (Prudhoe Bay); Griffiths et al., 1983 (Sagavanirktok Delta); Fechhelm et al., 1984 (Point Lay); Kinney, 1985 (Peard Bay).

1/ Values are presented as a percentage of total catch.
2/ Figures in parentheses present catch per fyke-net-day.

Although few arctic char were caught by Fechhelm et al. (1984) at Point Lay, and none were caught by Kinney (1985) at Peard Bay, arctic char are reported to be one of the main fish species caught along the coastal beaches by Wainwright residents (Nelson, 1981). Recent genetic studies of Beaufort Sea arctic char have suggested that separate stocks with distinctive genetic makeups occur in different river drainages (Everett and Wilmot, 1987). These genetic studies are currently being extended into streams bordering the northeastern Chukchi Sea.

Subsistence fishing is an important activity at Wainwright, Point Lay, and Point Hope. During the summer, fishing occurs along the shore for salmon and varying proportions of arctic char, ciscoes, sculpins, flounders, saffron cod, and whitefishes. During the fall, more fishing occurs inland along the rivers for anadromous and freshwater fish. During the winter, Wainwright Inlet is often fished for smelt (Craig, 1984). For a detailed discussion of the subsistence harvest of fish, see Section III.C.2.

b. Marine Fishes: The Chukchi Sea represents a transition zone between the fish communities of the Beaufort and Bering Seas. The fauna is basically arctic, with continual input of southern species through the Bering Strait (Craig, 1984). The marine fishes of this area include arctic staghorn; fourhorn, shorthorn, and twohorn sculpins; arctic cod; Canadian eelpout; arctic flounder; and saffron cod.

The distribution of marine-fish species in the Chukchi Sea appears to be influenced by temperature and salinity. Yellowfin sole and saffron cod occupy the shallower, seasonally warmer waters, while arctic cod, arctic staghorn sculpin, and Bering flounder are usually found in deeper, colder waters. Arctic flounder, starry flounder, and fourhorn sculpin frequent the low-salinity waters near estuaries and river mouths. Higher-salinity waters are apparently preferred by most of the other marine-fish species that occur throughout the broad marine-coastal shelf (Morris, 1981a). Fourhorn sculpin and arctic flounder were caught in increased numbers in nearshore coastal areas when temperature increased and salinity decreased (Fechhelm et al., 1984). In the Sagavanirktok River Delta in the Beaufort Sea, the numbers of arctic cod increased as the salinity increased (Griffiths, 1983; Cannon and Hachmeister, 1986).

Until recently, the marine fishes of the Chukchi Sea received little attention from investigators. Most trawl surveys concentrated on the region south of Cape Lisburne. Trawl samples taken in the northern Chukchi Sea were described by Frost and Lowry (1983a) and Fechhelm et al. (1984). Fyke- and gill-net samples of the coastal areas were described by Fechhelm et al. (1984) and Kinney (1985). In addition, food-habit studies of the seabird colonies at Capes Thompson and Lisburne contributed to the knowledge of marine fishes in offshore areas (Springer and Roseneau, 1979). Comprehensive information concerning the life history, population dynamics, distribution, and ecological relationships of most of these species is lacking (Maynard and Partch/Woodward-Clyde Consultants, 1984).

Relatively few fish species have accounted for a large percentage of the fish caught during surveys conducted in this region. During otter-trawl surveys conducted in the northeastern Chukchi and Beaufort Seas in early August 1977, 3 species accounted for 65 percent of all fishes caught: arctic cod, 37 percent; Canadian eelpout, 15 percent; and twohorn sculpin, 13 percent (Frost and Lowry, 1983a). In the late summer of 1983, otter-trawl and fyke- and gill-net surveys conducted primarily in the Sale 109 area showed that 5 species accounted for 93 percent of all fishes caught: arctic staghorn sculpin, 52 percent; arctic cod, 21 percent; shorthorn sculpin, 8 percent; hamecon, 7 percent; and saffron cod, 5 percent. Arctic cod made up 54 percent of the adjusted catch biomass (Fechhelm et al., 1984). During trawl surveys conducted in 1976 in the southeastern Chukchi Sea, arctic cod ranked fifth in biomass although they were the dominant marine fish in numbers and in frequency of occurrence (Wolotira, Sample, and Morin, 1977).

In Peard Bay in July and August 1983, 4 marine species accounted for 99.6 percent of the total fyke-net catch: arctic cod, 69.5 percent; fourhorn sculpin, 23.7 percent; saffron cod, 5.7 percent; and arctic flounder, 0.7 percent (Kinney, 1985). Fyke-net surveys in Kasegaluk Lagoon (Fechhelm et al., 1984) showed that arctic cod, fourhorn sculpin, and arctic flounder accounted for 36 percent, 20 percent, and 12 percent, respectively, of the total catch in this coastal area. In March 1983, winter fish sampling was conducted with fyke and gill nets under the ice in Peard Bay, Wainwright Inlet, and Ledyard Bay. Out of the 205 fish caught in the fyke nets, there were 204 arctic cod and 1 sculpin species. No fish were caught in the gill nets (Fechhelm et al., 1984).

The majority of the marine fishes of the Chukchi Sea are demersal as adults; Pacific herring, capelin, and Pacific sand lance are considered to be pelagic fishes as adults. It has been suggested that many of the marine-fish populations are maintained by recruitment of eggs and larvae that are transported north from the Bering Sea by the Alaska Coastal Current (Pruter and Alverson, 1962, as cited by Morris, 1981a). Fishes that probably maintain their populations by resident breeding stock include arctic cod, saffron cod, sand lance, capelin, sculpins, and some of the flounders. These resident spawners tend to lay large, yolky eggs in shallow water, with larvae becoming planktonic during the summer and some eventually sinking to deeper water to mature (Morris, 1981a).

Marine fish in this region are generally smaller than those in areas farther south, and densities are much lower (Bowden and Moulton, 1981; Frost and Lowry, 1983a). Arctic cod in the northern part of the Sale 109 area weighed significantly less per unit-length than arctic cod of the same length from the southern part of the sale area (Fechhelm et al., 1984). Both the average and maximum sizes of flatfishes taken during a study of the southeastern Chukchi Sea were below the sizes accepted by U.S. commercial-fishery markets (Alverson and Wilimovsky, 1966). The same investigators also suggested that the physical climate of the Chukchi Sea (see Sec. III.A) may be responsible for limiting the population sizes and depressing the growth patterns of some marine fishes.

Arctic cod young-of-the-year are normally found in the upper 50 meters of water, in the same zone where the greatest abundance of their food (plankton) is found. Quast (1974) estimated that more than 46 million pounds of juvenile arctic cod were present between Cape Lisburne and Icy Cape in 1970. In many bottom trawls, adult arctic cod are found in association with the bottom. They can also be found around ice, which may provide shelter from predators and food in the form of ice-associated invertebrates. Arctic cod are most often found around pressure ridges and rafted ice, where the undersurface of the ice is rough. The crevices, holes, caverns, and small ice cracks are commonly used. No large concentrations of adult arctic cod have been found in these habitats (Sekerak, 1982). Although arctic cod are known to spawn in the winter under the ice, most of their spawning areas are unknown (Morris, 1981a). A known arctic cod spawning ground is located in the nearshore waters of Stefansson Sound in the Beaufort Sea (Craig and Haldorson, 1981). It is reported that arctic cod spawn only once (Nikolskii, 1961, as cited by Morrow, 1980).

During the summer, large schools of Pacific sand lance are reported in Ledyard Bay, north of Cape Lisburne. Marine-bird-feeding studies suggest a major downcoast movement of these fish during late July and August (Roseneau and Springer, 1977). Sand lance spawn from November to February on sandy bottoms at depths of 50 to 75 meters (Morris, 1981b).

Capelin are poorly sampled by trawl surveys, and little is known of their areal abundance and distribution along the Chukchi Sea coast. Capelin generally prefer smooth sand and gravel beaches for spawning; they have been observed spawning from early to mid-July along the sandy seaward beaches of barrier islands (Seaman, 1982, oral comm.). On August 1-3, 1983, 3,358 capelin caught off Point Lay apparently were part of a spawning population. Only two more capelin were caught during the rest of the study. Since no capelin were taken in Kasegaluk Lagoon, spawning may have been restricted to the seaward shoreline of the barrier islands (Fechhelm et al., 1984).

The bulk of the Pacific herring population lies south of the Bering Strait, and the density in the Chukchi Sea is too low to develop a commercial fishery. In the spring, Pacific herring spawn in high-energy, nearshore environments, depositing eggs on vegetation or on bottom substrate that is free from silting. There was some evidence by gonadal weights and egg sizes that herring may have spawned in Kasegaluk Lagoon in the early summer of 1983; however, no trace of young-of-the-year herring was found throughout the end of the summer (Fechhelm et al., 1984).

Arctic flounder are shallow-water flatfishes whose spawning usually takes place in shallow coastal areas during late fall or winter (Morrow, 1980). During midwinter, fourhorn sculpin spawn on the bottom in nearshore habitats (Craig and Haldorson, 1981). Saffron cod are marine fish that generally inhabit nearshore areas and often enter rivers. They spawn annually during the winter in nearshore waters (Morrow, 1980).

Arctic cod are an important, early-season food source for the murres and kittiwakes at Capes Thompson and Lisburne, with peak numbers of cod taken by these marine seabirds during ice breakup (Springer and Roseneau, 1979). Swartz (1966) estimated that as many as 250 million arctic cod are consumed annually by the Cape Thompson seabird colonies. Lowry, Frost, and Burns, (1979) identified arctic cod as a key prey species for spotted and ringed seals and beluga whales in the Chukchi Sea. Summer distributions of arctic cod are unknown; however, large schools reportedly form in the fall and approach the coast and warm waters near river mouths. Large numbers of this species are occasionally stranded on beaches because of storms or possibly because of attempts to escape predation by whales (Sekerak, 1982). Other marine fishes that are important prey of marine mammals and seabirds in the

Chukchi Sea include Pacific sand lance, capelin, Pacific herring, saffron cod, sculpins, and smelt (Jangaard, 1974; Lowry, Frost, and Burns, 1979; Springer and Roseneau, 1979; Seaman and Burns, 1981).

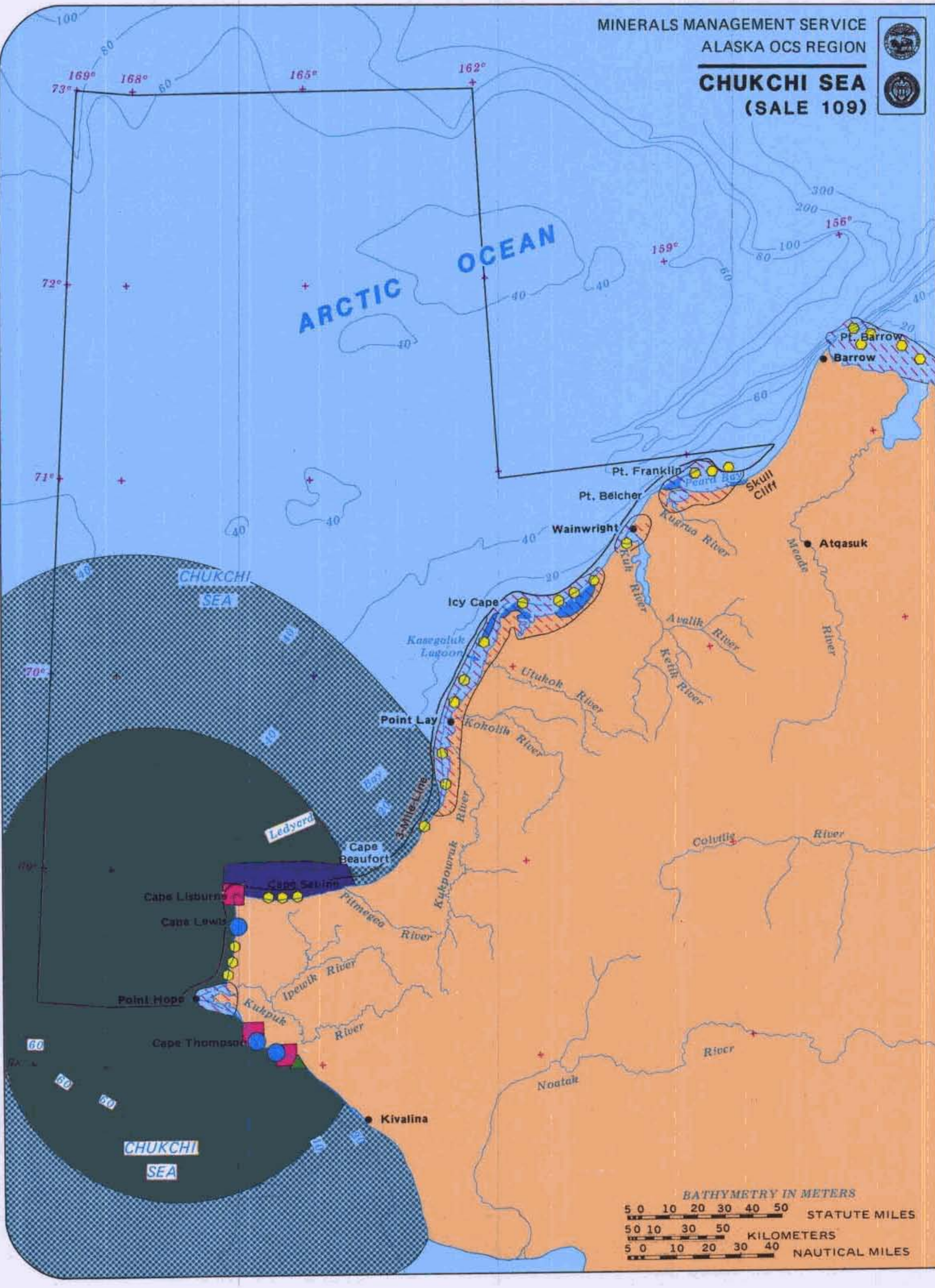
Fechhelm et al. (1984) studied the food habits of various fish species caught during their study in the northeastern Chukchi Sea. Capelin and Pacific herring ingested mostly Mysis littoralis. During the summer, arctic cod also ate mysids, but their diet varied from place to place and included copepods and amphipods. During the winter in Ledyard Bay, Wainwright Inlet, and Peard Bay, copepods were the principal food item for arctic cod. Saffron cod caught near Kotzebue and St. Lawrence Island ate fish (saffron cod and sculpin species) and gammarid amphipods. Fourhorn sculpin ate mostly isopods in both the lagoon and ocean environments. Arctic flounder ate polychaetes and unknown worms (Fechhelm et al., 1984). Sand lance fed primarily on small planktonic crustaceans (Morris, 1981b).

3. Marine and Coastal Birds: Several million birds consisting of about 150 species (Pitelka, as cited by Schamel, 1978) including seabirds, waterfowl, shorebirds, passerines, and raptors occur on the North Slope, adjacent to the proposed Sale 109 area in the northeastern Chukchi Sea. Nearly all of these species are found seasonally in the arctic from May through September, with the exception of small populations of black guillemot. Among the most abundant seabirds, waterfowl, and shorebirds that may be affected by the proposal are the common and thick-billed murres (in the southern portion of the Sale 109 area), black-legged kittiwakes, arctic terns, glaucous gulls, Ross' gulls, common eiders, Pacific brant, oldsquaw, northern pintails, red phalaropes, semipalmated sandpiper, pectoral sandpiper, and dunlins. Among these species, a major portion of the world's population of Ross' gulls occurs along the pack-ice edge in the northern Chukchi Sea to the far western Beaufort Sea offshore Point Barrow in September to October as the pack ice advances southward (Divoky, 1983). Gyrfalcons and snowy owls are two of the more common raptor species on the arctic coastal plain and ravens are also common.

There are large concentrations of foraging seabirds within the southern portion of the sale area, near Capes Lisburne and Lewis. Over 0.5 million seabirds nest at Capes Thompson, Lisburne, and Lewis (Graphic No. 1). Murres and kittiwakes represent the majority of nesting birds in these northernmost seabird colonies in Alaska. Over 90 percent of these nesting seabirds (Hansen, 1981) were rated high in vulnerability and sensitivity to oil spills (King and Sanger, 1979). Capes Thompson and Lisburne, Kasegaluk Lagoon barrier islands, Icy Cape, Point Franklin, and Peard Bay barrier islands shown on Graphic No. 1 are part of the Alaska Maritime National Wildlife Refuge.

Along the coast of the sale area, large concentrations of feeding and staging waterfowl and shorebirds are present from July through September at Kasegaluk Lagoon, at the mouth of the Kuk River, and in Peard Bay (Connors, Connors, and Smith, 1981; Lehnhausen and Quinlan, 1981; Gill, Handel, and Connors, 1985) (Graphic No. 1). Barrier-island spits and nearshore waters outside the lagoons are also important concentration areas for these species.

Spring migration to the North Slope and the northern Chukchi Sea generally occurs from late May through June (Lehnhausen and Quinlan, 1981). Migration to and through the sale area probably occurs along a broad front, as it does



GRAPHIC NO. 1

IMPORTANT HABITATS OF MARINE AND COASTAL BIRDS

LEGEND

SEABIRD COLONIES *

- > 100,000 – 1,000,000
- > 10,000 – 100,000
- > 1,000 – 10,000
- < 1,000

WATERFOWL– AND SHOREBIRD–FEEDING AND –STAGING AREAS

OBSERVED MAJOR SEABIRD–FORAGING AND WATERFOWL–MOLTING AREAS

PRIMARY SEABIRD–FORAGING AREA

SECONDARY SEABIRD–FORAGING AREA

SALTMARSH HABITATS FOR BRANT AND SHOREBIRDS IN SUMMER–FALL

SOURCES: Divoky, 1978; Sowls et al., 1978; State of Alaska, ADF&G, 1981; Springer et al., 1982; Roseneau and Herter, 1984.

*** Capes Thompson and Lisburne, and Barrier Islands of Kasegaluk Lagoon and Peard Bay, and Point Franklin are units of the Alaska Maritime National Wildlife Refuge.**

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along the Beaufort Sea coast, with offshore, coastal, and inland migration routes used by various species. Coastal and offshore migration routes are influenced by spring ice conditions, and the timing of migration varies with wind direction and availability of open-water leads (Divoky, 1983). Fair numbers of waterfowl, primarily Pacific brant and pintails, use salt marshes in the Icy Cape area for feeding and resting during spring migration. Murres and kittiwakes appear in the Cape Lisburne area by mid-May. Concentrations of rafting murres occur in ice leads near the Capes Thompson, Lisburne, and Lewis colonies.

Shortly after spring migration, most shorebird and waterfowl populations disperse to nesting grounds primarily on moist tundra and marshlands of the arctic slope. Semipalmated sandpiper and red phalaropes were reported as the most abundant tundra-nesting-shorebird species in the Icy Cape area, while pintails and oldsquaw were the most common waterfowl recorded (Lehnhausen and Quinlan, 1981). Some of the barrier islands, such as Solivik Island along Kasegaluk Lagoon near Icy Cape and the Seahorse Islands of Peard Bay, are important locally for nesting arctic terns, common eiders (which nest on Solivik Island), and black guillemots (which nest on the Seahorse Islands) (Divoky, 1978).

Salt marshes along the mainland coast of the sale area are very important feeding habitat, particularly for waterfowl and shorebirds. In the salt marshes of the Icy Cape area, densities of waterfowl have been reported to be greater than 100 to more than 600 ducks per square kilometer (km^2) during June through August. Pacific brant, pintails, and eiders were reported as the most abundant waterfowl species; dunlins and red phalaropes were the most abundant shorebirds (Lehnhausen and Quinlan, 1981). Fall migration in late August and September is much more focused along the coast than spring migration. Numerous staging concentrations of birds occur in the lagoons and river mouths and on the barrier islands. Kasegaluk Lagoon and Peard Bay are important feeding and molting areas for waterfowl, especially oldsquaw, as well as common eiders and Pacific brant, prior to and during the fall migration. Prior to the fall migration, the barrier-island and spit beaches are staging and/or feeding areas for large numbers (more than $100/km^2$) of red phalaropes, arctic terns, and oldsquaw (Lehnhausen and Quinlan, 1981). In September, large numbers of murres occur in rafts on the water near Capes Lisburne and Thompson prior to moving south to wintering areas.

Marine and coastal birds of the Siberian coast, specifically the Chukchi Peninsula and also Wrangel and Herald Islands just west of the sale area, are similar in diversity and abundance to the birds of arctic Alaska, with the following exceptions: major seabird colonies with large numbers of murres and other alcids occur at a more northern latitude in Siberia than in Alaska; large colonies are located on Wrangel and Herald Islands (Portenko, 1972); and a very large population of snow geese nests on Wrangel Island, while no comparable large population of snow geese nests in the Alaskan Arctic.

Marine and coastal birds of the Chukchi Sea can be differentiated into offshore and nearshore feeders. Offshore feeders prey primarily on fish, although some species, such as thick-billed murres, also prey on pelagic crustaceans. Arctic and saffron cod, sand lance, capelin, and sculpins comprise most of the diet of murres in this area (Roseneau and Herter, 1984). Offshore feeders include arctic terns, common and thick-billed murres, black guillemots, black-legged kittiwakes, and some gulls. Arctic cod is the major overall prey of offshore feeders (Divoky, 1983), although sand lance is particularly important to some populations, such as the Cape Thompson and Cape Lisburne black-legged kittiwakes, during the nesting season (Springer et al., 1982). Nearshore coastal feeders prey on various invertebrate fauna or graze on emergent vegetation. The principal prey and feeding habitat of nearshore coastal feeders generally changes between the nesting and post-nesting periods. During the nesting season, waterfowl and shorebirds feed on various insect larvae, adult insects, crustaceans, and mollusks that inhabit the coastal salt marshes and tundra ponds. Chronomid fly larvae are particularly important for various shorebird species (Connors, Connors, and Smith, 1981). During the postnesting and staging period, in preparation for fall migration, many waterfowl and shorebirds shift their feeding habitat to the coastal lagoons, mudflats, and beaches. In Peard Bay during this period, amphipods and mysids appear to be especially important for red phalaropes, while sea ducks such as the oldsquaw feed intensively on epibenthic crustaceans, particularly amphipods, during the postnesting and fall staging period (Gill, Handel, and Connors, 1985).

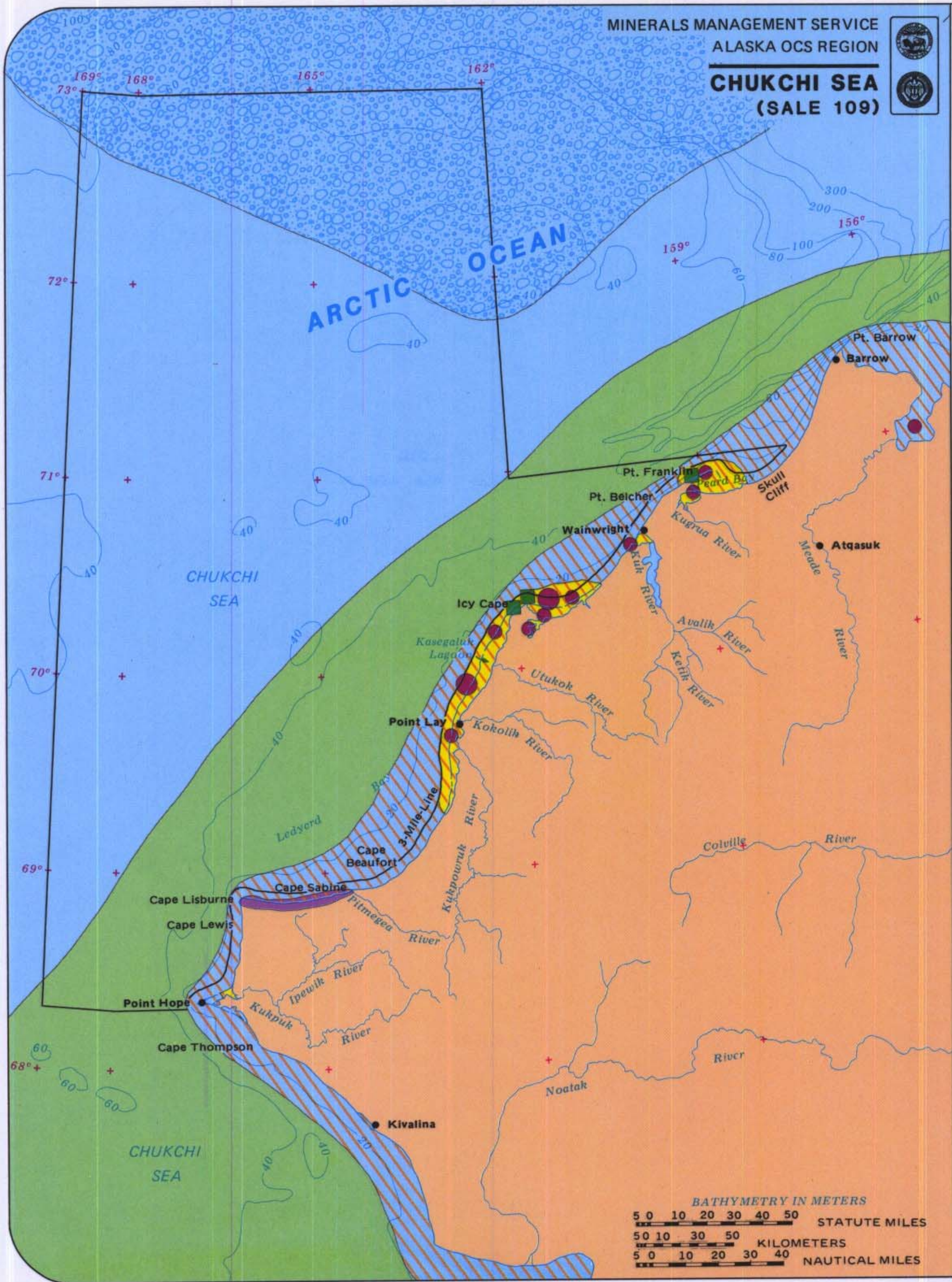
4. Pinnipeds, Polar Bears, and Beluga Whales: This account emphasizes species of marine mammals--other than endangered whales commonly occurring in the northern Chukchi Sea habitats--that may be affected by oil and gas activities in the proposed Sale 109 area. Species covered include the pinnipeds ringed, bearded, and spotted seals and Pacific walrus; polar bear; and beluga whale. Other species that are uncommon or rare in the sale area but occur occasionally in small numbers include the ribbon seal, harbor porpoise, killer whale, minke whale, narwhal, and Steller sea lion. Due to the relative numerical insignificance of the latter species in the northern Chukchi Sea, they are not discussed further. All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. In the Act, the U.S. Congress declared its intent that marine mammals "be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management, and that the primary objective of their management should be to maintain the health and stability of the marine ecosystem." General pinniped, polar bear, and beluga whale habitat areas are shown in Graphic No. 2.

a. Pinnipeds:

(1) Ringed Seal: This species is the most abundant seal in the sale area, with an estimated Chukchi Sea winter population of 300,000 to 450,000 seals (Burns, 1981) and a summer population of 1 or 2 million in ice habitats. In coastal habitats of the Bering and Chukchi Seas, ringed seal abundance is closely tied with the stability and extent of shorefast ice, the preferred pupping habitat of this species (see Graphic No. 2). Low ridges or hummock areas on stable, landfast ice provide optimum areas for ringed seal-lair construction and are the most productive pupping areas (Smith, 1980). The estimated average density index for ringed seals in the northern Chukchi Sea landfast-ice zone is two to three seals per square kilometer (Burns, Shapiro, and Fay, 1980). During the summer, high densities of ringed seals have been reported in association with ice remnants (Burns, Shapiro, and Fay, 1980). Between 1970 and 1977, ringed seal densities were noted to decline as much as 50 percent in the Beaufort and northern Chukchi Seas, apparently due to heavy ice in 1975 and 1976 in Alaska, and in 1974 and 1975 in the Canadian

GRAPHIC NO. 2

IMPORTANT HABITATS OF PINNIPEDS, POLAR BEARS, AND BELUGA WHALES



LEGEND

- LANDFAST ICE – RINGED SEAL PUPPING AREA
- ICE-LEAD AREA OR FLAW ZONE – IMPORTANT WINTER-SPRING HABITAT OF POLAR BEARS, BEARDED AND RINGED SEALS, PACIFIC WALRUSES, AND BELUGA WHALES
- APPROXIMATE SUMMER PACK-ICE EDGE – FRINGE ZONE
- SPOTTED SEAL HAULOUT SITES
  - Major Site
  - Minor Site
- PACIFIC WALRUS COASTAL-HAULOUT AREA
- POLAR BEAR TRANSITORY COASTAL-CONCENTRATION AREA
- BELUGA WHALE AND/OR SPOTTED SEAL COASTAL HABITATS

Sources: University of Alaska, AEIDC, 1978; Frost et al., 1983; Davis and Thomson, 1984.

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Beaufort Sea. Increased densities occurred concurrently in the Bering and southern Chukchi Seas. Ringed seal densities within the sale area may depend on a variety of factors such as food availability, proximity to human disturbance, water depth, and ice stability. Although ringed seals do not occur in large herds, loose aggregations of tens or hundreds of animals do occur, probably in association with abundant prey.

Ringed seals are opportunistic feeders; the prey consumed depend on season and location and include cod, amphipods, mysids, euphausiids, and small pelagic fishes. The availability of small prey organisms in concentrations sufficient for effective feeding is of particular importance in the annual nutrition requirements of ringed seals (Lowry, Frost, and Burns, 1980b). In areas where, and during times when, these kinds of prey are not available, food may be a limiting factor in the abundance of ringed seals (Frost and Lowry, 1981). During the winter, arctic cod are considered the most important food source of ringed seals.

Probably a polygynous species, ringed seals, when sexually mature, establish territories during the fall which they maintain during the pupping season (Smith and Hammill, 1981). Pups are born in late March and April (Burns, Kelly, and Frost, 1981) in lairs that are excavated in snowdrifts and pressure ridges (Smith and Stirling, 1975). Females appear to be impregnated in mid- to late April, shortly after parturition. During the pupping and breeding season, adults on shorefast ice are generally less mobile than individuals in other habitats; they depend on relatively few holes and cracks in the ice for breathing and foraging. During nursing (4-6 weeks), pups are generally confined to the birth lair. Ringed seals molt during May, June, and early July (Eley and Lowry, 1978). At this time, warmth and rest--acquired by basking on ice for long periods of time--are apparently required for rapid growth of hair. Polar bears and arctic foxes are important predators of ringed seals. Ringed seals are a major subsistence resource comprising as much as 58 percent of the total seals harvested by subsistence hunters in Alaska (Burns and Eley, 1977). Over 14,000 ringed seals are harvested annually in northwestern and western Alaska (Moulton and Bowden, 1981).

(2) Bearded Seal: This species is circumpolar in its occurrence and generally prefers areas where seasonal, broken sea ice occurs over water less than 200 meters deep. The majority of the bearded seal population in Alaskan OCS areas are in the Bering and Chukchi Seas, where an estimated 300,000 to 450,000 individuals occur (Braham, Fiscus, and Rugh, 1977). In the Chukchi Sea, the winter population is estimated at 120,000 seals (Burns, 1981), while the summer population is substantially higher. This species feeds primarily on benthic and epibenthic invertebrate prey such as shrimps, crabs, and bivalve mollusks, while benthic fish such as sculpins, cod, and flatfishes are taken secondarily (Lowry, Frost, and Burns, 1980a). Bearded seals generally do not haul out on land; they are generally associated with ice habitats throughout the year.

Pupping occurs on top of the ice from late March through May, primarily in the Bering and Chukchi Seas, although some pupping occurs in the Beaufort Sea. The nursing period is very short (12-18 days), with most pups reaching approximately 63 percent of their adult length when they are weaned (Burns, 1967). Bearded seals do not form herds, although loose aggregations of animals do occur. This seal is a relatively important subsistence species that is preferred by subsistence users; over 6,000 bearded seals are harvested annually (Molton and Bowden, 1981).

(3) Spotted Seal: This species is a very common seasonal resident of the Chukchi Sea coast. Spotted seals are found in large numbers along the coast of the sale area from June through September-October. The summer population of the Chukchi Sea is estimated to be between 30,000 and 37,500 seals (Burns, 1981). Spotted seals are particularly common in bays, estuaries, and river mouths (Frost, Lowry, and Burns, 1983).

This is the only seal species that commonly hauls out on land adjacent to the sale area. Icy Cape-Kasegaluk Lagoon, the Kuk River mouth, and Peard Bay are important spotted seal haulout and concentration areas adjacent to the sale area (see Graphic No. 2). Two to three thousand seals frequent these coastal-habitat areas. Spotted seals frequently enter estuaries and sometimes ascend rivers, presumably to feed on anadromous fishes. Important prey include pelagic fishes, octopuses, and crustaceans (State of Alaska, ADF&G, 1981). Spotted seals migrate out of the Chukchi Sea in the fall (September to mid-October) as the shorefast ice reforms and the pack ice advances southward. They spend winter and spring periods along the ice front in the Bering Sea, where pupping, breeding, and molting occur. This species is also an important subsistence resource, with over 7,000 seals being harvested annually in the northern Bering Sea (State of Alaska, ADF&G, 1981) and some harvests occurring in the sale area.

(4) Pacific Walrus: The walrus population of the North Pacific--over 250,000 animals--represents about 80 percent of the world population (Kelly, 1980). Most of this population is generally associated year-round with the moving pack ice. Walruses spend the winter in the Bering Sea, and over 150,000 individuals summer in the Chukchi Sea (Burns, 1981)--including the sale area.

Nearly all the adult females with dependent young migrate into the Chukchi Sea during the summer, while a substantial number of adult males remain in the Bering Sea (Fay, 1982). Spring migration usually begins in April, and most of the walruses move through the Bering Strait by late June (Fay, 1982). Females with calves comprise most of the early spring migrants. During the summer, two large arctic areas are occupied--from the Bering Strait west to Wrangel Island and along the northwest coast of Alaska from about Point Hope to north of Point Barrow, encompassing the sale area. The Chukchi Sea is the summer feeding habitat for all adult females with calves (Fay, 1982).

Most walruses concentrate along the pack-ice front in areas of less than 50 percent ice over water depths less than 50 meters, with low walrus numbers occurring farther into the pack-ice zone. During the summer and fall, a few hundred walruses occasionally haul out on land between Capes Lisburne and Sabine (Graphic No. 2). With the southern advance of the pack ice during the fall (October-December), most of the walrus population migrates south of the Bering Strait. Solitary animals may occasionally overwinter in the Chukchi Sea and the eastern Beaufort Sea (Fay, 1982).

Walruses are benthic feeders that rely, to a large extent, on bivalve mollusks (clams). Some other foods include polychaetes, snails, crustaceans, and seals. Food sources other than mollusks appear to be of secondary or tertiary importance by volume, but some prey taken in small quantities may be of critical importance if they contain needed trace elements or nutrients that are scarce or absent in mollusks (Fay, 1982). Estimated daily food requirements are from 110 to 175 pounds per adult walrus (Kelly, 1980). Aerial census results over the past 20 years indicate that the walrus population has increased rapidly and expanded its range (Fay and Kelly, 1980). Decreases in the physical fitness (mean blubber thickness) of animals collected recently indicate that the population has reached or exceeded the carrying capacity of the environment (Fay, 1981).

Walrus mating takes place from January to March, and calves are born during the northward migration from mid-April to mid-June. The gross reproductive rate of walruses is considerably lower than that of seals (Fay, 1982). Females produce one calf every 2 years at best, rather than every year as with other pinnipeds. Walruses are a very important cultural and subsistence resource. Annual Alaskan harvests yielded around 1,000 to about 3,000 animals in the past 15 years (State of Alaska, ADF&G, as cited by Fay, 1982). The total kill of walruses in recent years (harvest plus losses) may be exceeding recruitment, and the population probably is in a decline at the present time (Sease, 1985).

b. Polar Bears: Polar bears are circumpolar in distribution. Two possible distinct populations in the Alaskan arctic are the western Alaska population, which occurs primarily in the Chukchi Sea, and the northern Alaska population, which occurs north and east of Barrow in the Beaufort Sea (DeMaster and Stirling, 1981). The total Alaskan population is estimated at 3,000 to 5,000 bears (Amstrup, 1983a). The greater proportion of this population is believed to be distributed in the Chukchi Sea, rather than the Beaufort.

There is substantial annual variation in the seasonal distribution and local abundance of polar bears in the Alaskan Beaufort and Chukchi Seas. Average density appears to be one bear for every 30 to 50 square miles, with much lower densities occurring farther than 100 miles offshore (Amstrup, 1983b). The two most important natural factors affecting polar bear distribution are sea ice and food availability.

Drifting pack ice off the coast of the Chukchi Sea probably supports greater numbers of polar bears than either shorefast or polar pack ice because of the abundance and availability of subadult seals in this habitat (Smith, 1980). Local concentrations of polar bears may occur along the coast of Alaska when pack ice drifts close to the shoreline and shorefast ice forms early in the fall.

Polar bears off the Alaskan coast prey primarily on ringed seals and, to some extent, bearded seals and walruses. Polar bears are typically opportunistic feeders that sometimes frequent coastal areas to feed on carrion, especially whale carcasses, and human refuse when it is available. Polar bears generally roam along the shore of the Chukchi Sea from October to March, when shorefast ice enables them to travel from drifting pack ice to the beach. However, polar bears are capable of swimming several miles in open water and could be found year-round in coastal areas, as they are along the coast of Hudson and James Bays in Canada (Jonkel et al., 1972). Two polar bear coastal-concentration areas are located at Icy Cape and Point Franklin, locations of carrion and refuse accumulation adjacent to the sale area (Davis and Thomson, 1984) (Graphic No. 2).

Pregnant and lactating females and newborn cubs are the only polar bears that occupy winter dens for extended periods. Polar bears concentrate such denning on offshore islands and certain portions of the mainland. Dens are typically more sparsely distributed in the Alaskan coastal zone than in areas receiving consistent use, such as Wrangel Island (Uspenski and Kistchinski, 1972) and Hudson and James Bays (Jonkel et al., 1972). Pregnant females come to coastal areas in late October or early November to construct maternity dens. They have relatively rigid requirements for denning locations; major factors appear to be depth and density of snow cover. Most terrestrial dens are located close to the seacoast, usually not more than 8 to 10 kilometers inland (Uspenski and Kistchinski, 1972), although one den was found 48 kilometers from the coast (Lentfer and Hensel, 1977). Offspring are born from early December to late January (Uspenski and Belikov, 1974), and females and cubs break out from the dens in late March or early April. According to Lentfer (1972), polar bear dens have been located along river banks, on barrier islands, and on shorefast ice. Dens along the Chukchi Sea coast appear to be less concentrated than in many denning areas elsewhere in the arctic. Polar bears have been reported to bear young in maternity dens far offshore on the pack ice (Lentfer, 1975; Amstrup, 1985). The majority of Beaufort Sea polar bear dens located using radio-telemetry were found on sea ice rather than on land (Amstrup, 1985). Polar bears are an important subsistence resource, when available. About 50 bears are harvested annually by villages adjacent to the sale area (Lowry, 1983, as cited by Davis and Thompson, 1984).

In addition to being protected by the Marine Mammal Protection Act of 1972, polar bears and their habitats are also protected by the International Agreement on the Conservation of Polar Bears of 1976 among Canada, Denmark, Norway, the U.S.S.R., and the U.S. In Article II, the agreement states, "Each contracting party shall take appropriate action to protect the ecosystems of which polar bears are a part, with special attention to habitat components such as denning and feeding sites and migration patterns" (Lentfer, 1974).

c. Beluga Whales: Beluga whales (a circumboreal species) are seasonal summer inhabitants of the northern Chukchi Sea. The North American arctic population is estimated to be at least 30,000 (Sargeant and Brodie, 1975), while an estimated 11,500 whales migrate through the proposed sale area to the eastern Beaufort Sea (Davis and Evans, 1982). Most of the latter population migrate from the Bering Sea into the Beaufort Sea in April or May. However, some whales may pass Point Barrow as early as late March and as late as July. The spring migration routes through ice leads are similar to those of the bowhead whale (see Sec. III.B.5). An estimated 2,500 to 3,000 beluga whales frequent bays and estuaries in Kotzebue Sound and along the northern Chukchi Sea coast during the open-water season (Seaman, Frost, and Lowry, 1985) (see Graphic No. 2).

Kasegaluk Lagoon is an important beluga whale habitat area adjacent to the sale area (see Graphic No. 2). Some calving occurs and molting may occur in this warm-summer-water lagoon. Fall migration through and from the sale area occurs in September and October. Few belugas are reported to overwinter in the southern Chukchi Sea immediately south of the sale area.

Beluga whales feed and calve in the nearshore habitats of the Chukchi Sea (Moulton and Bowden, 1981). Their prey include a variety of marine vertebrates and invertebrates such as capelin, cod, herring, squid, and various crustaceans. Beluga whales, an important subsistence resource of the Inuit Natives in Canada, are also important to the Inupiat Natives in Kotzebue, Point Lay, Point Hope, and Wainwright. Over 185 belugas are taken annually in western-northwestern Alaska (Moulton and Bowden, 1981).

5. <u>Endangered and Threatened Species</u>: The Endangered Species Act (the Act) of 1973, as amended, defines an endangered species as any species that is in danger of extinction throughout all or a significant portion of its range. The Act defines a threatened species as one that is likely to become endangered within the foreseeable future. The following paragraphs describe the endangered and threatened species that may occur in or adjacent to the proposed Sale 109 area. These include the endangered bowhead, gray, fin, and humpback whales, and the threatened arctic peregrine falcon. Information on endangered and threatened species in Sections III and IV of this EIS also serves as the Biological Assessment referred to in Section 7(c) of the Act. There are no listed endangered-plant species in areas adjacent to the sale area.

a. <u>Bowhead Whale:</u> Bowhead whales are ice-associated and the entire western arctic stock, estimated at 7,200 individuals (International Whaling Commission [IWC], [In Press]) is believed to pass through the sale area on their spring and fall migrations (Fig. III-16). The spring migration begins in March from the bowhead overwintering areas in the Bering Sea. From April through June, bowheads pass through the sale area following ice leads in the flaw zone. The bowheads typically do not appear again in the sale area until the fall migration--generally during September through November, although they were observed in the sale area in August 1975, a heavy ice year (Ray, Wartzok, and Taylor, 1984). In the fall, bowheads move from Point Barrow toward the northern shore of the Chukotsk Peninsula, either following the shoreline between Point Barrow and Wainwright or moving from Point Barrow across the Chukchi Sea toward Wrangel Island.

Bowheads may also calve, mate, and feed within the sale area. The bowhead calving period appears to extend from March through August, with a peak in births occurring during May (Nerini et al., 1984). Most of the breeding probably occurs between March and May. Although most feeding occurs during the summer in the Canadian Beaufort Sea, feeding bowheads have been observed off Wainwright and Point Barrow during the spring migration (Carroll and George, 1985). Samples taken from the gastrointestinal tracts of Eskimo-killed bowheads have provided information on bowhead prey selections. At least 56 species of prey have been identified--primarily euphausiids (<u>Thysanoessa raschii</u>, <u>T. inermis</u>); copepods (<u>Calanus hyperboreus</u>, <u>C. glacialis</u>; and hyperiid and gammarid amphipods (<u>Parathemisto libellula</u>; <u>Anonyx nugax</u>) (Lowry and Frost, 1984).

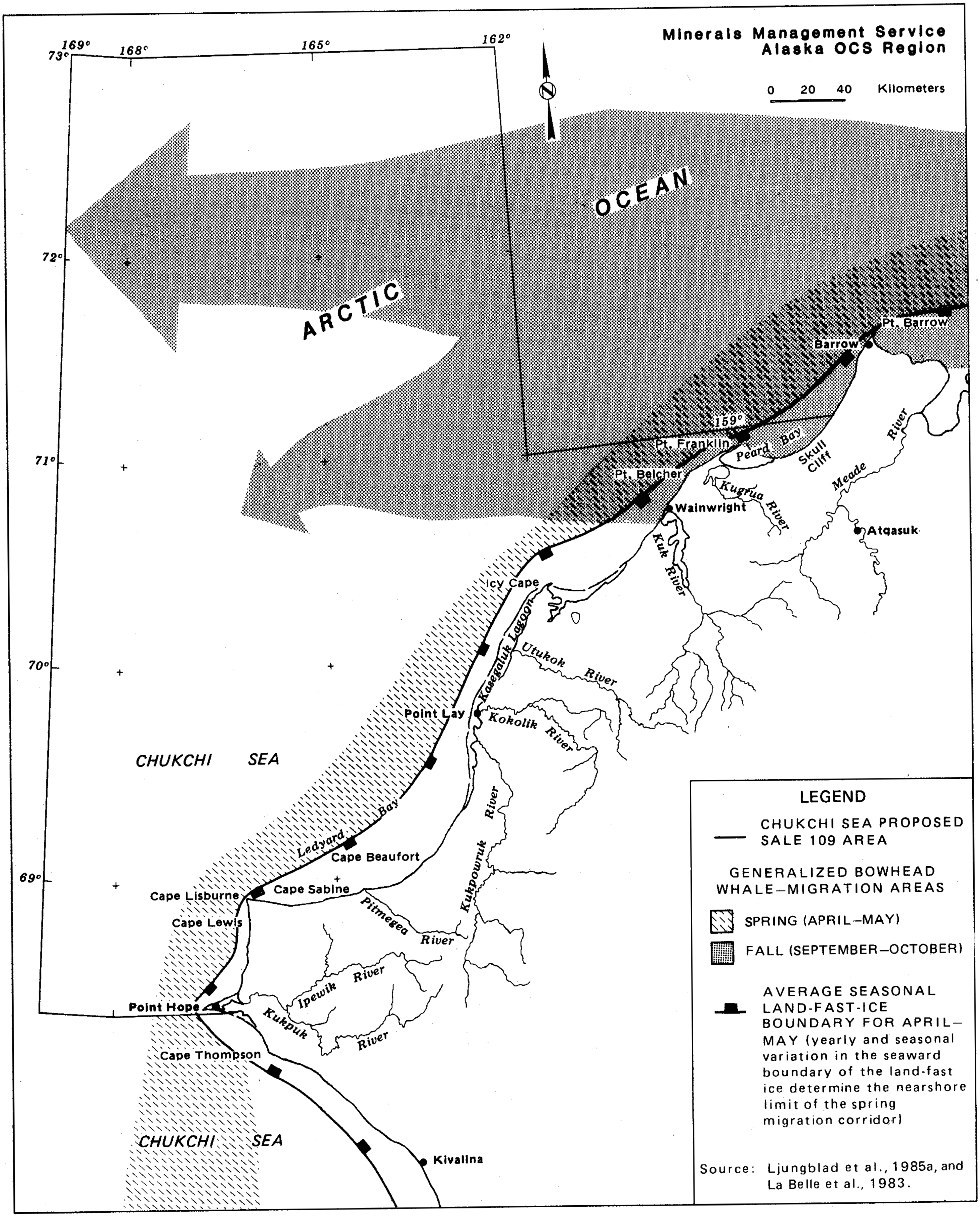


FIGURE III–16. BOWHEAD WHALE–MIGRATION AREAS

b. Gray Whale: The northern boundary of the migration route of the endangered gray whale extends to Point Barrow, with the whales passing through and feeding in the sale area during the summer and fall (see Fig. III-17). The current eastern North Pacific stock is estimated at 17,000 individuals (Rugh, 1984), of which approximately 25 to 60 percent reach the Chukchi Sea by June (Rice and Wolman, 1971; Berzin, 1984). Berzin (1984) reported a group of 200 whales in the vicinity of Point Belcher during the summer. Moore, Clarke, and Ljungblad (1986) reported 323 gray whales from 1982 to 1984 during July through October; they were seen generally within 14.5 kilometers of shore, feeding between Point Hope and Point Barrow--generally between Wainwright and Point Barrow. The farthest-offshore sighting was of three feeding gray whales approximately 176 kilometers northwest of Barrow (71°44'N. latitude, 160°57'W. longitude) in August. All cow/calf pairs were seen in July between Wainwright and Point Barrow and Cape Lisburne and Point Lay, within 4 kilometers of shore. These sightings may be an example of cow/calf segregation on the northern range (Moore, Ljungblad, and Van Shoik, 1984), as has been reported on their southern range and along their migration route. The sale area appears to be important as a calf-rearing area. The southbound migration generally begins in mid-October (Johnson et al., 1981).

Gray whales are predominantly suction bottom-feeders, but in some areas they have been observed feeding on dense swarms of pelagic euphausiids (Guerrero, 1985). Most feeding activities (69-79%) are believed to take place on the northern feeding grounds (Oliver et al., 1983); however, feeding during the spring migration has been documented to begin as early as March (Braham, 1984; Folkens, 1985). Feeding in the sale area occurred most often in the Point Belcher area but was observed between Point Hope and Point Barrow (Ljungblad et al., 1985a). On the summer feeding grounds of the Chukchi and Bering Seas, gray whales feed primarily on benthic gammaridean amphipods; however, approximately 100 different prey species have been identified from stomach analysis.

c. Fin Whale: Endangered fin whales have occasionally been observed in the Chukchi Sea during the ice-free summer months (late June-October). The sale area appears to be near the northern edge of this species' range. Votrogov and Ivashin (1980) reported a total of 80 fin whales sighted in the Gulf of Anadyr, the Bering Strait, and the Chukchi Sea between 1969 and 1978. The North Pacific population is estimated to range from 17,000 to 21,000 individuals, of which approximately 5,000 enter the Bering Sea during summer (Morris, 1981c). The southbound migration is generally completed in November but may be completed earlier, depending on ice conditions. Fin whales, which feed in upwelling areas where prey tend to concentrate, are opportunistic feeders that consume euphausiids, copepods, fish, and squid, generally concentrating on the first two items.

d. Humpback Whale: Endangered humpback whales also have occasionally been observed in the Chukchi Sea during the ice-free summer months (late June-October). The sale area is near the northern edge of this species' range, as it is for the fin whale.

Votrogov and Ivashin (1980) recorded 60 humpback whales in the Gulf of Anadyr, the Bering Strait, and the Chukchi Sea between 1969 and 1978. The present North Pacific population is estimated to range from 1,200 to 1,600 whales (Morris, 1981c). The southbound migration begins as early as September, depending on ice conditions. Humpbacks feed on euphausiids, copepods, mysids,

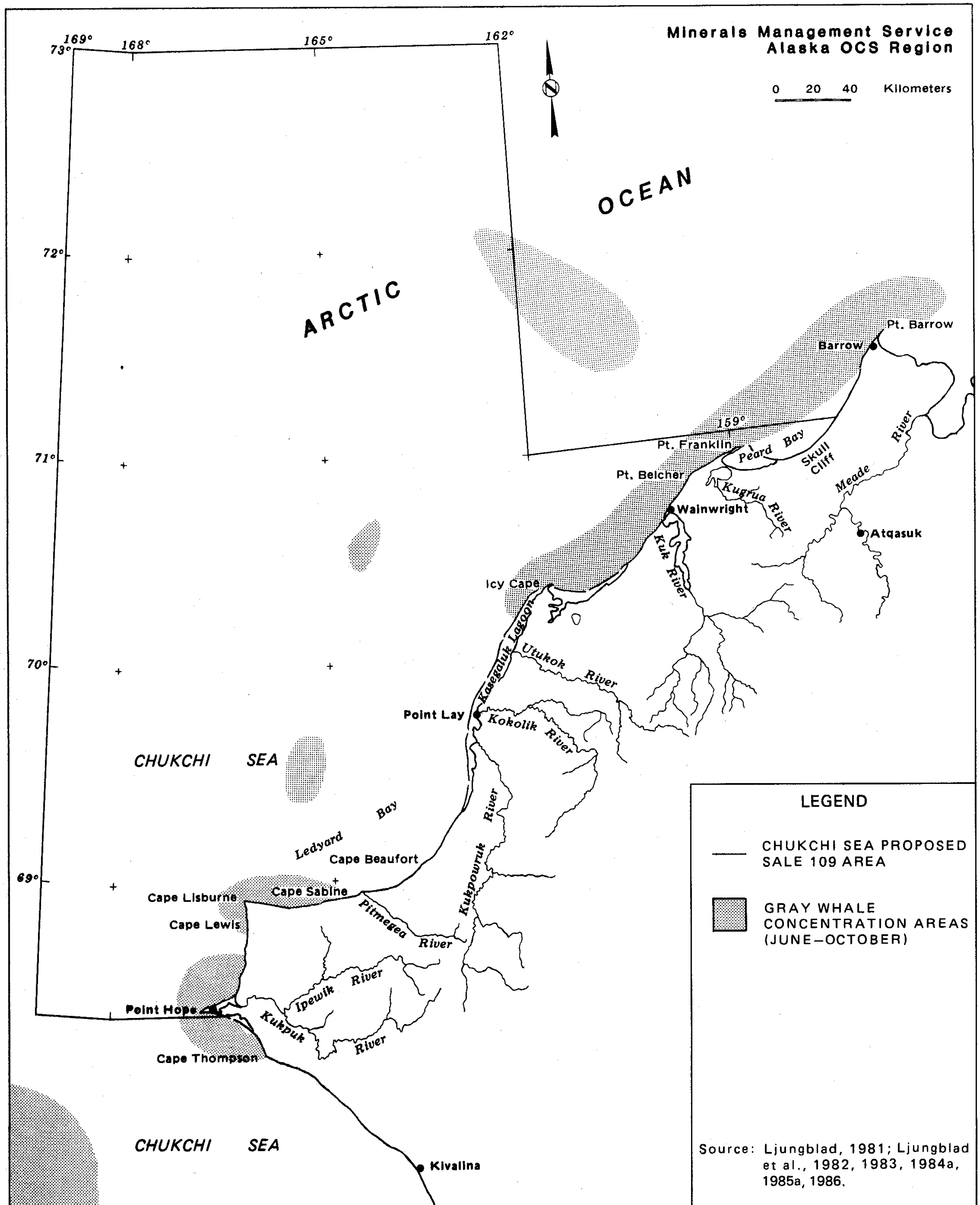


FIGURE III–17. GRAY WHALE–CONCENTRATION AREAS and small, schooling fishes (Tomilin, 1957). They capture prey by engulfing or lateral feeding at the surface; sometimes "bubble nets" are created to concentrate prey items. Wing and Krieger (1983) observed that areas where feeding occurred seemed to have more dense concentrations of prey than other adjacent areas.

e. Arctic Peregrine Falcon: Threatened arctic peregrine falcons may occasionally enter the coastal area adjacent to the eastern boundary of the sale area--generally between May and September--although cliff habitat used for nesting is virtually absent along the coast from Point Barrow to Cape Lisburne. The closest known nest sites are at Cape Thompson, to the south of the sale area; however, nesting is probable on the cliffs at Cape Lisburne (Fyfe, Temple, and Cade, 1976). Peregrines have been observed at Capes Lisburne and Sabine, and they have been seen migrating in the vicinity of Point Lay (Amaral, 1986, oral comm.). Peregrines feed mostly on birds; in coastal areas, seabirds and shorebirds would likely comprise their major food resource.

The Arctic Peregrine Falcon Recovery Team (APFRT) has reported 44 recently active peregrine falcon nests (1960-1981) and 72 known historical nest sites on the Colville, Sagavanirktok, and other river drainages east and west of the Sagavanirktok River (USDOI, FWS, 1982). Two of the recently active sites were indicated as "coastal" and possibly included sites south of Barrow. The Colville River drainage was identified by the APFRT as the center of the peregrine distribution on the North Slope, and populations apparently have been increasing in the last decade (USDOI, FWS, 1982). The most frequent occurrence of peregrines in coastal habitats of the northern Alaskan coast is east of the mouth of the Colville River. Immature birds most probably use this area on a transient basis from mid-August to mid-September (Sale 87 FEIS [USDOI, MMS, 1984a, Sec. III.B.5.d]).

6. Caribou: Among the terrestrial mammals that occur along the coast of the proposed Sale 109 area, barren-ground caribou could be affected by onshore development activities associated with OCS oil and gas leasing. The western arctic caribou herd, the largest herd in Alaska, currently numbers over 200,000 animals (James, 1985) which use coastal habitats adjacent to or near the sale area. The herd ranges over territory in northwestern Alaska that extends approximately from the Colville River to the western coast of Alaska, and north from the Kobuk River to the Beaufort Sea coast.

During the summer months, caribou use coastal habitats of the northern Chukchi and Beaufort Sea coasts such as sand bars, spits, river deltas, and some barrier islands for relief from insect pests. The main calving area for the western arctic herd is located generally in the Utukok River uplands area, extending south to the Colville River (Fig. III-18). Calving takes place during late May and early June. Postcalving and summer ranges include coastal tundra habitats adjacent to the sale area and the Beaufort Sea coast. A sizable number of caribou also overwinter in coastal habitats adjacent to the sale area, while the rest of the herd overwinter in the Noatak River area. Migration routes vary from year to year; general movement patterns are shown in Figure III-18. Over the past 20 years, the western arctic herd has fluctuated in numbers from over 240,000 to 65,000 to 200,000 individuals. Various

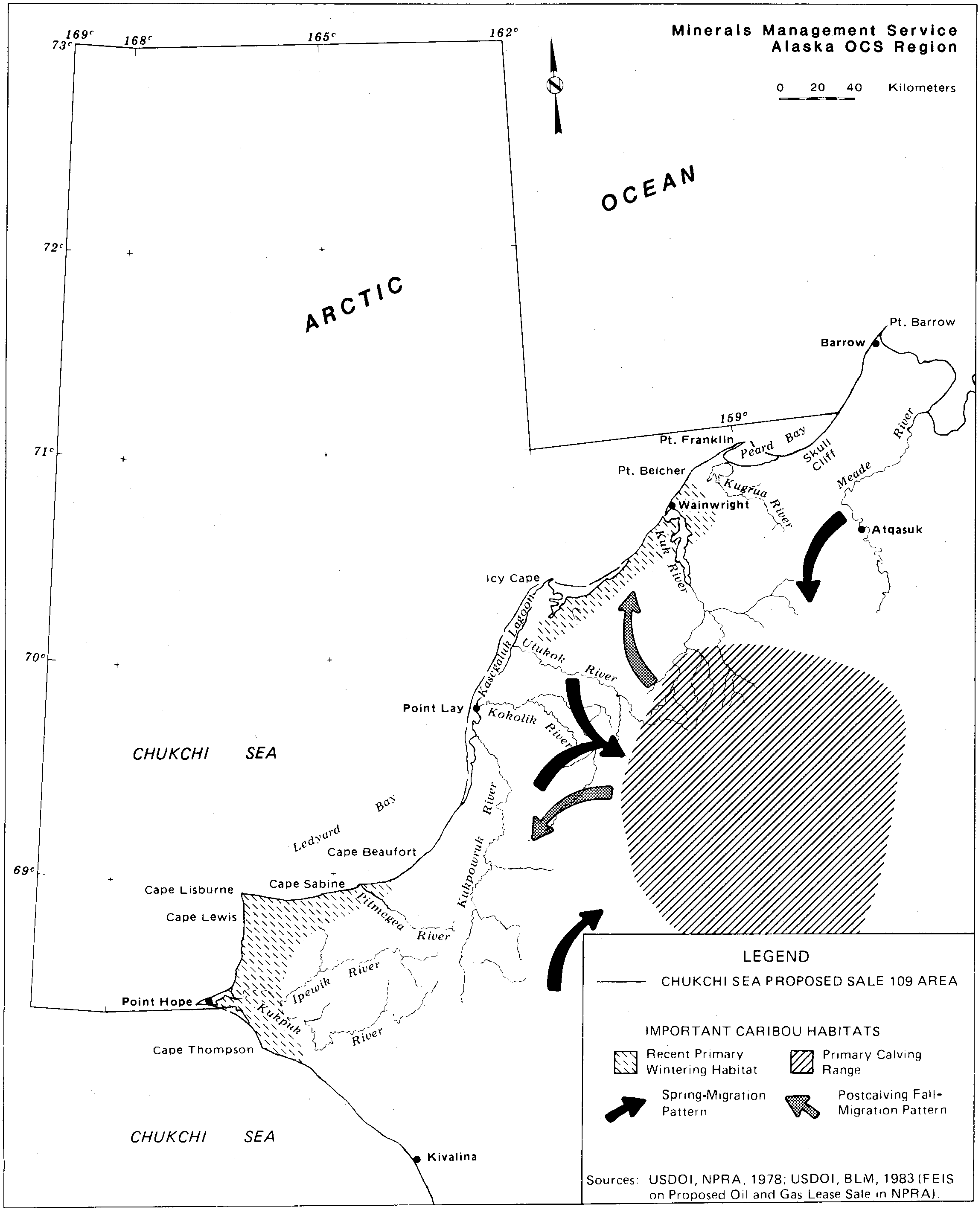


FIGURE III–18. IMPORTANT HABITATS OF THE WESTERN ARCTIC CARIBOU HERD reasons for this fluctuation have been postulated, including habitat changes due to fires, disease, overhunting, and predation; however, natural fluctuations in the western arctic caribou population must be acknowledged.

The caribou diet shifts from season to season and depends on the availability of forage. The winter diet has been characterized as consisting predominantly of lichens and mosses, with a shift to vascular plants during the spring (Thompson and McCourt, 1981). Eriophorum-tussock-sedge buds appear to be very important in the diet of lactating caribou cows during the calving season (Lent, 1966; Thompson and McCourt, 1981), while orthophyll shrubs (especially willows) are the predominant forage during the postcalving period (Thompson and McCourt, 1981). The availability of sedges during the spring--which apparently depends on temperature and snow cover--probably affects specific calving locations and success.

C. Social Systems

1. The Economy of the North Slope Borough: The North Slope Borough (NSB) includes the entire northern coast of Alaska, as well as extensive inland areas, and contains 15 percent of the land area of Alaska. The residents are predominantly Inupiat and have traditionally relied upon subsistence activities for their livelihood. Located within the region is a vast petroleum-industry development centered at Prudhoe Bay. The NSB government is the most important economic linkage between this development and the permanent residents of the region. The NSB collects very large property-tax revenues from assessments on the petroleum-industry facilities--revenues that have funded greatly improved government services, an extensive Capital Improvements Program (CIP), and the creation of large numbers of jobs for permanent residents.

The description of the NSB economy contained in Section III.D.1 of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) is herein incorporated by reference. The following summary has been augmented by additional material, as cited.

The following information (actual and projected) on NSB revenues and expenditures, employment, and population under existing conditions is incorporated by reference from "Economic and Demographic Projections on the North Slope Borough: Beaufort Sea Lease Sale 97 and Chukchi Sea Lease Sale 109" (University of Alaska, ISER, 1986). The assumptions for the model used to generate the report's projections are presented in Appendix F, Table F-2. The four assumptions to which the model is most sensitive are: (1) future NSB revenues, (2) the relationship between Native migration and unemployment, (3) the share of jobs available to Natives in each employment category, and (4) the percentage of Native workers who will seek work in the oil industry.

a. North Slope Borough Revenues and Expenditures: The tax base that has allowed the recent high levels of local-government expenditures consists primarily (more than 95% in Fiscal Year [FY] 1984) of the enormously highly valued petroleum-industry-related property in the Prudhoe Bay area. The NSB's tax base in 1984 was more than triple the base in the Fairbanks-North Star Borough and almost equaled the base in the Municipality of Anchorage. Real-property taxes were the primary source (71%) of the NSB's general-fund revenues in FY 1985.

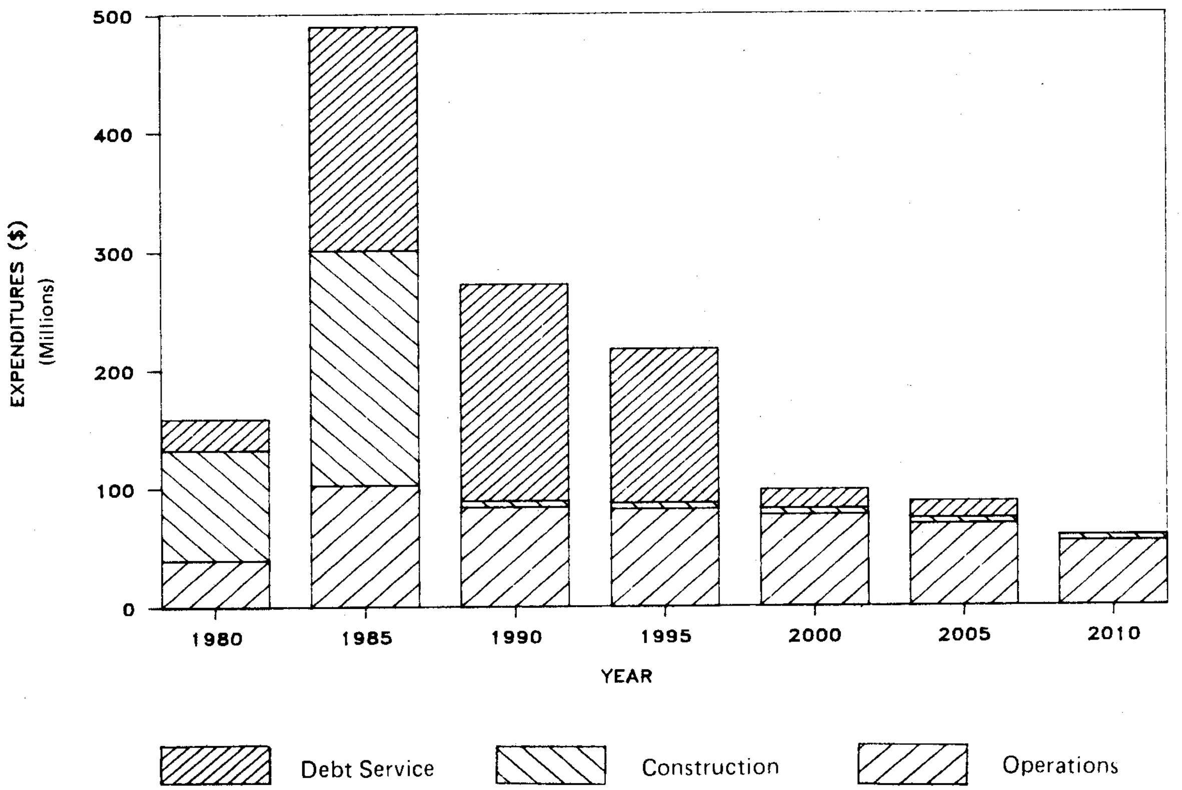
The total property-tax value is projected to rise until 1990 and decline thereafter. Property values could be higher or lower than those projected, depending primarily on world-energy prices and their effect on North Slope development. However, property value is not considered to be the constraining factor for future NSB revenues; they are likely to be constrained by a number of other factors including (1) existing and potential State-imposed limits, (2) the willingness of NSB residents to assume higher property-tax burdens, and (3) State and Federal revenue-sharing policies.

State statutes limit the portion of the mill rate that can be allocated to Borough operations. Because the NSB's current rate is well under the limit, the NSB administration currently faces no legal constraints on raising the rate. However, due to perceived adverse political and economic consequences, the NSB administration is not expected to increase the total mill rate. Total property-tax revenues are projected to rise until 1988 and decline thereafter. Debt service is projected to peak in 1988; as a consequence, the debt-service mill rate is projected to decline. This decline would allow the projected increase in the operations mill rate without an increase in the overall mill rate.

Actual (1980) and projected NSB expenditures from 1985 to 2010 are shown in Figure III-19. Construction expenditures, primarily for CIP projects, are projected to decline dramatically by the year 1990; operating expenditures are also projected to decline. Because these projections were prepared in 1985, the projected CIP expenditures for FY 1985 (a projected $199 million vs the actual $116 million spent) and FY 1986 (a projected $124 million vs the actual $75 million spent) were overestimated (NSB Planning Department, 1986). The CIP expenditures projected by ISER for most years after FY 1986 underestimate the most recent NSB projections, in part because the Borough has decided to use nonbonded funding to supplement the traditional bonded funding (NSB Planning Department, 1986). For example, the most recent Borough projections for CIP expenditures exceed $10 million per year for the years 1991 to 2000, compared to ISER's projection of $5 million per year. This general trend of expenditure declines is the most important factor in the projected decline of resident employment discussed in the following section.

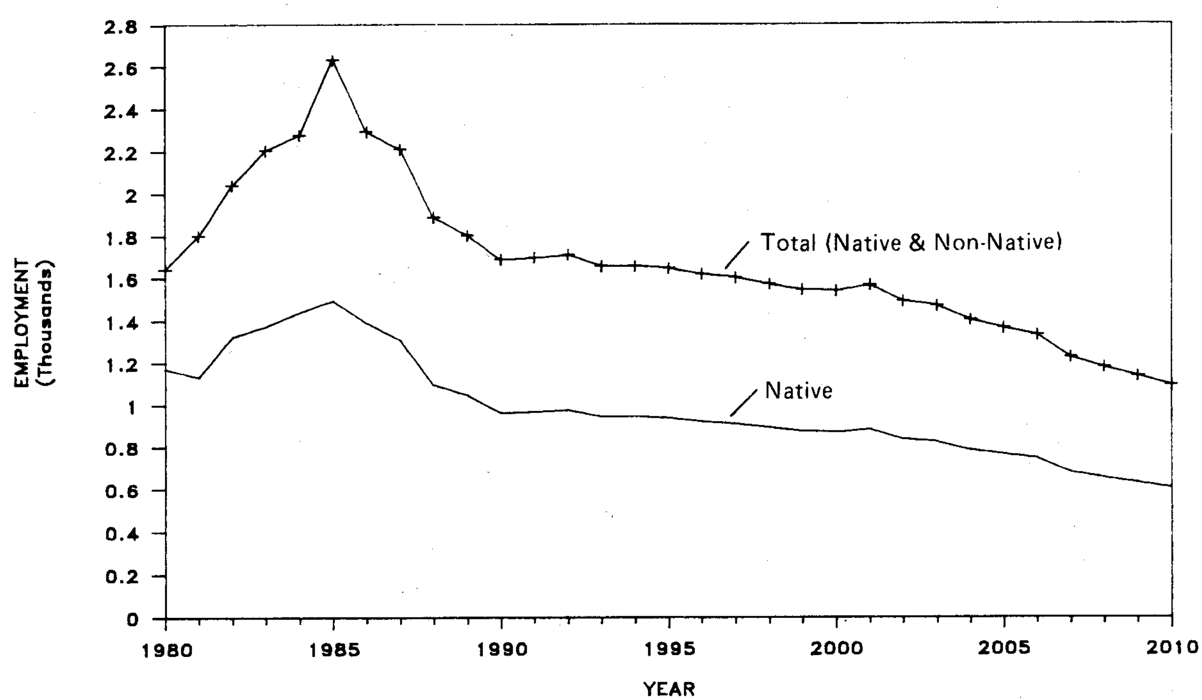
b. Employment: In 1985, total North Slope employment (resident and commuter) was estimated at around 9,000, down from a peak of over 10,300 in 1983. In 1985, around 6,000 (66%) of the jobs were in the petroleum industry, down from a peak of almost 7,800 oil-related jobs in 1983. Almost all petroleum-industry jobs (over 99%) are held by workers who commute to permanent residences outside the region. The vast majority of the commuters are employed in isolated, self-sufficient industrial enclaves that have little direct economic interaction with the NSB communities. Most of these enclaves are related to petroleum exploration or production, although one small enclave is a defense-related communication site.

Estimates and projections of Native- and non-Native-resident employment since 1980 are provided in Figure III-20. Total resident employment in 1985 was projected at around 2,600, with about 57 percent of those jobs held by Natives. A breakdown of employment by category is provided in Table III-8. In 1985, approximately 96 percent of Native employment was projected to be related to NSB funds. As shown in Table III-8, most residents (65%) were projected to be employed either by NSB operations or the CIP. In 1985, CIP employment was projected to continue to fall from its peak of 378 jobs in



Source: University of Alaska, ISER, 1986, and MMS, Alaska OCS Region.

FIGURE III-19. ACTUAL AND PROJECTED NORTH SLOPE BOROUGH EXPENDITURES WITHOUT SALE 109



Source: University of Alaska, ISER, 1986, and MMS, Alaska OCS Region.

FIGURE III-20. ACTUAL AND PROJECTED NORTH SLOPE BOROUGH-RESIDENT EMPLOYMENT WITHOUT SALE 109

Table III-8
Projected Native- and Non-Native-Resident Employment by Category
in the North Slope Region in 1985

Employment Category	Residents' Status		
	Native (percent)	Non-Native (percent)	Total (percent)
North Slope Borough			
Operations	681 (45%)	662 (58%)	1,343 (51%)
CIP	302 (20%)	100 (9%)	402 (15%)
Other CIP[1/]	147 (10%)	0 (0%)	147 (6%)
Subtotal	1,129 (75%)	762 (67%)	1,891 (72%)
Federal and State Government	23 (2%)	57 (5%)	80 (3%)
Petroleum Industry	30 (2%)	0 (0%)	30 (1%)
All Other	315 (21%)	317 (28%)	632 (24%)
TOTAL	1,497 (100%)	1,136 (100%)	2,633 (100%)

Source: University of Alaska, ISER, 1986.

1/ Employees of private contractors working on NSB-funded CIP projects.

1982, while operating employment was projected to reach a new peak. Because of the underestimation of the actual decline in CIP expenditures in FY 1985, actual CIP employment in 1985 was probably considerably less than what had been projected.

Only a small number of permanent residents hold jobs in the petroleum industry enclaves. Residents seem to prefer the employment created by the NSB to potentially available oil-related jobs. Pay scales offered by the NSB are equal to or better than those in the petroleum industry, and the Natives consider the working conditions and flexibility offered by the NSB to be superior to those prevailing in the petroleum industry. However, with the dramatic decline in CIP jobs, residents are now probably more interested in jobs with the petroleum industry. A detailed description of the employment situation and the reasons for the low level of Native involvement in the petroleum industry are provided in the "Description of the Socioeconomics of the North Slope Borough" (University of Alaska, ISER, 1983).

Non-Native-resident employment was projected to more than double between 1980 and 1985; most (67%) were projected to be employed with NSB operations and the CIP. These employment opportunities for non-Natives have resulted in the significant increase in the non-Native population that is discussed in the next section.

The major reason for the projected continuing decline in resident employment is the projected decline in NSB revenues and expenditures. As CIP projects are completed, expenditures shift toward operations. Even with an increased emphasis on operations, however, operations employment is expected to decline slightly. Because of the underestimation of currently projected CIP expenditures from FY 1987 on, ISER's projections of CIP employment in those years will probably be too low. The share of resident employment held by Natives is projected to remain at about 56 percent between 1985 and 2010. Employment of Native residents in the petroleum industry is expected to rise quickly between 1985 and 1990 and to peak at 92 employed during 1992 (see Fig. IV-27). This coincides with the projected dramatic decline in CIP employment. After 1992, Native employment would be constrained by industry's demand for labor (ability and willingness to offer industry-employment opportunities to Natives).

After falling to very low levels for several years, the unemployment rate for Natives rose in 1985 and is projected to reach 50 percent by 2002. Out-migration of residents is assumed to occur and, therefore, would keep the unemployment rate from rising above 50 percent. This out-migration would aggravate the decline in NSB revenues because intergovernmental transfers and operations revenues (from property taxes) are proportional to population levels.

c. Population: Most of the following information is incorporated by reference from Section III.C.1 of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a). The population of the North Slope region can be measured in two ways. The traditional method counts only those people who reside in the region--referred to as permanent residents. Using this method, the primarily Inupiat permanent-resident population was estimated to be 5,272 in 1985. A breakdown of the 1985 population among the eight communities in the region is presented in Table III-9. The alternative method for calculating the population, used for fiscal purposes, is to include a portion of the

Table III-9
Population of the North Slope Region
1980 and 1985

		1980[1/]	1985[3/]
	Anaktuvuk Pass	203	278
	Atqasuk	107	248
	Barrow	2,207	3,075
	Kaktovik	165	220
	Nuiqsut	208	332
	Point Hope	464	570
	Point Lay	68	142
	Wainwright	405	507
SUBTOTAL	Traditional Inupiat Communities	3,827	5,372
SUBTOTAL	Oil-Related Enclaves, Military Stations, and Others	372[2/]	2,936[4/]
TOTAL	NORTH SLOPE BOROUGH	4,199	8,308

Sources: As indicated in the footnotes below.

1/ Source: U.S. Dept. of Commerce, Bureau of the Census (1981).
2/ The census counts people by place of residence; therefore, the thousands of nonresidents working in the NSB were not counted.
3/ Source: State of Alaska, Dept. of Community and Regional Affairs, FY 1986 Revenue Sharing Program.
4/ This number was calculated by 2/ using a different methodology from that used in the 1980 Census. In 1982 the military stations contained around 200 people. The remainder of this subtotal consists of 39.1 percent of the latest average annual employment of the Prudhoe Bay, Kuparuk, and Pipeline areas.

commuters working in enclaves in the region even though they may reside elsewhere--both in and outside of Alaska. When the enclave and military populations are added to the permanent-resident population, the total population of the region in 1985 was estimated at 8,308.

As a result of NSB expenditures and their effect on employment, the population of the communities boomed, especially in the early 1980's. This boom resulted from a combination of (1) fewer people out-migrating, (2) people returning who had previously out-migrated, and (3) new people in-migrating--particularly non-Natives. The non-Native proportion of the population grew, especially in Barrow. While some non-Native in-migrant workers brought families with them, most of them did not; thus, the non-Native population is primarily of working age.

In 1985, ISER estimated the permanent-resident population at 5,152, of which 71 percent were Native. Under existing conditions, the resident population is projected to grow to 5,673 by 2001 (a growth rate of 0.6% per year) and then to decline to the 1983-population level of around 4,500 by 2010 (a rate of decline of 2.5% per year). This projected decline is based on the reduced employment opportunities discussed above. Native out-migration is projected to rise from less than 20 residents per year between 1991 and 2001 to over 100 per year by 2003 and to over 200 per year by 2006. The non-Native-resident population is projected to decline by almost 50 percent between 1986 and 2010. The proportion of Natives in the population is projected to increase to 86 percent by 2010. This projection results from the assumption that non-Native residents leave the region more quickly than Native residents in response to declining job opportunities.

While no projections are available for the populations of the individual communities, it can reasonably be assumed that Barrow is the place of residence of most of the non-Natives projected to leave the NSB. As the regional center, Barrow's Native-resident population would not be affected proportionally as much by decreased NSB expenditures as would the smaller communities. One possibility is that some of the out-migrating non-Native residents of Barrow would be replaced by Native residents of the smaller communities who are attracted to Barrow's more stable economic future.

2. Subsistence-Harvest Patterns:

a. Introduction: This section describes the subsistence-harvest patterns of the Inupiat (Eskimo) communities closest to the Sale 109 area--Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk--and the inland-subsistence-harvest patterns of Nuiqsut. This community-by-community description provides general information on subsistence-harvest patterns, harvest information by resource and community, timing of the subsistence-harvest cycles, and harvest-area concentrations by resource and by community. Subsistence-harvest patterns of several of the communities adjacent to the Chukchi Sea Sale 109 area are described in Section III.C.3 of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and incorporated by reference. The following description is augmented by the "Barrow Arch Socioeconomic and Sociocultural Description" (Alaska Consultants, Inc., C.S. Courtnage, and Stephen Braund and Associates [ACI/Courtnage/Braund], 1984) and the "Subsistence Study of Alaska Eskimo Whaling Villages" (ACI/Braund, 1984).

The community residents in the Sale 109 area participate in a subsistence way of life. Alaska Statutes define "subsistence uses" as those customary and traditional uses in Alaska of fish, wildlife, and vegetation for direct personal, family, and community needs (AS 16.05.940). Subsistence activities, which are assigned the highest cultural value by the Inupiat, provide a sense of identity as well as an important economic activity. The importance of hunting to the maintenance of cultural identity is expected to grow in the near future as social pressures associated with oil development build. Inupiat scoping concerns regarding oil development for Sale 109 can be divided into four categories (Kruse, Baring-Gould, and Schneider, 1983): (1) direct damage to subsistence resources and habitats, (2) disruption of subsistence species during migration, (3) disruption of access to subsistence areas, and (4) loss of Native food.

Effects on subsistence could be serious even if the net quantity of available food did not decline. Some species are important for the role they play in the annual cycle of subsistence-resource harvests. However, the consumption of harvestable subsistence resources provides more than dietary benefits; these resources also provide materials for personal and family use. The sharing of harvestable subsistence resources helps maintain traditional family organization. Subsistence resources provide special foods for religious and social occasions such as Christmas, Thanksgiving, and--the most important ceremony in the communities of the Sale 109 area--Nalukatak, which celebrates the bowhead whale harvest. The sharing, trading, and bartering of harvestable subsistence resources structures relationships among communities adjacent to the Sale 109 area, while the giving of such foods helps maintain ties with family members elsewhere in Alaska. Finally, subsistence provides a link to the cash economy. Households within the sale area earn cash from crafting walrus ivory and whale baleen and from harvesting furbearing mammals. As the availability of wage earnings associated with the oil industry and NSB Capital Improvements Program (CIP) projects declines in future years, this link may be expected to increase in importance in the communities of the sale area. These are examples of possible effects on consumption. The production side of the subsistence system may also be affected. The temporary elimination of a species from a community's subsistence-harvest spectrum could impair the hunt of that species without substantially affecting the overall diet.

b. Community Subsistence-Harvest Patterns: This section provides general information regarding subsistence-harvest patterns in all of the communities close to the Sale 109 area as well as the inland-subsistence-harvest patterns of Nuiqsut. The extent of the subsistence area used by each community in the sale area is shown in Figure III-21. Figures III-22 through III-27 show the harvest concentration areas for the various subsistence resources used by the communities of Barrow, Wainwright, Point Lay, Point Hope, Atqasuk, and Nuiqsut. Specific information regarding the harvest areas, species harvested, and quantities harvested is provided in the following discussion of each community. Under certain conditions, harvest activities may occur anywhere in the sale area; but they tend to be concentrated along rivers and coastlines, near communities, and at particularly productive sites.

While the subsistence areas and activities of all six communities on the North Slope would be affected at least indirectly by proposed Sale 109, the entire marine-subsistence-harvest areas of Wainwright, Point Lay, and Point Hope lie within the Sale 109 boundary. Parts of Atqasuk's and Barrow's marine-

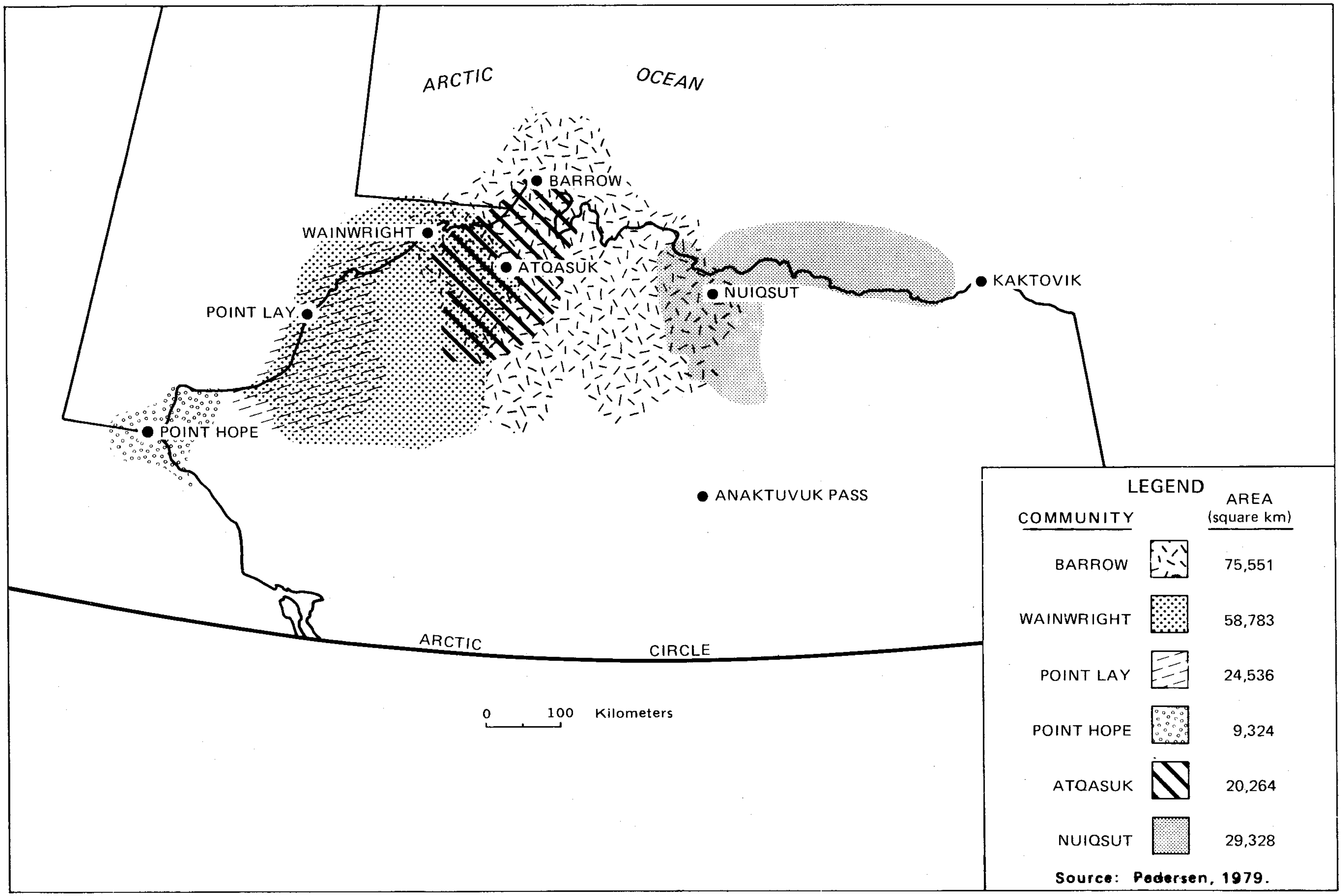


FIGURE III–21. SUBSISTENCE-HARVEST AREAS FOR SELECTED NORTH SLOPE COMMUNITIES

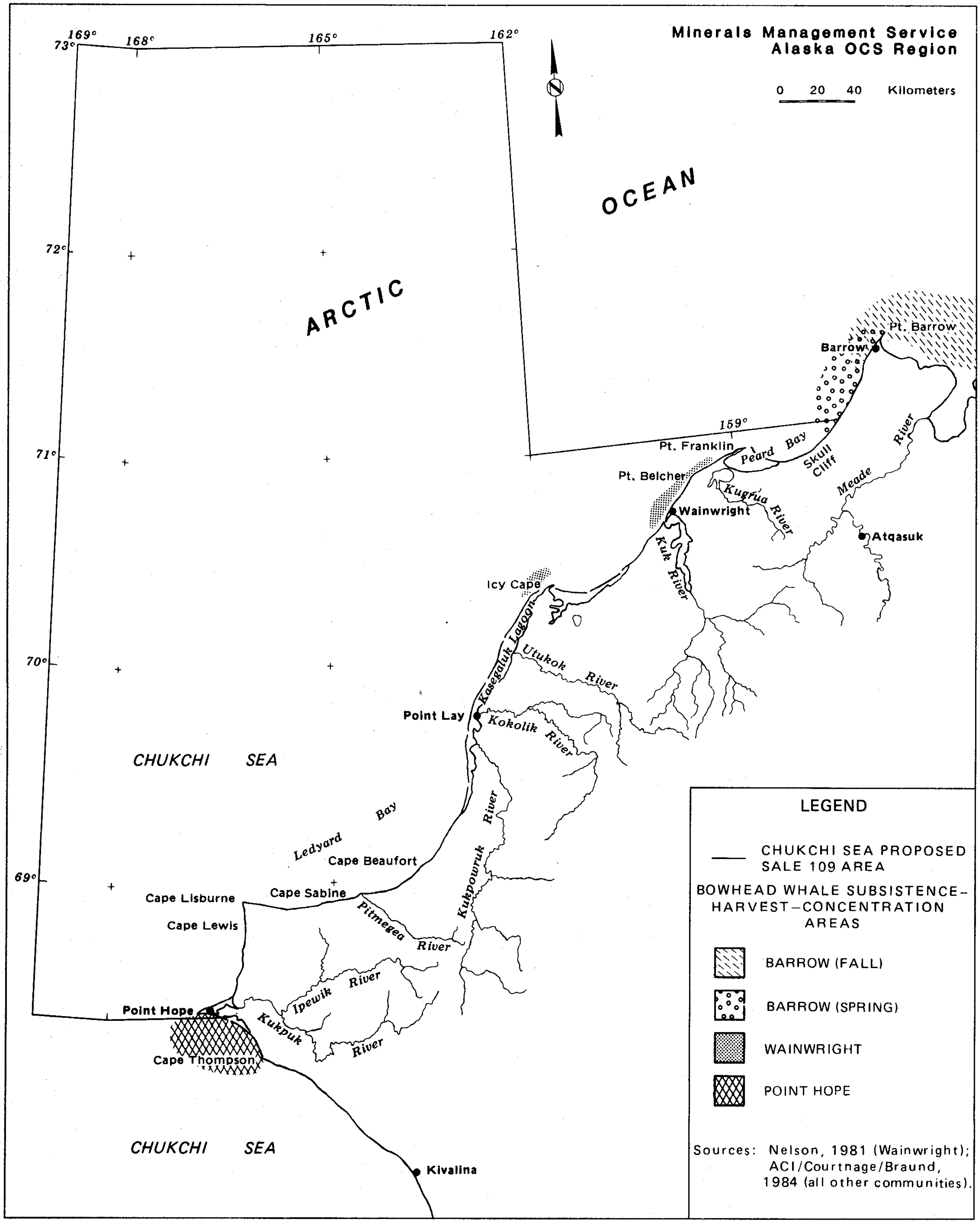


FIGURE III-22. SUBSISTENCE-HARVEST-CONCENTRATION AREAS FOR BOWHEAD WHALES

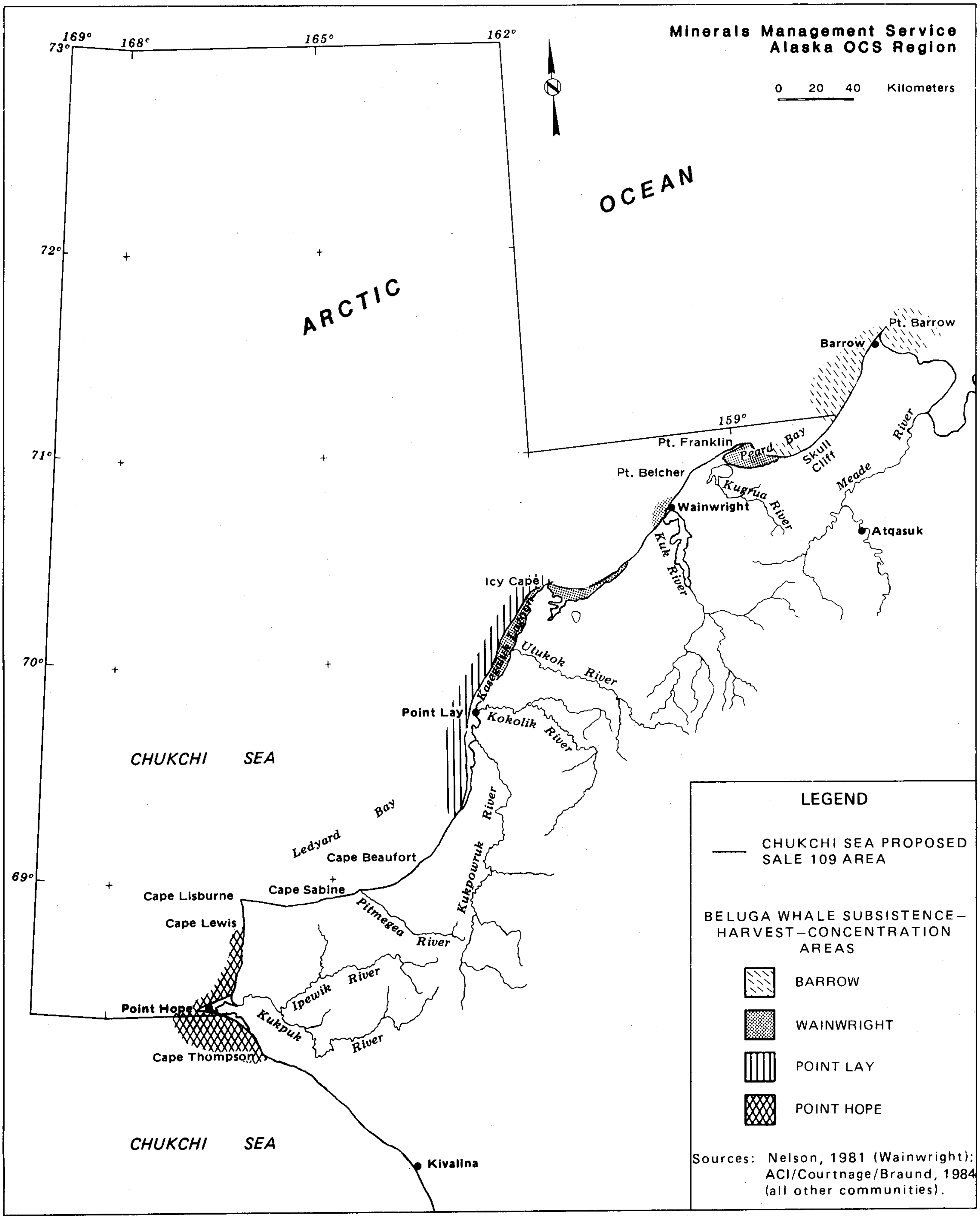


FIGURE III-23. SUBSISTENCE-HARVEST-CONCENTRATION AREAS FOR BELUGA WHALES

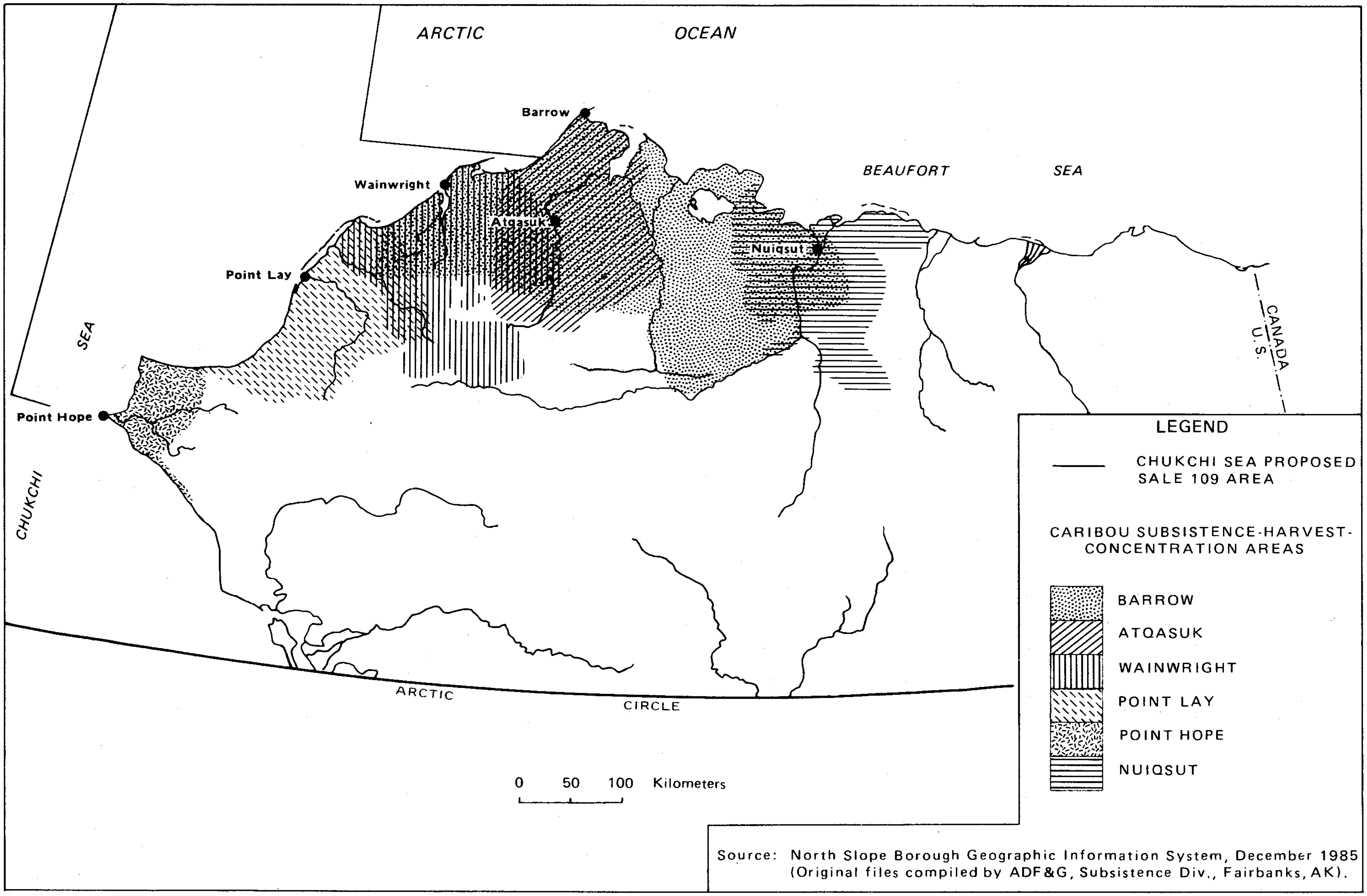


FIGURE III–24A. SUBSISTENCE–HARVEST–CONCENTRATION AREAS FOR CARIBOU

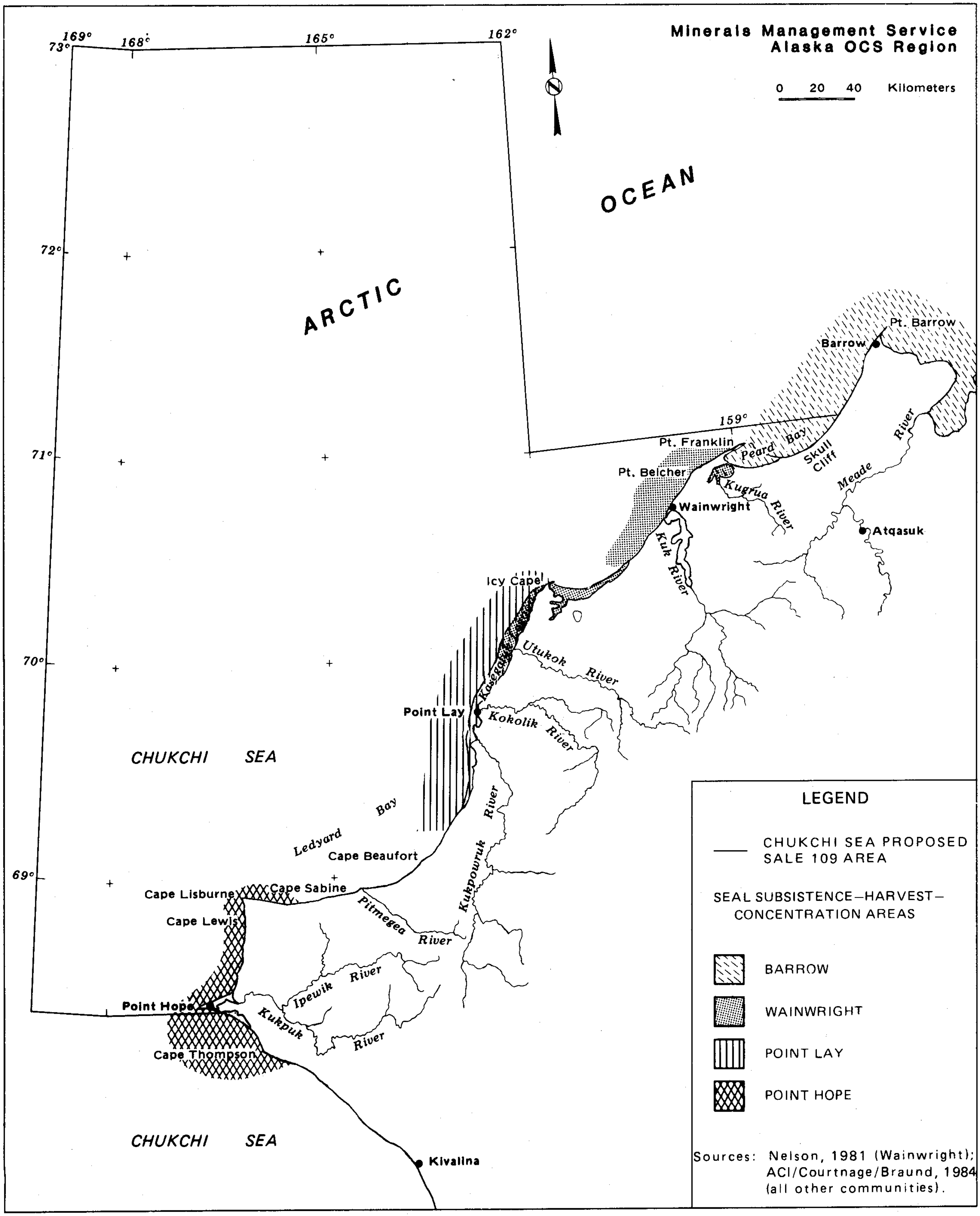


FIGURE III–24B. SUBSISTENCE–HARVEST–CONCENTRATION AREAS FOR SEALS

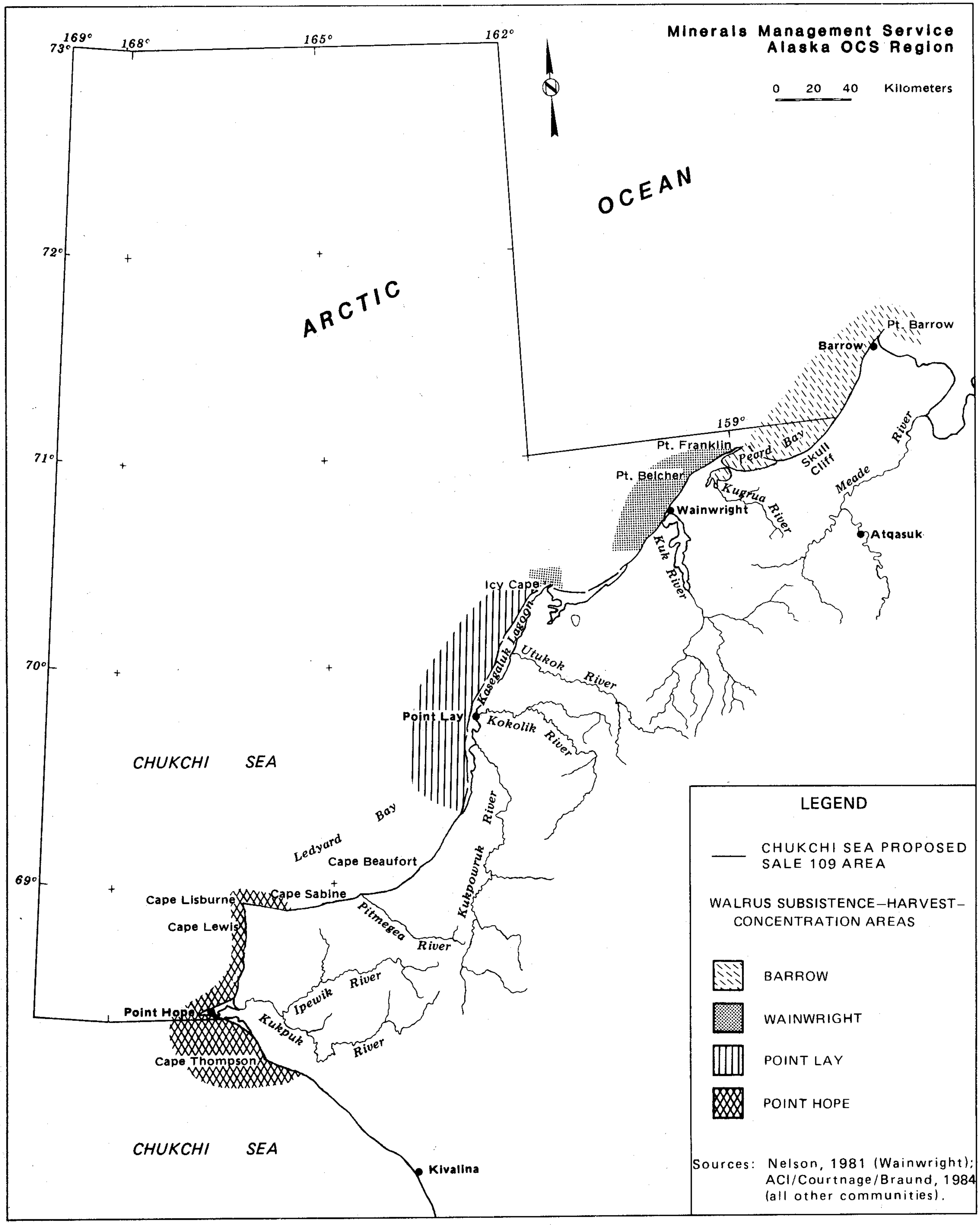


FIGURE III–25. SUBSISTENCE–HARVEST–CONCENTRATION AREAS FOR WALRUSES

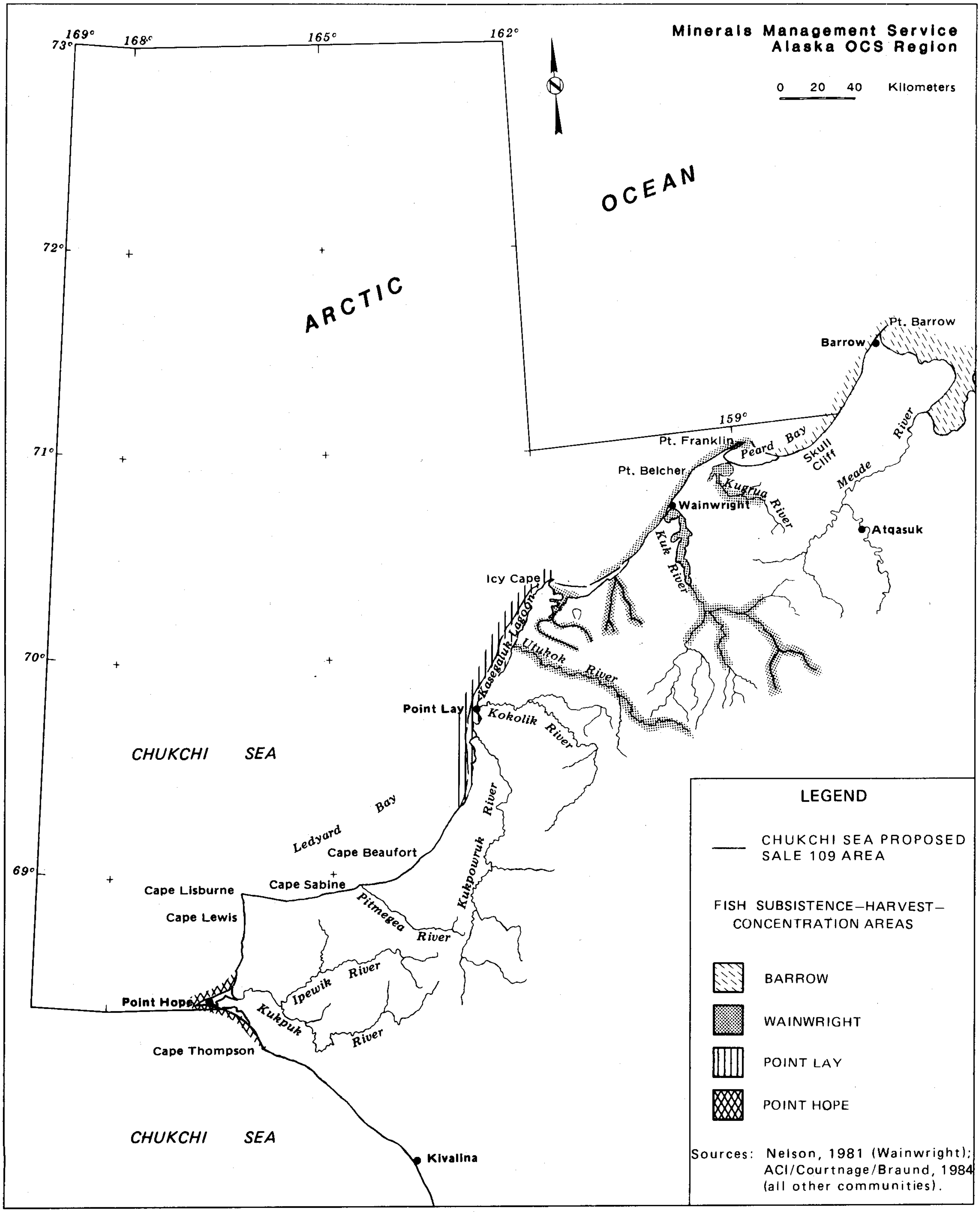


FIGURE III–26. SUBSISTENCE–HARVEST–CONCENTRATION AREAS FOR FISHES

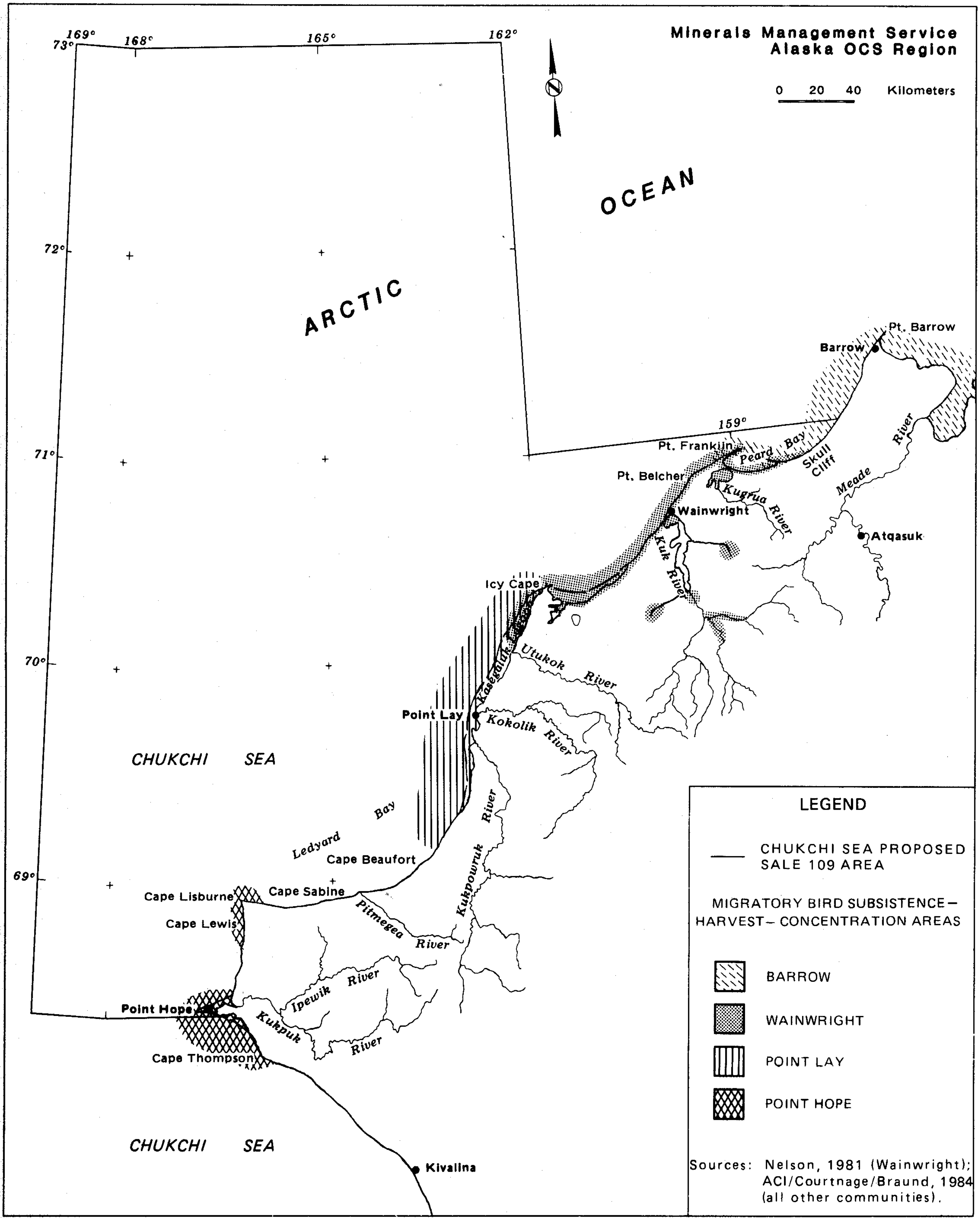


FIGURE III–27. SUBSISTENCE–HARVEST–CONCENTRATION AREAS FOR MIGRATORY BIRDS subsistence-harvest areas--especially for bowhead whales and other marine mammals, marine fishes, and migratory waterfowl--lie within this boundary. The caribou-hunting areas of Barrow, Wainwright, Atqasuk, and Nuiqsut would be most directly affected by pipelines and other onshore facilities associated with the proposal.

Subsistence harvest of vegetation by communities adjacent to the Sale 109 area is limited, while the harvest of faunal resources such as marine and terrestrial mammals and fishes is heavily emphasized. The spectrum of available resources in this region is limited when compared to more southerly regions. Table III-10 presents a list of resources harvested by each community in the sale area. Tables III-11 through III-14 summarize residents' responses to the following categories: (1) subsistence resources most often harvested by communities close to the sale area, (2) resources that provided the largest source of meat, (3) resources that were consumed most often, and (4) resources that were preferred (see the Beaufort Sea Sale 97 FEIS, Sec. III.C.3 [USDOI, MMS, 1987a]). While the responses differed from community to community, the combination of caribou, bowhead whale, and fish was identified by between 75 and 95 percent of all respondents as being the primary group of resources harvested (Tables III-11 through III-13). The lowest percentage for this combination occurred in Point Hope, where residents use the greatest variety of subsistence resources.

Available data on kilograms of harvested and/or consumed subsistence resources provide a good idea of subsistence levels and dependency (Stoker, 1983, as cited by ACI/Braund, 1984). The caribou is the most important resource in terms of effort spent hunting, quantity of meat hunted, and quantity of meat consumed (effort spent hunting is measured by frequency of hunting trips rather than total kilograms harvested [Tables III-11 through III-13]). The bowhead whale is the preferred meat (Table III-14) and is also the subsistence resource most important as the basis for sharing and community cooperation--the foundation of the sociocultural system (see the Sale 97 DEIS, Sec. III.C.3). Depending on the community, fish are the second- or third-most-important resource after caribou and bowhead whale (Table III-12). The bearded seal and birds are also considered primary subsistence species. Waterfowl are particularly important during the spring, when they provide variety to the subsistence diet.

Seal oil from hair and bearded seals is an important staple and a necessary complement to other subsistence foods.

Whaling is a major concern in the Sale 109 area. The subsistence pursuit of bowhead whales occurs at Barrow, Wainwright, and Point Hope. Because they migrate too far offshore, bowheads are unavailable to the people of Point Lay. In Point Lay, a communal hunt of beluga whales serves many of the same economic and social functions that bowhead whaling serves in other coastal NSB communities. The people of Point Lay share the highly valued beluga meat with other communities in the area. Whaling is the most valued activity in the subsistence economy of the sale area today. This is true in spite of International Whaling Commission (IWC) quotas and relatively plentiful supplies of caribou, fish, and other subsistence foods and a limited supply of retail-grocery foods (except in Barrow). Whaling traditions include kinship-based crews, use of skin boats, shoreline preparation for distribution of the meat, and total community participation and sharing. In spite of the rising cash

Table III-10
Subsistence Resources Harvested by Selected North Slope Communities[1/]

Resource	Barrow C/IN[2/]	Wainwright C/IN	Point Lay C/IN	Point Hope C/IN	Atqasuk IN	Nuiqsut IN/C
Bowhead Whales	X	X	3/	X		X
Caribou	X	X	X	X	X	X
Fishes	X	X	X	X	X	X
Beluga Whales	X	X	3/	X		X
Seals	X	X	X	X		X
Bearded Seals	X	X	X	X		X
Walruses	X	X	X	X		X
Polar bear	X	X	X	X		X
Moose	X	X	X	X	X	X
Sheep				X		
Small land mammals	X	X	X	X	X	X
Ducks	X	X	X	X	X	X
Geese[4/]	X	X	X	X	X	X
Murres						
Owls					X	
Ptarmigan	X	X	X	X	X	X
Bird eggs	X	X	X	X	X	X
TOTAL	14	14	14	16	9	13

Sources: NSB Contract Staff, 1979:10-14; ACI/Braund, 1984: Tables 96, 97, 98, and 108.

1/ This list of resources is derived from NSB Contract Staff (1979:14). For the purposes of this table, "primary" and "secondary" resources are joined and designated with an "X." Following ACI/Braund (1983, Tables 96, 97, 98, and 108), bowhead whales, caribou, and fishes are listed first to designate their relative importance.

2/ C = Coastal/Marine; IN = Inland/Freshwater; the code listed first is emphasized.

3/ Of these three important resources--bowhead whales, caribou, and fish--caribou and fish are major resources for both inland and coastal settlements. Bowhead whales are an important resource for all coastal North Slope communities except Point Lay, where they are not available. The beluga whale is very important at Point Lay, however, and plays an equivalent role to the bowhead in the Point Lay economy.

4/ Migratory birds, particularly geese, are of increasing importance to the subsistence system; however, because of their limited mass, they cannot be classed with bowheads, caribou, or fish.

Table III-11
Subsistence Resources Most Often Harvested in 1981
by Selected North Slope Communities[1]
(Percentage Distribution of Responses)

Resource	Barrow	Wainwright	Point Hope	Nuiqsut
Caribou	33.8	62.2	12.5	76.7
Walruses	5.6	2.7	6.2	0.0
Bowhead Whales	26.8	21.6	50.0	0.0
Fishes	24.0	10.8	9.4	16.7
Seals	1.4	0.0	3.1	0.0
Bearded Seals	4.2	2.7	9.4	16.7
Birds	1.4	0.0	0.0	3.3
Other	2.8	0.0	9.4	3.3
Total	100.0	100.0	100.0	100.0
(Number of respondents)	(32)	(37)	(71)	(30)

Source: ACI/Braund, 1984.

1/ No data available for Point Lay or Atqasuk.

Table III-12
Largest Sources of Meat Harvested in 1981
by Selected North Slope Communities[1]
(Percentage Distribution of Responses)

Resource	Barrow	Wainwright	Point Hope	Nuiqsut
Caribou	64.2	55.2	26.5	75.9
Walruses	4.5	0.0	2.9	0.0
Bowhead Whales	10.4	20.7	17.6	0.0
Fishes	14.9	10.3	32.4	20.7
Seals	0.0	0.0	5.9	0.0
Bearded Seals	1.5	6.9	11.8	3.4
Birds	3.0	6.9	0.0	0.0
Other	1.5	0.0	2.9	0.0
Total	100.0	100.0	100.0	100.0
(Number of respondents)	(67)	(29)	(34)	(29)

Source: ACI/Braund, 1984.

1/ No data available for Point Lay or Atqasuk.

Table III-13
Meat Most Often Consumed from
Subsistence Harvests by Selected North Slope Communities[1/]
(Percentage Distribution of Responses)

Resource	Barrow	Wainwright	Point Hope	Nuiqsut
Caribou	71.4	79.4	32.4	93.4
Walruses	0.0	0.0	0.0	0.0
Bowhead Whales	8.6	17.6	29.4	0.0
Fishes	0.0	0.0	20.6	0.0
Seals	0.0	0.0	0.0	0.0
Bearded Seals	1.4	3.0	11.8	0.0
Birds	17.2	0.0	2.9	3.3
Other	1.4	0.0	2.9	3.3
Total	100.0	100.0	100.0	100.0
(Number of respondents)	(70)	(34)	(34)	(30)

Source: ACI/Braund, 1984.

1/ No data available for Point Lay or Atqasuk.

Table III-14
Preferred Meat from Subsistence Harvests
for Selected North Slope Communities[1/]
(Percentage Distribution of Responses)

Resource	Barrow	Wainwright	Point Hope	Nuiqsut
Caribou	17.8	30.5	2.7	50.0
Walruses	1.4	0.0	0.0	0.0
Bowhead Whales	72.6	66.7	94.6	32.1
Fishes	5.5	0.0	0.0	10.7
Seals	0.0	0.0	0.0	0.0
Bearded Seals	2.7	0.0	0.0	0.0
Birds	0.0	0.0	0.0	0.0
Other	0.0	2.8	2.7	3.6
Total	100.0	100.0	100.0	100.0
(Number of respondents)	(73)	(36)	(37)	(28)

Source: ACI/Braund, 1984.

1/ No data available for Point Lay or Atqasuk.

income, these traditions remain as central values and activities for all the Inupiat in these communities (see the Sale 97 DEIS, Sec. III.C.3, for a discussion on the cultural importance of whaling).

Bowhead whaling strengthens family and community ties and the sense of a common Inupiat heritage, culture, and way of life. Thus, whaling activities provide strength, purpose, and unity in the face of rapid change. Barrow is the only community within the area that whales in both the spring and the fall (see Fig. III-22), although its fall-whaling area lies to the east of the Sale 109 area. Wainwright and Point Hope residents hunt bowheads only during the spring season.

Harvest data for Barrow, Wainwright, and Point Hope are only estimates that represent average values. Because of this limitation, resource-harvest data are presented in terms of a 20-year average for selected North Slope communities (Table III-15). Table III-16, which shows the contribution made by various harvestable subsistence resources to the Native diet, is based on the amount of usable meat and fat contributed to the diet rather than on the number of animals harvested. The 20-year averages do not reflect the important shift in subsistence-harvest patterns that occurred in the late 1960's, when the substitution of snow machines for dog sleds decreased the importance of ringed seals and walruses (two key dog foods) and increased the relative importance of waterfowl in the subsistence system. While ringed seals and walruses remain significant human foods and walruses still provide important raw materials for Native handicrafts, this shift illustrates that technological or social change may lead to long-term modifications of the subsistence system. Because of a projected decline in NSB CIP projects, community wage work, and incomes (see Sec. III.C.1), subsistence hunting in general may increase. The hunting of walruses and polar bears, particularly, may increase because of their importance for Native handicrafts. Because of recent changes in technology and subsistence-harvest patterns, the dietary importance of waterfowl may also continue to increase. However, none of these changes would affect the predominant dietary roles of caribou, whales, or fish--the three resources that play central and specialized roles in the North Slope subsistence system and for which there are no logical substitutes.

(1) Barrow: As with other communities adjacent to the Sale 109 area, Barrow residents (population 3,075 in 1985) enjoy a diverse resource base that includes both marine and terrestrial animals. Barrow's location is unique among the communities in the sale area--the community is a few miles southwest of Point Barrow, the demarcation point between the Beaufort and Chukchi Seas. This location offers superb opportunities for hunting a diversity of marine and terrestrial mammals and fishes.

(a) Bowhead Whales: Unlike residents of other communities close to the Sale 109 area, Barrow residents hunt the bowhead whale during both spring and fall; however, more whales are harvested during the spring whale hunt, which is the major whaling season. In 1977, the IWC established a quota for subsistence hunting of the bowhead whale by Alaskan Inupiat. The quota is currently regulated by the Alaska Eskimo Whaling Commission (AEWC), which annually decides how many bowheads each community may take; this number depends on the overall quota set by the IWC. Barrow whalers hunt in the fall only if they do not get their quota during the previous spring hunt. There are approximately 30 whaling camps along the edge of the landfast ice. The

Table III-15
Annual Harvest of Subsistence Resources Averaged for the Period 1962-1982 for Selected North Slope Communities[1,2,3/]
(Percentage Distribution of Responses)

Resource	Barrow	Wainwright	Point Hope	Nuiqsut
Bowhead Whales				
Number harvested	10.10	1.50	4.50	0.30
Usable weight (kg)	89,890	13,350	40,050	2,670
Percentage of average total community harvest	21.3%	8.2%	22.3%	8.6%
Caribou	3,500	1,200	756	400
	245,000	84,000	52,920	28,000
	58.2%	51.6%	29.5%	90.2%[4/]
Walruses	55	86	15	--
	19,250	30,205	5,250	--
	4.6%	18.5%	2.9%	--
Bearded Seals	150	250	200	--
	12,000	20,000	16,000	--
	2.9%	12.3%	8.9	--
Hair Seals	955	375	1,400	--
	18,145	7,125	26,600	--
	4.3%	4.4%	14.8%	--
Beluga Whales	5	11	29	--
	2,000	4,400	11,600	--
	0.5%	2.7%	6.5%	--
Polar Bears	7	7	9[6/]	1
	1,575	1,575	2,025	225
	0.4%	1.0%	1.1%	0.1%
Moose	5	2	4	--
	1,125	450	900	--
	0.3%	0.3%	0.5%	--
Reindeer	0	0	0	--
	0	0	0	--
	0.0%	0.0%	0.0%	--

Table III-15
Annual Harvest of Subsistence Resource Averaged for the Period 1962-1982 for Selected North Slope Communities[1,2,3]
(Percentage Distribution of Responses)
(Continued)

Resource	Barrow	Wainwright	Point Hope	Nuiqsut
Small Land Mammals	5/ 455 0.1%	-- -- --	-- -- --	-- -- --
Birds	5/ 3,636 0.9%	5/ 545 0.3%	5/ 5,682 3.2%	-- -- --
Fishes	5/ 27,955 6.6%	5/ 1,273 0.8%	5/ 18,182 10.1%	-- -- --
Vegetation	-- -- --	-- -- --	-- -- --	-- -- --
Total Harvest (kilograms)	421,031	162,923	179,209	--
Per Capita Harvest (kilograms)	245	439	413	--

Source: Stoker, 1983, as cited by ACI/Braund, 1984.

1/ Results are expressed as number of animals harvested/usable weight(kg)/ percentage of average total community harvest (see bowhead whale for example).
2/ The actual per capita harvests may be somewhat higher because of incomplete data and underestimates of some harvests. See also footnotes to Tables III-17, III-18, and III-19.
3/ No data available for Point Lay or Atqasuk.
4/ Caribou-harvest statistics were available only for 1976, and harvest levels were not available for most other species. Consequently, the percentages of average total community harvest may not be representative of actual percentages.
5/ Data expressed only as usable weight (kg) rather than as number of animals harvested.

6/ Schliebe (1985).

Note: -- Denotes no data.

Table III-16
Primary Subsistence Resources Harvested for the Period 1962-1982
by Selected North Slope Communities[1]
(Percent of Average Total Community Harvest)

Barrow	Wainwright	Point Hope
Caribou 29.5%	Caribou 51.6%	Caribou 58.2%
Bowhead Whales 22.3%	Walruses 18.5%	Bowhead Whales 21.3%
Hair Seals 14.8%	Bearded Seals 2.3%	Fishes 6.6%
Fish 10.1%	Bowhead Whales 8.2%	Walruses 4.6%
Bearded Seals 8.9%	Hair Seals 4.4%	Hair Seals 4.3%
Beluga Whales 6.5%	Beluga Whales 2.7%	Bearded Seals 2.9%
Birds 3.2%	Other 2.3%	Other 2.1%
Walruses 2.9%		
Other 1.8%		

Source: Stoker, 1983, as cited by ACI/Braund, 1984.

1/ No data available for Point Lay, Atqasuk, or Nuiqsut.

location of the camps depends on ice conditions and currents. Strong currents and many leads near Point Barrow prohibit crews from camping near the point. Most whaling camps are located south of Barrow, as far south as Walakpa Bay.

The bowhead is hunted in two different areas, depending on the season. In the spring (from early April until the first week of June [Fig. III-28]), the bowheads are hunted from leads that open when the pack-ice conditions deteriorate. Bowhead whales are harvested along the coast from Point Barrow to the Skull Cliff area (Fig. III-22). The distance of the leads from shore varies from year to year. The leads generally are parallel and quite close to shore, but they occasionally break directly from Point Barrow to Point Franklin and force Barrow whalers to travel over the ice as much as 16 kilometers offshore to the open leads (see also Fig. III-16). The lead is normally open from Point Barrow to the coast, and the hunters are able to whale only 2 to 5 kilometers from shore. A stricken whale can be chased in either direction in the lead. Spring whaling in Barrow is conducted almost entirely with skin boats because the narrow leads prohibit the use of aluminum skiffs, which are more difficult to maneuver than the traditional boats (ACI/Courtnage/Braund, 1984). Fall whaling occurs outside of the Sale 109 area east of Point Barrow (Fig. III-22) from the Barrow vicinity in the Chukchi Sea to Cape Simpson in the Beaufort Sea. Hunters use aluminum skiffs with outboard motors to chase the whales during the fall migration, which takes place in open water up to 48 kilometers offshore.

No other marine mammal is harvested with the intensity and concentration of effort that is expended on the bowhead whale. Bowheads are very important in the subsistence economy, and they account for 21.3 percent (an average of 10.10 whales per year) of the annual subsistence harvest over the past 20 years (Table III-15). As with all species, the harvest of bowheads varies from year to year; over the past 20 years, the number taken each year has varied from zero to 23 (Table III-17).

In the memory of community residents, 1982 is the only year in which a bowhead whale was not harvested (1984).

(b) Beluga Whales: Beluga whales are available from the beginning of whaling season through June and occasionally in July and August (Fig. III-28) in ice-free waters. Barrow hunters do not like to hunt beluga whales during the bowhead hunt for fear of scaring the bowheads. The hunters harvest belugas after the spring bowhead season ends, which depends on when the bowhead quota is achieved. Belugas are harvested in the leads between Point Barrow and Skull Cliff (Fig. III-23). Later in summer, belugas are occasionally harvested on both sides of the barrier islands of Elson Lagoon. Because the lagoon has numerous passes, it is not possible to herd the belugas as is done in Point Lay (ACI/Courtnage/Braund, 1984). The annual average beluga harvest over 20 years is estimated at 5, or 0.5 percent of the total annual subsistence harvest (Table III-15).

(c) Caribou: Caribou, the primary source of meat for Barrow residents, are available throughout the year, with peak-harvest periods from February through early April and from late June through late October (Fig. III-28). (Specific harvest-area locations for caribou are shown in Fig. III-24A.) Residents harvest an annual average (over 20 years) of 3,500 caribou (Table III-15), which accounts for 58.2 percent of the total annual subsistence harvest.

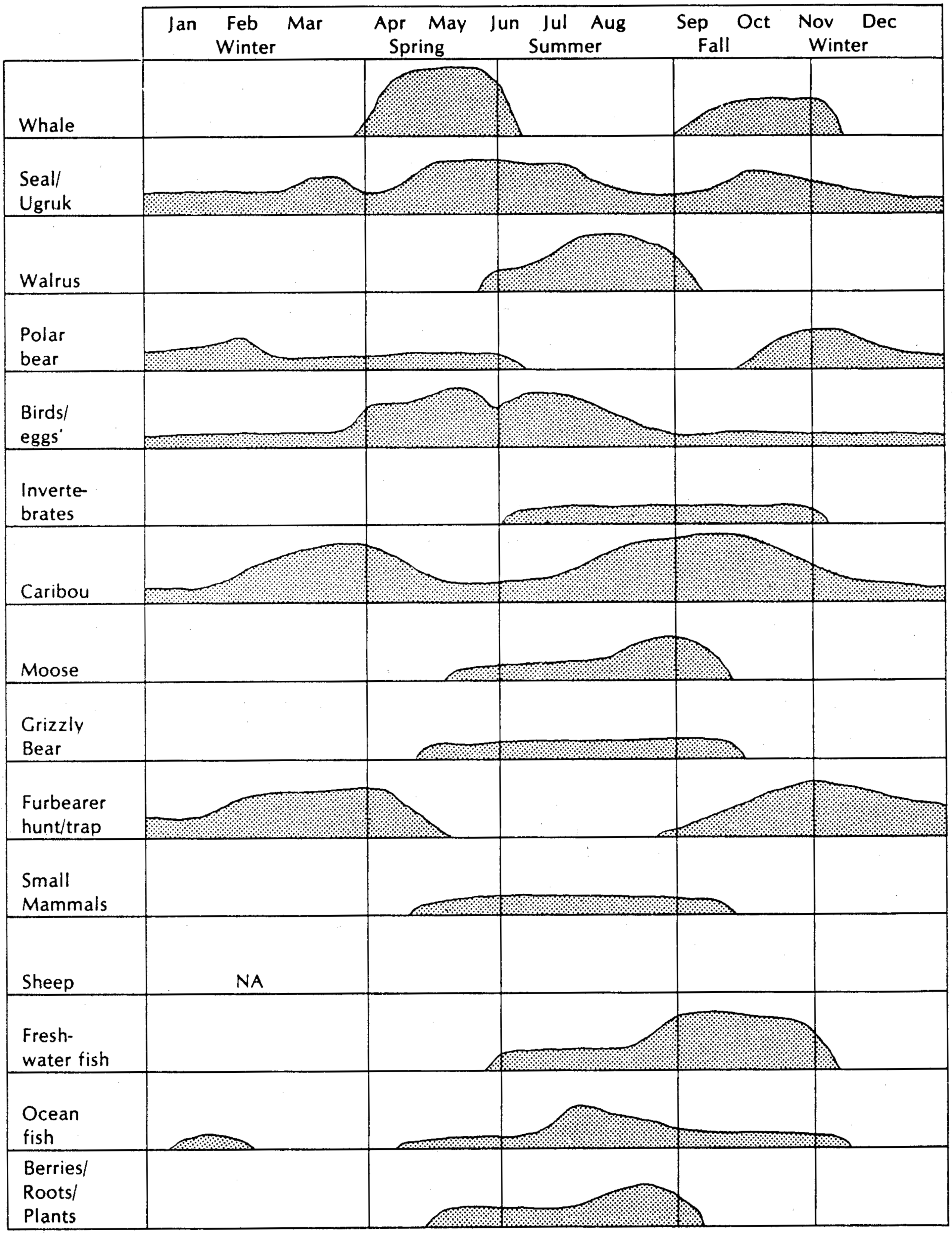


FIGURE III–28. BARROW ANNUAL SUBSISTENCE CYCLE [1/]   Source: North Slope Borough Contract Staff, 1979.

[1/] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods for pursuit of subsistence resources.

Table III-17
Annual Harvest of Subsistence Resources
for Which Sufficient Data Are Available for the Period 1962-1982
Barrow

Year	Bowhead Whales	Walruses	Hair Seals 1/	Polar Bears	Total Harvest 2/
1962	5	--	450	- 3/	366,046
1963	5	165	412	- 3/	403,824
1964	11	10	--	- 3/	413,291
1965	4	57	114	- 3/	351,462
1966	7	12	63	- 3/	361,443
1967	3	55	31	- 3/	390,284
1968	10	16	102	- 3/	433,996
1969	11	7	2,100	- 3/	478,896
1970	15	39	2,000	- 3/	461,496
1971	13	51	1,800	- 3/	547,421
1972	19	150	1,700	6	480,196
1973	17	20	1,500	5	405,196
1974	9	35	1,000	7	407,671
1975	10	15	1,000	10	565,496
1976	23	136	1,000	9	514,346
1977	20	62	1,000	15	348,741
1978	3	30	--	5	347,741
1979	3	30	--	1	411,891
1980	9	--	--	9 4/	365,766
1981	4	--	--	5 4/	412,131
1982	0	--	--	7 4/	--
Annual Average	10.1	55	955	7	424,716.7

Source: Stoker, 1983, as cited by ACI/Braund, 1984.

1/ Seal-harvest figures are estimates only and are probably on the low side.
2/ Estimated kilograms, includes all species.
3/ Data not available by community, only for the entire State (Schliebe, oral comm., 1987).
4/ Schliebe (1985, Tables 8, 9, and 10).

Note: -- Denotes no data available.

(d) Seals: Hair seals are available from October through June; however, because of the availability of bowheads, bearded seals, and caribou during various times of the year, seals are harvested primarily during the winter months, especially during February through March (Fig. III-28). Ringed seals are the most common hair seal species harvested. Spotted seals are harvested only in the ice-free summer months. Ringed seal hunting is concentrated in the Chukchi Sea, although some hunting occurs off Point Barrow and along the barrier islands that form Elson Lagoon (Fig. III-24B). During the winter, leads in the area immediately adjacent to Barrow and north toward the point make this area an advantageous spot for sealing. Spotted seals are also occasionally harvested off Point Barrow and the barrier islands of Elson Lagoon. Oarlock Island in Admiralty Bay is a favorite place for hunting spotted seals (ACI/Courtnage/Braund, 1984). In the past 20 years, hair seal harvests are estimated at between 31 and 2,100 seals a year (Table III-17). The average annual harvest over the past 20 years is estimated at 955 seals, or 4.3 percent of the total annual subsistence harvest (Table III-15).

The hunting of bearded seals is an important subsistence activity in Barrow because bearded seal is a preferred food, and its skin is used to cover the whaling boats--six to nine skins are needed to cover a boat. Bearded seals are harvested more than the smaller hair seals because of their larger size and use for skin boat covers. They are hunted from spring camps in the Chukchi Sea and from open water during concurrent pursuit of other marine mammals. The majority are harvested during the spring and summer months. Bearded seals occasionally are available in Dease Inlet and Admiralty Bay (Fig. III-24B) (ACI/Courtnage/Braund, 1984). No harvest data are available for the number of bearded seals harvested annually; however, the annual subsistence harvest averaged over 20 years was 150 seals, or about 2.9 percent of the total annual subsistence harvest (Table III-15).

(e) Fishes: Barrow residents harvest marine and riverine fishes, but their dependency on fish varies according to the availability of other resources. Capelin, char, cod, grayling, salmon, sculpin, trout, and whitefish are harvested (ACI/Courtnage/Braund, 1984). Fishing occurs primarily in the summer and fall months and peaks in September and October (Fig. III-28). Fishing also occurs concurrently with caribou hunting in the fall. From December through March, communities fish for tomcod through the ice.

The subsistence-harvest area for fish is extensive, primarily because Barrow residents supplement their camp food with fish whenever they are hunting. From Peard Bay west of Barrow to east of Pitt Point on the Beaufort Sea coast, marine fishing occurs in the summer in conjunction with the pursuit of other subsistence resources (Fig. III-26). Most fishing occurs closer to Barrow in three areas: (1) along the Chukchi Sea coastline from Point Barrow to Walikpa Bay, (2) inside Elson Lagoon near Barrow, and (3) along the barrier islands of Elson Lagoon (Craig, 1987). From Barrow to Peard Bay, fishing occurs primarily during the spring and summer hunts for waterfowl and marine mammals. Intensive marine fishing takes place in the area of the Chukchi Sea just west of the point immediately adjacent to Barrow. In Elson Lagoon and along the Beaufort Sea coast and in Dease Inlet and Admiralty Bay, fishing occurs during the summer and fall from caribou hunting camps, fall-whaling stations, and other camps. Marine fishing is conducted with gill nets and by jigging. Species harvested include whitefishes, least cisco, grayling, and a few burbot and salmon (Craig, 1987).

Fish camps have been established at traditional family sites along the coast. These camps are generally on points of land, at the mouths of rivers, and at other strategic locations. While coastal fishing can be an important source of fish, most of the fishing occurs at inland fish camps, particularly in lakes and rivers that flow into the southern end of Dease Inlet (Craig, 1987). Inland fish camps are found in the Inaru, Meade, Topogoruk, and Chipp River drainages. These camps provide good fishing opportunities as well as access to inland caribou and birds (ACI/Courtnage/Braund, 1984). During 1969-1973, the average annual harvest or fish was about 37,727 kilograms (Craig, 1987); in the past 20 years, the estimated annual average was 27,955 kilograms, which accounts for 6.6 percent of the total annual subsistence harvest (Table III-15). In a 1986 partial estimate of fish harvests for the Barrow fall fishery in the Inaru River, the catch composition was least cisco (45%), broad whitefish (36%), humpback whitefish (16%), arctic cisco (1%), fourhorn sculpin (1%), and burbot (0.5%) (Craig, 1987).

(f) Walruses: Walruses are harvested during the spring marine mammal hunt west of Point Barrow and southwest to Peard Bay (Fig. III-25). Most hunters will travel no more than 24 to 32 kilometers to hunt walruses. The major walrus-hunting effort occurs from late June through mid-September, with the peak season in August (Fig. III-28). The annual average harvest from 1970 through 1979 is estimated at 57 (Table III-17). The annual average harvest over 20 years is estimated at 55 walruses, or 4.6 percent of the total annual subsistence harvest (Table III-15).

(g) Migratory Birds: Migratory birds, particularly eider ducks and geese, provide an important food source for Barrow residents--not because of the quantity of meat harvested or the time spent hunting them, but because of their dietary importance during spring and summer. Geese are harvested more often inland along rivers, while most eider and other ducks are harvested along the coast. Once harvested extensively, snowy owls are no longer taken regularly. Eggs are still gathered occasionally, especially on the offshore islands where foxes and other predators are less common. Waterfowl--hunted during the whaling season (beginning in late April or early May) as they fly along the open leads--provide a fresh-meat source for whaling camps. Later n the spring, Barrow residents harvest many geese and ducks, with a peak in May and early June continuing until the end of June (Fig. III-28). Birds may be harvested throughout the summer, but only incidentally to other subsistence activities. In late August and early September, with a peak in the first 2 weeks of September, ducks and geese migrate south and are again hunted by Barrow residents. Birds, primarily eiders and other ducks, are hunted along the coast from Point Franklin to Admiralty Bay and Dease Inlet. Concentrated hunting areas are located along the shores of the major barrier islands of Elson Lagoon.

After spring whaling, geese are hunted inland (Fig. III-27). A favorite spot for hunting birds is the "shooting station" at the narrowest point of the barrier spit that forms Point Barrow and separates the Chukchi Sea from Elson Lagoon. This area, a highly successful hunting spot during the spring and fall bird migrations, is easily accessible to Barrow residents (ACI/Courtnage/Braund, 1984). Barrow residents harvested an estimated annual average (over 20 years) of 3,636 kilograms of birds, which accounts for about 0.9 percent of the total annual subsistence harvest (Table III-15).

(h) Polar Bears: Barrow residents hunt polar bears from October to June (Fig. III-28). The locations of harvest areas are unavailable at this time. Polar bears comprise a small portion of the Barrow subsistence harvest, with an annual average of 7 bears harvested from 1971 to 1981 (Table III-17), or only 0.4 percent of the annual subsistence harvest (Table III-15).

(2) Wainwright: Wainwright residents (population 507 in 1985) enjoy a diverse resource base that includes both terrestrial and marine resources. Wainwright is located on the Chukchi Sea coast about 160 kilometers southwest of Barrow. Marine-subsistence activities are focused on the coastal waters from Icy Cape in the southern range to Point Franklin and Peard Bay in the northern. The Kuk River lagoon system--a major marine estuary--is an important marine and wildlife habitat used by local hunters. Wainwright is not situated on a geographic point, as are Point Hope and Barrow, but rather on a long bight that affects sea-ice conditions as well as marine-resource concentrations.

(a) Bowhead Whales: Bowhead whales are Wainwright's most important marine resource. Beginning in late April, bowhead whales are available in the Wainwright area (Fig. III-22). Wainwright is not as ideally situated for bowhead whaling as are Point Hope and Barrow. Ice leads often break far from shore and are often wider than those near Barrow or Point Hope, and multiple leads are common. Skin boats are used early in the season, when the leads are narrower (ACI/Courtnage/Braund, 1984). Because of the wider leads that occur later in the season, Wainwright whalers are likely to use aluminum boats to pursue bowheads farther offshore. There are approximately eight whaling camps along the edge of the landfast ice (ACI/Braund, 1984). In some years, these camps are 16 to 24 kilometers offshore. The bowhead whale-harvest area delineated in Figure III-22 indicates the harvest-concentration areas over the past few years. The harvest areas vary from year to year, depending on where the open leads form; and the distance of the leads from shore varies from year to year (ACI/Courtnage/Braund, 1984). The bowhead accounts for 8.2 percent of the total annual subsistence harvest (an average of 1.5 whales taken each year over the past 20 years) (Table III-15). The annual bowhead harvest has not varied as much as the harvest of other subsistence resources; over the past 20 years, the number taken has varied only from zero to three (Table III-18).

(b) Beluga Whales: Beluga whales are available to Wainwright hunters during the spring-bowhead-whaling season (late April to early June); however, pursuing belugas during this time jeopardizes the bowhead whale hunt and therefore occurs only if no bowheads are in the area. Belugas are also available later in the summer (July through late August) along the coast in the lagoon systems (Figs. III-23 and III-29). The reluctance of Wainwright residents to harvest belugas during the bowhead whaling season means that they must rely on the unpredictable summer harvest for the major volume of this resource. Consequently, the relative importance of the beluga whale varies from year to year (Nelson, 1981; ACI/Courtnage/Braund, 1984). The annual average harvest of belugas (over 20 years) is estimated at 11, or 2.7 percent of the total annual subsistence harvest (Table III-15).

(c) Caribou: Caribou are the primary source of meat for Wainwright residents. Prior to freezeup, caribou hunting is conducted along the inland waterways, particularly along the Kuk River system. During the winter months,

Table III-18
Annual Harvest of Subsistence Resources
for Which Sufficient Data Are Available for the Period 1962-1982
Wainwright

Year	Bowhead Whales	Walruses	Hair Seals 1/	Polar Bears	Total Harvest 2/
1962	1	--	328	- 3/	157,580
1963	2	132	573	- 3/	187,130
1964	1	225	--	- 3/	207,018
1965	0	194	345	- 3/	186,698
1966	1	140	69	- 3/	171,454
1967	0	47	277	- 3/	133,956
1968	2	85	40	- 3/	160,553
1969	3	92	450	- 3/	179,693
1970	0	89	480	- 3/	152,513
1971	2	23	250	- 3/	142,843
1972	2	56	1,600	3	179,143
1973	3	31	250+	4	153,968+
1974	1	38	250+	5	138,843+
1975	0	65	250+	4	139,168+
1976	3	257	250+	10	234,318+
1977	2	24	250+	9	143,643+
1978	2	20	--	7	144,265+
1979	1	36	--	0	139,293
1980	1	--	--	9 4/	158,923
1981	3	--	--	10 4/	177,623
1982	2	--	--	17 4/	167,373
Annual Average	1.5	86	375	7	164,571.33

Source: Stoker, 1983, as cited by ACI/Braund, 1984.

1/ Seal-harvest figures are estimates only and are probably on the low side.
2/ Estimated kilograms, includes all species.
3/ Data not available by community, only for the entire State (Schliebe, oral comm., 1987).
4/ Schliebe (1985, Tables 8, 9, and 10).

Note: -- Denotes no data available.

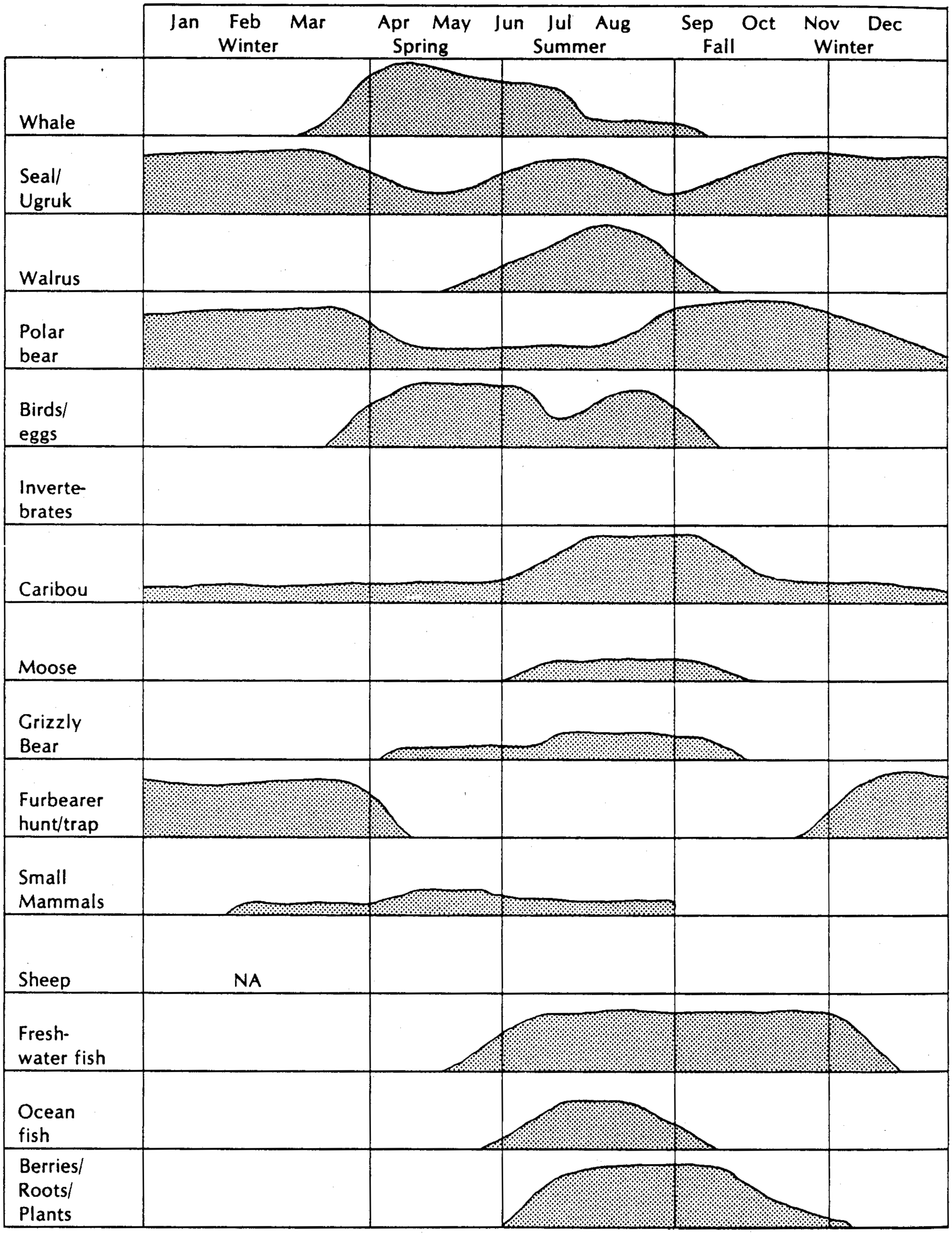


FIGURE III-29. WAINWRIGHT ANNUAL SUBSISTENCE CYCLE[1/] Source: North Slope Borough Contract Staff, 1979.

[1/] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods for pursuit of subsistence resources.

most of the herd moves inland into the Brooks Range and then south of the North Slope; but some caribou remain near the coast. During the spring, the herd returns and concentrates near the Utukok and Colville River headwaters. In June, the herd follows major stream and river drainages toward the coast (Nelson, 1981). Wainwright's caribou harvest area is shown in Figure III-24B. An annual average (over 20 years) of 1,200 caribou is harvested (Table III-15), for 51.6 percent of the total annual subsistence harvest. Caribou are available throughout the year, with a peak harvest period from August to October (Fig. III-29).

(d) Walruses: Walruses are present only seasonally in Wainwright, with the exception of a few that overwinter in the area. The peak hunting period occurs from July to August (Fig. III-29) as the southern edge of the pack ice retreats. In late August and early September, Wainwright hunters occasionally harvest walruses that are hauled out on beaches. The focal area for hunting walruses is from Milliktagvik north to Point Franklin, although hunters prefer to harvest them south of the communities (Fig. III-25) so that the northward-moving pack ice can carry the hunters back toward home while they butcher their catch on the ice. This northward-moving current also helps the hunters return home in their heavily loaded boats (Nelson, 1981). The estimated annual harvest ranges from 20 to 257 animals (Table III-18). The annual average (over 20 years) is estimated at 86 walruses, or 18.5 percent of the total annual subsistence harvest (Table III-15).

(e) Seals: Wainwright residents hunt four seal species--ringed, spotted, ribbon (all hair seals), and bearded seals. Ringed seals (the most common species) are generally available throughout the ice-locked months. Bearded seals are available during the same period, but they are not as plentiful. Although they are harvested less frequently, spotted seals are common in the coastal lagoons during the summer; most are taken in Kuk Lagoon. Ribbon seals occasionally are available during the spring and summer months. Ringed and bearded seals are harvested most intensely from May through July (ACI/Courtnage/Braund, 1984). Most ringed seals are harvested along the coast from Milliktagvik to Point Franklin, with concentration areas along the shore from Kuk Inlet southward to Milliktagvik and from Nunagiaq to Point Franklin. Migrating seals are most concentrated at Qipuqlaich, just south of Kuk Inlet (Fig. III-24B) (Nelson, 1981). The harvest of bearded seals is an important subsistence activity in Wainwright because it is a preferred food and the skins are used as covers for the whaling boats (ACI/Courtnage/Braund, 1984). The best harvest areas for bearded seal are on the flat ice south of Wainwright, off Qilamittagvik and Milliktagvik and beyond towards Icy Cape (Fig. III-24B) (Nelson, 1981). Although no annual harvest data are available for bearded seals, the annual average subsistence harvest (over 20 years) is estimated at 250 seals, or about 12.3 percent of the total annual subsistence harvest (Table III-15). One hair seal harvest during the past 20 years is estimated at between 250 and 1,600 seals. In recent years, approximately 250 hair seals have been harvested each year (Table III-18). The average annual harvest (over 20 years) is estimated at 375, or 4.4 percent of the total annual subsistence harvest (Table III-15).

(f) Fishes: Wainwright residents harvest a variety of fishes in most marine and freshwater habitats along the coast and in lagoons, estuaries, and rivers. The most important local fish harvest occurs from September through November (Fig. III-29) in the freshwater areas of the Kuk, Kugrua, Utukok, and other river drainages (Craig, 1987) (Fig. III-26). Ice fishing for smelt and tomcod (saffron cod) occurs near the community primarily during January, February, and March. In the summer months, Wainwright residents harvest arctic char, chum and pink salmon, Bering cisco (whitefish), and sculpin along the coast and along the lower portions of Kuk Lagoon (Nelson, 1981; ACI/Courtnage/Braund, 1984). The most common species harvested in the Kuk River system are Bering and least ciscoes, grayling, ling cod, burbot, and rainbow smelt. Other species harvested less frequently along the coast--in some cases, in estuaries or freshwater--include rainbow smelt, flounder, cisco, saffron cod, arctic cod, trout, capelin, and grayling (Nelson, 1981, Craig, 1987). Marine fishing is conducted from Peard Bay to Icy Cape and in Kuk Lagoon.

During the period 1969 to 1973 (the only available harvest data), the annual fish harvest was about 1,727 kilograms. The annual per capita fish catch was 4 kilograms. (The ADF&G cautions that this data was not systematically collected or verified [Craig, 1987]). Stoker (1983, as cited by ACI/Braund, 1984) uses this data and lists fish as a minor resource in the total harvest of Wainwright subsistence resources (approximately 0.8% of the annual harvest averaged over 20 years [Table III-15]); fish were the third-largest source of subsistence foods (Table III-12) and the third-most-important species harvested (Table III-11) in Wainwright in 1981. This difference can be attributed to the increase in the importance of fish as a subsistence resource because of the introduction of snow machines and motorized skiffs that have made distant fish camps more accessible, and to a value change that has stimulated the residents' interest in fishing and camping away from the community (Nelson, 1981). The fish harvest plays an important role in strengthening kinship ties in the community (Nelson, 1981; ACI/Courtnage/Braund, 1984). In addition, fish are a crucial resource when other resources are less abundant or unavailable; over time, fish are a more reliable and more stable resource (Nelson, 1981).

(g) Migratory Birds: The migration of ducks, murres, geese, and cranes begins in May and continues through June. The harvest of waterfowl is initiated in May at whaling camps and continues through June (Fig. III-29). Hunting decreases as the bird populations disperse to their summer ranges. During the fall migration southward, the range is dispersed over a wide area (Fig. III-27); and hunting success is limited except at Icy Cape (ACI/Courtnage/Braund, 1984). Wainwright residents annually harvest an estimated 545 kilograms of birds (averaged over 20 years), or about only 0.3 percent of the total annual subsistence harvest (Table III-15). Although the volume of waterfowl meat is a relatively small portion of the total subsistence harvest, waterfowl hunting is a key element in Wainwright's subsistence routine. Like fishing, bird hunting is highly valued in social and cultural terms (see the Sale 97 FEIS, Sec. III.C.3 [USDOI, MMS, 1987a]). Waterfowl dishes are an essential part of community feasts prepared for holidays like Thanksgiving and Christmas (Nelson, 1981).

(h) Polar Bears: Polar bears are generally harvested along the coastal area in the Wainwright region, around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island (Nelson, 1981). Wainwright residents hunt polar bears primarily in the fall and winter, less frequently in the spring, and rarely during the summer (Fig. III-29). Polar bears comprise a small portion of the Wainwright subsistence harvest, with an annual average (over 20 years) of 7 harvested, or only 1.0 percent of the annual subsistence harvest (Table III-15). Since 1972, the prohibition of the commercial sale of polar bear hides has diminished the intensity of the harvest. Even so, the pursuit of polar bears continues to be an important manifestation of Inupiat traditional skills and an expression of manhood in a society that places an extremely high value on hunting as a way of life (Nelson, 1981).

(3) Point Lay: The environmental setting of Point Lay (population 129 in 1985 [ACI/Courtnage/Braund, 1984]) and the local land use patterns are different from those of the other coastal communities in the Sale 109 area. Point Lay is located on a point near the Kokolik River Delta that is not as prominent as the spit formations at Barrow or Point Hope. Point Lay's location consequently is not suitable for bowhead whaling. Although bowhead whaling occurred in the past, the most recent bowhead harvests occurred in the 1930's near Icy Cape and the old (Point Lay) community site. A few Point Lay residents participate in Barrow's and Wainwright's bowhead whale hunts. No harvest data are available for Point Lay to the extent found for other communities in the Sale 109 area; however, available data are reported here and cited where appropriate.

(a) Beluga Whales: Beluga whales are the most important marine resource harvested by Point Lay residents at this time. For the past several years this species has provided a greater quantity of food than any other marine resource; in 1982, Point Lay hunters harvested 28 belugas. Local hunters actively harvest beluga whales during the first 2 weeks of July (Fig. III-30), when the hunt is concentrated in Naokok and Kukpowruk Passes, south of Point Lay (Fig. III-23). The hunters use as many boats as possible to herd the belugas into Kasegaluk Lagoon, where the whales are herded into shallow water and shot. If the hunt is unsuccessful in the passes, Point Lay hunters travel north to Akunik Pass and other passes in search of whales. Prior to July, hunters may occasionally try to harvest belugas south of the community, traveling by snow machine south along the coast toward Cape Beaufort, where the ice breaks early in the season. When the season is poor, hunters continue to search for whales into early August and, in rare cases, may travel as far north as Icy Cape. The beluga whale hunt is the only Point Lay subsistence activity that is a communal effort. Although the beluga hunt does not compare in cultural significance with the bowhead whale hunt in some other communities in the sale area, it is an important cultural and community unifier that involves all members of the community and, as with other subsistence foods, the meat is shared with friends and relatives (see the Sale 97 FEIS, Sec. III.C.3 [USDOI, MMS, 1987a]).

(b) Caribou: Caribou are the primary source of meat for Point Lay residents. (Point Lay's caribou harvest area is shown in Fig. III-24A.) Although caribou are available throughout the year, primary harvest times occur from February through April and from June through October, with the peak harvest from late August through October (Fig. III-30).

(c) Seals: Point Lay residents hunt two species of hair seal--ringed and spotted seals. Although ringed seals are available throughout most of the year, they are difficult to locate only in the ice-free months when the pack ice is farther offshore (July and August). The peak of the ringed seal harvest occurs from April through June (Fig. III-30). The first ringed seals harvested in April are taken near Cape Beaufort (Fig. III-24B). Ringed seals are sometimes taken incidentally to walrus and bearded seal harvests in June and July. As spring progresses, ringed seals are harvested near the community. Spotted seals are hunted in Kasegaluk Lagoon during the summer months. These hair seals have desirable pelts and can be hunted in open water during the late summer because they are fat and buoyant when killed (ACI/ Courtnage/ Braund, 1984).

Bearded seals do not have the same importance to Point Lay residents as to other communities in the sale area because the residents do not hunt the bowhead whale and, therefore, do not use boats covered with bearded seal skin. The majority of bearded seals are harvested in June and sometimes as late as August if the hunters follow the ice north. Bearded seal hunting usually takes place 8 to 10 kilometers offshore, but hunters may go farther out as they look for walruses. All seals--except the spotted seal--leave when the ice disappears, although seals are occasionally seen in Kasegaluk Lagoon. Point Lay hunters annually harvest from 2 to 10 bearded seals for the entire community, while they harvest an annual average of 3 to 4 ringed seals for each family (ACI/Courtnage/Braund, 1984).

(d) Walruses: Although the community's walrus-hunting range is greater than that of any other marine mammal, the importance of walruses in Point Lay has declined in recent years. Traditionally a primary source of dog food, the walrus is now only occasionally harvested for human consumption. During favorable ice conditions, Point Lay hunters harvest as many as 10 to 15 walruses; but no walruses can be harvested when ice conditions restrict offshore access. Point Lay residents hunt walruses along the length of Kasegaluk Lagoon, south of Icy Cape, and as far as 32 kilometers offshore (Fig. III-25). Because navigation in broken and moving ice is dangerous, the hunters prefer to hunt for walruses between 16 and 32 kilometers directly offshore of the community. Walruses are generally hunted from the end of June through the month of July (Fig. III-30). If the hunters travel north to Icy Cape, walruses can be hunted into August. One reason for the decline of the walrus hunt is that the peak harvest time coincides with the annual pursuit of beluga whales--a preferred species to eat as well as a safer and more efficient species to hunt (ACI/Courtnage/Braund, 1984).

(e) Fishes: Because fish are abundant and fishing is not a labor-intensive activity, this resource plays an important role in the subsistence economy of Point Lay (ACI/Courtnage/Braund, 1984). Point lay residents harvest a variety of fishes in most marine and riverine habitats along the coast from Icy Cape to the southern edge of Kasegaluk Lagoon and in inland waters including the Utukok, Kokolik, and Kukpowruk Rivers (Craig, 1987). From July through October, Point Lay residents harvest arctic char, Pacific herring, whitefish, flounder, and grayling (Fig. III-30). Marine fishes are pursued with set-gill-nets along the barrier islands and mainland coast, including a portion of Kasegaluk Lagoon south of Icy Cape and a small portion of the Chukchi Sea near the southern end of Kasegaluk Lagoon and occasionally at Sitkok Point (Fig. III-26). Set-netting occurs primarily along Naokok Pass, on both sides of the barrier island where the old Point Lay site is located, and along the shores of the mainland near the present community site. Although fishing is excellent around Icy Cape, Point Lay residents rarely travel that far north because fishing nearer the community is generally quite successful. Most fishing occurs within several miles of the community (Craig, 1987). Younger residents now fish with rod and reel for salmon several kilometers offshore of the southern end of Kasegaluk Lagoon. The proximity of good fishing to the

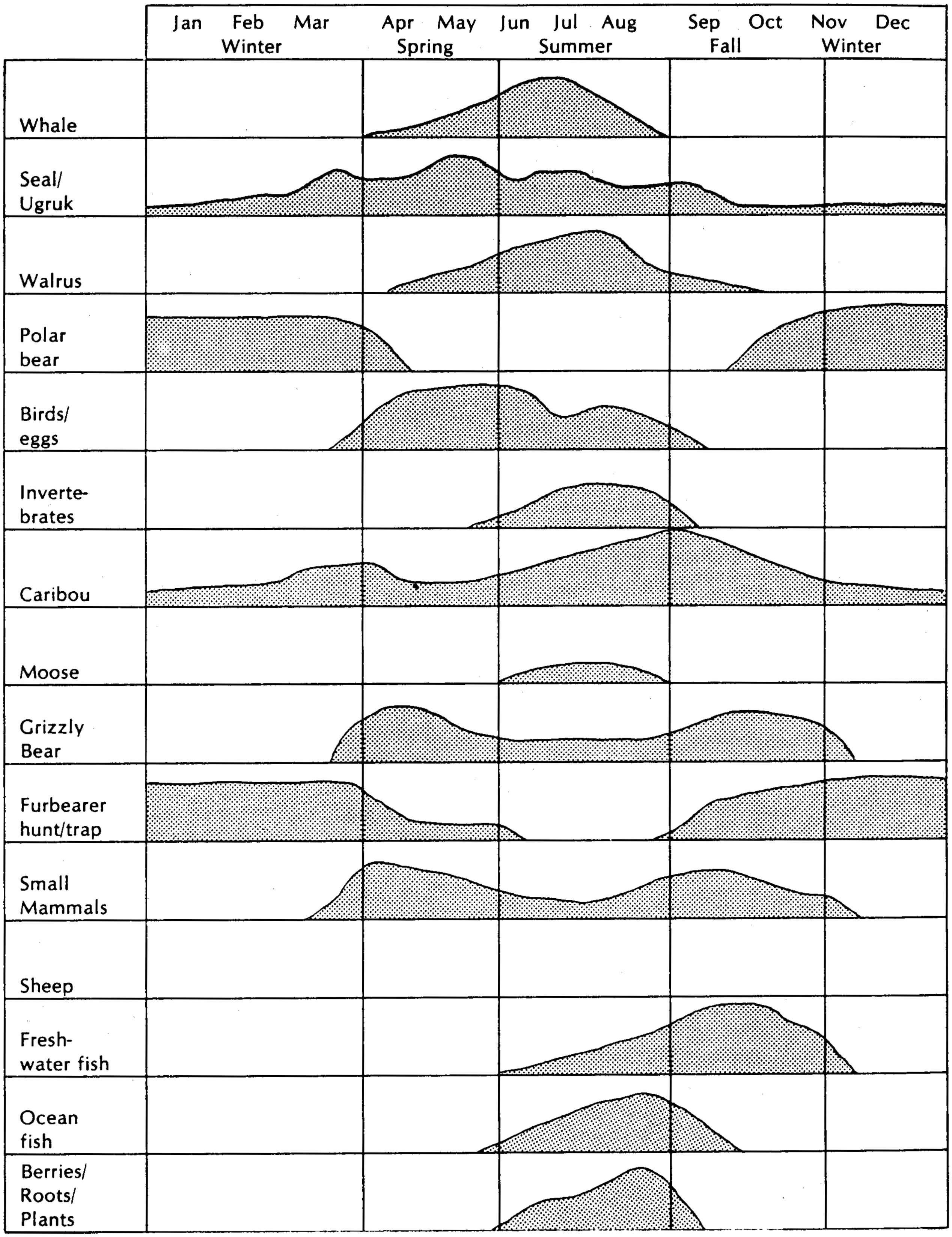


FIGURE III–30. POINT LAY ANNUAL SUBSISTENCE CYCLE [1/] Source: North Slope Borough Contract Staff, 1979.

[1/] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods for pursuit of subsistence resources.

community allows employed residents to check their nets daily after work, thus minimizing any conflicts between subsistence activities and wage employment. August is the peak month for marine fishing. Fishing--primarily for grayling--also occurs along the Kukpowruk and Utukok Rivers during September and October.

Harvest figures are available only for the summer and fall fisheries of 1983. The summer fishery (65 kg of mostly pink salmon) and the fall fishery (114-136 kg of mostly grayling) yielded a total catch of about 182 to 205 kilograms, for an annual per capita catch of 1.4 to 1.9 kilograms. Residents thought the catch was low that year, probably since pink salmon are less abundant in odd-numbered years (Craig, 1987).

(f) Migratory Birds: Waterfowl and other migratory birds provide a source of food for Point Lay residents in early spring, when fresh meat can be scarce. Eiders and other ducks, brant, geese, and loons are harvested primarily in the spring (Fig. III-30). The harvest range for birds is as large as for other marine resources because birds are harvested concurrently (Fig. III-27). For example, waterfowl are hunted from the edges of ice leads during May, when Point Lay residents are hunting bearded and other seals (ACI/Courtnage/Braund, 1984).

(g) Polar Bears: Point Lay residents occasionally hunt polar bears along the coast from late September to April (Fig. III-30). Although polar bears were more available in past years, few were seen in 1983. Local hunters rarely travel more than 3 kilometers offshore in pursuit of polar bears (ACI/Courtnage/Braund, 1984).

(4) Point Hope: Point Hope residents (population 570 in 1985) enjoy a diverse resource base that includes both terrestrial and marine animals. The location of the community--on a cuspate spit that juts out into the Chukchi Sea--offers superb opportunities for hunting a diversity of marine mammals.

(a) Bowhead Whales: Beginning in late March or early April, bowhead whales are available in the Point Hope area (see Figs. III-22 and III-31). Point Hope's strategic location close to the pack-ice lead makes it uniquely situated for hunting bowhead whales. Approximately 15 to 18 whaling camps are located along the edge of the landfast ice. The actual harvest area varies from year to year, depending on where the open leads form. Camps as far south as Cape Thompson have been reported, but in recent years the camps tended to be closer to the community. In the recent past, the camps were situated south and southeast of the point. The intensive-use area delineated in Figure III-22 indicates the harvest-concentration areas over the past few years. The distance of the lead from shore varies from year to year. The lead is rarely more than 10 to 11 kilometers offshore, but hunters have had to travel away from the community as far as 16 kilometers over the ice to find the necessary open water for spring whaling (ACI/Braund, 1984).

Point Hope generally has open water for the majority of the whaling season; but sometimes two narrow leads develop, which presents a problem for Point Hope hunters because the whales may travel in the lead that is farther from shore and thereby become inaccessible to the whalers. The duration of the whaling season is limited by the IWC's quota. Despite the limited nature of

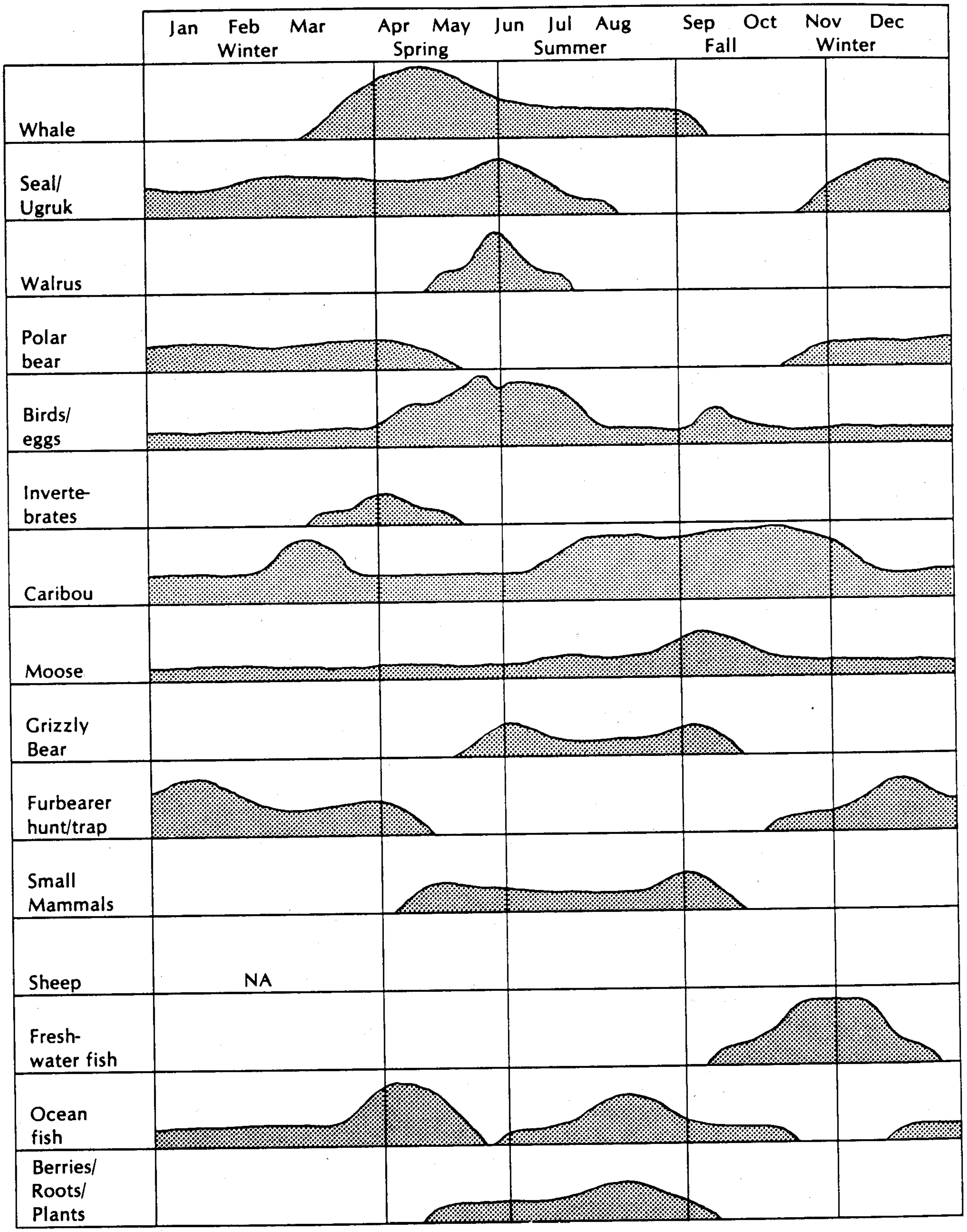


FIGURE III–31. POINT HOPE ANNUAL SUBSISTENCE CYCLE [1/]

Source: North Slope Borough Contract Staff, 1979.

[1/] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods for pursuit of subsistence resources.

both the whaling season and the harvest area, no other marine mammal is harvested with the intensity and concentration of effort that is focused on the bowhead whale. The most important resource in Point Hope's subsistence economy, the bowhead whale accounts for 22.3 percent of the subsistence harvest (an annual average of 4.5 whales per year) over the past 20 years (Table III-15). The harvest periods of all resources vary from year to year, and the bowhead season is no exception. In the past 20 years, the total annual number of bowheads landed has varied from zero to 14 (Table III-19). In the memory of community residents, 1980 was the only year in which a bowhead whale was not harvested (ACI/Braund, 1984).

(b) Beluga Whales: Point Hope hunters actively harvest beluga whales during the offshore spring-bowhead-whaling season (late March-early June) and along the coast later in summer (July-late August/early September) (Figs. III-23 and III-31). The first--and larger--harvest of belugas occurs coincidentally with the spring-bowhead-whale harvest. Hunters often use the beluga as an indicator for the bowhead. The number of belugas harvested varies (Table III-19); according to Lowenstein (1981), each whaling crew harvests at least one beluga--and usually more--during the whaling season. The average annual beluga harvest (over 20 years) is estimated at 29, or 6.5 percent of the total annual subsistence harvest (Table III-15). Beluga whales are harvested intensively at distances as far south as Cape Thompson (Fig. III-23). The hunters go far offshore only during spring whaling. Although not as common, belugas are also harvested in open water throughout the summer. During the summer season, hunters pursue belugas primarily near the southern shore of Point Hope in the southern Chukchi Sea, in close proximity to the beach, as well as in coastal areas on the northern shore as far north as Cape Dyer. Because belugas feed on the anadromous fishes of the Kukpuk River, hunters are particularly successful near Sinuk. Although belugas are available in May and June, Point Hope residents generally do not pursue them because of deteriorating ice conditions along the landfast-ice margins and the greater availability of bearded seals and walruses at this time.

(c) Caribou: Caribou are the primary source of meat for Point Hope residents. (Point Hope's caribou harvest area is shown in Fig. III-24A). An annual average of 756 caribou is harvested (Table III-15), which accounts for 29.5 percent of the total annual subsistence harvest. Although caribou are available throughout the year, peak harvest times occur from February to March and from late June through mid-November (Fig. III-31).

(d) Fishes: Point Hope residents harvest a variety of fishes during the entire year (Fig. III-31). As the shorefast ice breaks free in mid- to late June, residents use set-nets and beach seines to catch arctic char and pink, coho, and chum salmon. Fishing occurs from coastal fish camps (often converted from spring camps for hunting bearded seal and walrus) located along the shore from Cape Thompson north to Kilkralik Point (Fig. III-26). Some fishing may occur outside this area, but only in conjunction with other activities such as egg gathering or caribou hunting. The summer-fishing season extends from mid- to late June through the end of August, with July the peak month. Other fishes harvested by Point Hope residents include whitefish, grayling, tomcod, and occasionally flounder. In the fall, residents harvest grayling and whitefish on the Kukpuk River during the October upriver-fishing period. From December through February, residents fish for tomcod through the ice near the point (ACI/Courtnage/Braund, 1984). The numbers of fish harvested are not available; however, an estimated annual average (over 20 years) of 18,182 kilograms is harvested, which accounts for 10.1 percent of the total subsistence harvest (Table III-15).

(e) Seals: Hair seals are available to Point Hope residents from October through June; however, because of the availability of bowheads, bearded seals, and caribou during various times of the year, seals are harvested primarily during the winter months, from November through March (Fig. III-31). The ringed seal is the most common hair seal species harvested, and the month of February is the most concentrated harvest period for this species. Hair seals are hunted as far south as south of Cape Thompson and as far north as Ayugatak Lagoon, east of Cape Lisburne (Fig. III-24B). The area south of Point Hope is safer and more advantageous for hunting seals. In good-weather conditions, it is safe for a hunter to travel 16 to 24 kilometers offshore of the southern side of the point; however, it is more common for residents to hunt seals closer to shore. The area north of the point is more dangerous for seal hunting because of the poor ice conditions. Seal hunting in this area occurs closer to shore and is most successful at Sinuk, near the mouth of the Kukpuk River, and at the numerous small points between Point Hope and Cape Lisburne where open water is found (i.e., Kilkralik Point and Cape Dyer). South of the point, ringed seal hunting is generally concentrated within 8 kilometers of shore on the ice pack between Point Hope and Akoviknak Lagoon. Some hair seal hunting takes place directly off the point when the ice first forms in October and early November (ACI/Courtnage/Braund, 1984). Over the past 20 years, hair seal harvests have been estimated at between 250 and 2,752 seals a year; in recent years, approximately 700 a year have been harvested (Table III-19). Over the past 20 years, the average annual harvest is estimated at 1,400 seals, or 14.8 percent of the total annual subsistence harvest (Table III-15).

Hunting of the bearded seal is an important subsistence activity in Point Hope--the meat is a preferred food and the skin is used to cover the whaling boats. The majority of bearded seals are harvested during May and June, sometimes as late as mid-July, as the landfast ice breaks up into floes. More bearded seals than the smaller hair seals are harvested because of the former's larger size and use for skin-boat covers. Since the rifle was introduced, hunters have pursued seals with rifles and--in recent years--large aluminum boats with outboard motors. Larger engines allow the hunters to travel over larger areas in the same or less time than in the past. Bearded seals--like hair seals--are hunted from Cape Thompson to Ayugatak Lagoon (ACI/Courtnage/Braund, 1984). No annual harvest data are available for bearded seals; however, the average annual harvest (over 20 years) was 200 a year, or about 8.9 percent of the total annual subsistence harvest (Table III-15).

(f) Migratory Birds: Throughout the year, waterfowl and other migratory birds also provide a source of food for Point Hope residents. Eiders and other ducks, murres, brant, geese, and snowy owls are harvested at various times of the year (Fig. III-31). Eiders are hunted and harvested as they fly along the open leads during the whaling season, thereby providing a fresh-meat source for the whaling camps. Murre eggs are harvested from the cliffs at Capes Thompson and Lisburne. Later in the spring, Point Hope residents harvest eiders, geese, brant, and other migratory waterfowl along both the northern and southern shores of the point and in the numerous lakes and lagoons (Fig. III-27). Geese are harvested from mid-May until mid-June, while

Table III-19
Annual Harvest of Subsistence Resources
for Which Sufficient Data Are Available for the Period 1962-1982
Point Hope

Year	Bowhead Whales	Beluga Whales	Walruses	Hair Seals 1/	Polar Bears	Total Harvest 2/
1962	6	--	--	2,000	- 3/	204,184
1963	3	--	10	2,752	- 3/	190,022
1964	1	--	10	--	- 3/	146,534
1965	2	--	6	2,016	- 3/	165,738
1966	5	--	16	2,571	- 3/	206,483
1967	1	--	3	980	- 3/	136,104
1968	3	--	21	264	- 3/	146,600
1969	3	--	5	2,300	- 3/	179,684
1970	8	--	6	1,900	- 3/	216,934
1971	6	--	35	1,800	- 3/	207,384
1972	14	10	45	250+	5	234,910+
1973	7	55	13	700+	3	196,509+
1974	6	35	69	727	14	202,197
1975	4	35	10	700+	27	166,159+
1976	12	35	4	700+	16	232,784+
1977	2	53	9	700+	11	151,609+
1978	1	16	1	--	7	137,509
1979	3	11	5	--	1	153,359
1980	0	--	--	--	10 4/	139,384
1981	4	--	--	--	6 4/	174,084
1982	1	--	--	--	5 4/	148,284
Annual Average	4.5	29	15	1,400	9	177,926.43

Source: Stoker, 1983, as cited by ACI/Braund, 1984.

1/ Seal-harvest figures are estimates only and are probably on the low side.
2/ Estimated kilograms, all species included.
3/ Data not available by community, only for the entire State (Schliebe, oral comm., 1987).
4/ Schliebe (1985, Tables 8, 9, and 10).

Note: -- Denotes no data available.

brant are harvested at this time and during September as they migrate from their summer breeding grounds. Snowy owls are occasionally trapped later in the fall, in October, as they migrate south (ACI/Courtnage/Braund, 1984). An estimated annual average (over 20 years) of 5,682 kilograms of birds is harvested, which accounts for about 3.2 percent of the total annual subsistence harvest (Table III-15).

(g) Walruses: The Point Hope Inupiat have traditionally used walruses; however, the increasing importance of the walrus as a subsistence resource has been directly related to its fluctuating population, which also has increased over the past decade. Walruses are harvested during the spring marine mammal hunt, which is based along the southern shore of the point (Fig. III-25). The major walrus-hunting effort coincides with the spring bearded-seal harvest, and both species are harvested from the same camps that stretch from Point Hope to Akoviknak Lagoon. Although walruses are hunted primarily during June and early July (Fig. III-31), they are also hunted by boat during the rest of the summer along the northern shore, especially along the rocky capes and other points where they tend to haul out. The walrus harvest occurs in conjunction with other subsistence activities such as egg gathering, fishing, or traveling the shores in search of caribou. An estimated 10 to 30 animals are harvested during June (ACI/Courtnage/Braund, 1984). The annual average harvest (over 20 years) is estimated at 15 walruses, or 2.9 percent of the total annual subsistence harvest (Tables III-15 and III-19).

(h) Polar Bears: Point Hope residents hunt polar bears primarily from January to April concurrently with the winter-seal-hunting season, and occasionally from late October to January (Fig. III-31). Polar bears are harvested mainly south of the community, generally in the area of intensive seal hunting (ACI/Courtnage/Braund, 1984). Polar bears comprise a small portion of the Point Hope subsistence harvest with an annual average (over 20 years) of 9 harvested, or only 1.1 percent of the total annual subsistence harvest (Table III-15).

(5) Atqasuk: Atqasuk (population 214 in 1985) is the only inland community close to the Sale 109 area. The marine-resource areas used by Atqasuk residents are inclusive of those used by Barrow residents and thus are discussed in Section III.C.2.a(1). Only a small portion of the marine resources used by Atqasuk residents is acquired on coastal hunting trips initiated in Atqasuk; the majority of the marine resources are acquired on hunting trips initiated in Barrow with Barrow relatives or friends (ACI/Courtnage/Braund, 1984). However, Atqasuk hunters harvest fish, migratory birds, and caribou in completely different areas from those of Barrow.

(a) Caribou: Caribou are the most important resource harvested by Atqasuk residents. (Atqasuk's caribou harvest area is shown in Fig. III-24A.) Although the fall harvest is the most important, caribou are also harvested throughout the winter and in early spring (Fig. III-32). Migration patterns and limited access to caribou prohibit hunting in the late spring and summer. In recent years the caribou population has been high, and Atqasuk residents have not had to travel far to harvest caribou (distances are not available). Caribou camps often are also used for fishing along the Meade, Inaru, Topogoruk, and Chipp River drainages (ACI/Courtnage/Braund, 1984).

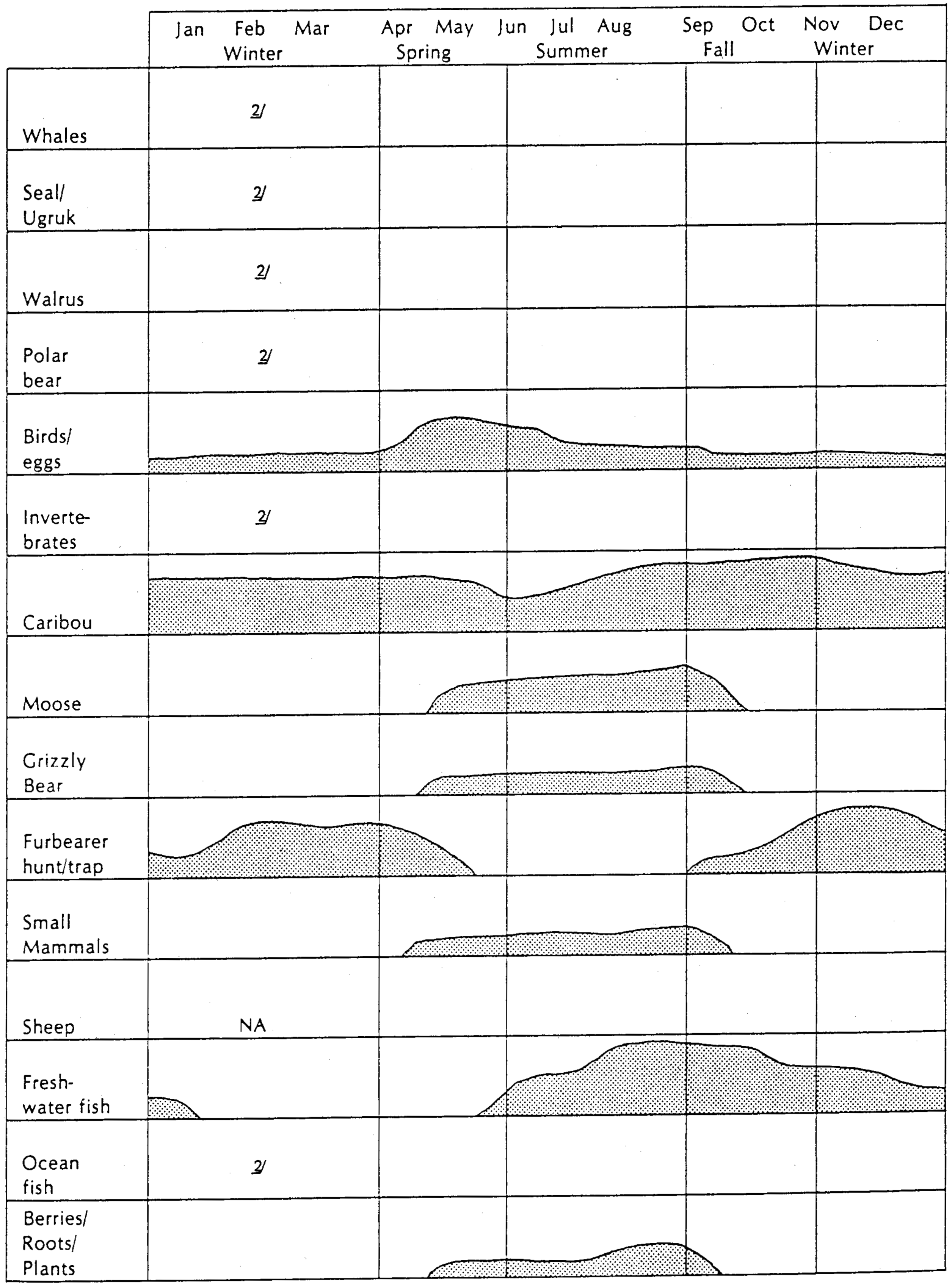


FIGURE III–32. ATQASUK ANNUAL SUBSISTENCE CYCLE.[1] Source: North Slope Borough Contract Staff, 1979.

[1] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods of pursuit of subsistence resources.

[2] These species are harvested only out of hunts originating in Barrow.

(b) Fishes: Fish are a preferred food in Atqasuk, although respondents in one study (ACI/Courtnage/Braund, 1984) said that fish are the secondary resource in quantity harvested. Most fishing occurs along the Meade River. Fish camps are also located on two nearby streams (Usuktuk and Nigisaktuvik Rivers) and downstream on the Meade River, near the Okpiksak River (Craig, 1987). Humpback whitefish, least cisco, grayling, broad whitefish, burbot, and chum salmon (Craig, 1987) are fished with gill nets and baited hooks and by jigging. The most successful fishing months are July and August (Fig. III-32), when water levels drop in the Meade River and the river is clearer. Nets are most commonly set in close proximity to the community. During the fall and winter, fishing continues under the ice in the Meade River and in nearby lakes (ACI/Courtnage/Braund, 1984).

Humpback whitefish and least cisco accounted for 96 percent of the summer catch in 1983 (the only year of harvest data). The summer gillnet fishery in the Meade and Usuktuk Rivers caught approximately 3,840 kilograms of fish. With other gear (500 kg) and winter catches (1,227 kg), the total harvest was approximately 5,568 kilograms. The annual per capita catch was about 19.5 kilograms (Craig, 1987).

(c) Migratory Birds: Atqasuk residents harvest migratory birds from late April through June, and again from late August through September, on numerous lakes and ponds as well as on the Meade River and its tributaries (Figs. III-27 and III-32). Eggs are gathered in the immediate vicinity of the community for a short period during June (ACI/Courtnage/Braund, 1984).

(6) Nuiqsut: Although the community of Nuiqsut (population 337 in 1985) is outside the Sale 109 area, it is discussed here because some of its subsistence-harvest areas lie in the vicinity of the overland pipeline included in the development-and-production scenario for this lease sale. Marine resources are not considered in detail because the subsistence-use area lies outside of the Sale 109 area. Located on the mouth of the Colville River, Nuiqsut's primarily terrestrial subsistence economy is oriented toward caribou.

(a) Caribou: Caribou, Nuiqsut's primary source of meat, provide an estimated 76 percent of the total subsistence harvest (Table III-12). (Nuiqsut's caribou harvest area is shown in Fig. III-24A.) Caribou are harvested throughout the year, with peak harvests from April through June and in September and October (Fig. III-33). Caribou-harvest statistics are available only for 1976, when 400 caribou provided approximately 28,000 kilograms of meat (Stoker, 1983, as cited by ACI/Braund, 1984).

(b) Fishes: Anadromous fish provide an important subsistence resource at Nuiqsut. The harvests of most subsistence resources, such as caribou, fluctuate widely from year to year because of variable migration patterns and because harvesting techniques are extremely dependent on ice and weather conditions. The harvest of fish is an exception to this rule, which adds to the importance of fish in Nuiqsut's subsistence system. Nuiqsut has the largest documented subsistence harvest on the U.S. Beaufort Sea coast (Moulton, Field, and Brotherton, 1986). Moreover, in October and November, fish may provide the only source of fresh subsistence foods. Nuiqsut residents harvest fish from January through May and from late July through

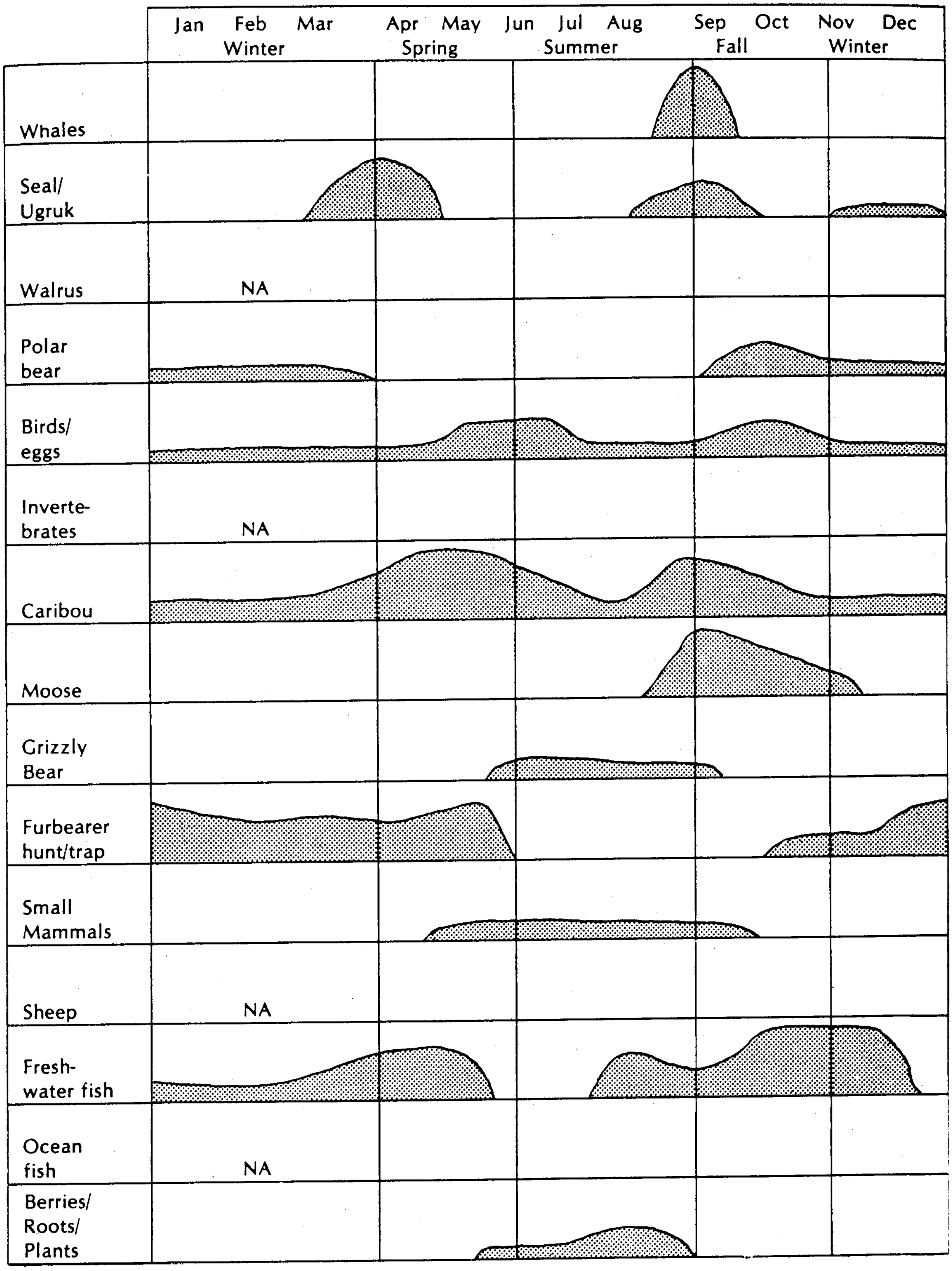


FIGURE III–33. NUIQSUT ANNUAL SUBSISTENCE CYCLE [1/] Source: North Slope Borough Contract Staff, 1979.

[1/] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods of pursuit of subsistence resources.

mid-December, with the peak harvest apparently occurring in November and early December (Fig. III-33).

Fishing is an important activity for Nuiqsut residents due to its proximity to the Colville River, with its large resident fish populations. The river supports 20 species of fish; approximately half of these are taken by Nuiqsut residents (George and Nageak, 1986). Local residents harvest fish primarily during the summer and fall. The summer, open-water harvest lasts from breakup to freezeup (early June to mid-September). The summer harvest covers a greater area and is longer than the fall/winter harvest in duration, and a greater number of species are caught. Broad whitefish is the primary species harvested during the summer and is the only anadromous species harvested in July in the Nechelik Channel. In July, lake trout, northern pike, broad whitefish, humpback whitefish, and arctic char are harvested in the Main Channel south of Nuiqsut. Salmon species reportedly have been caught in August, but not in large numbers. All five species of Pacific salmon have been reported in the Colville; pink and chum salmon are the most commonly caught, although there reportedly has not been a great interest in harvesting these species (George and Nageak, 1986). Although arctic char is found in the Main Channel of the Colville River (Entrix, Inc., 1986), there is little mention of char as a subsistence species in subsistence studies (George and Nageak, 1986; George and Kovalsky, 1986). Char are apparently liked but are not abundantly caught because the timing is critical (Moulton, 1986, oral comm.).

The fall/winter under-ice harvest begins after freezeup, when the ice is safe for travel by snowmachine. Local families fish for approximately 1 month or less after freezeup. The Kupigruak Channel is the most important fall fishing area in the Colville region. The primary species harvested are arctic and least cisco, harvested primarily in the Kupigruak Channel; other fishing for arctic and least cisco also occurs in the Nechelik and Main Channels of the Colville River. Arctic and least cisco composed 88 and 99 percent of the harvest in 1984 and 1985, respectively; however, this varied greatly depending on the net-mesh size. Humpback and broad whitefish, sculpin, and some large rainbow smelt also are harvested, but in low numbers (George and Kovalsky, 1986; George and Nageak, 1986). A fish identified as "spotted least cisco" also has been harvested--this fish is not identified by Morrow (1980) but may be a resident form of least cisco (George and Kovalsky, 1986). Weekend fishing for burbot and grayling also occurs at Itkillikpaat, 10 kilometers from Nuiqsut, even though the success rate for grayling is quite low (George and Nageak, 1986).

The summer catch in 1985 totaled about 8,755 kilograms of mostly broadfish. In the fall, approximately 27,682 kilograms of fish were caught, totaling 36,436 kilograms--an annual per capita catch of 109 kilograms (however, some of this catch was shipped to Barrow). In 1986, there was a reduced fishing effort in Nuiqsut; and the fall harvest was only 59 percent of that taken in 1985 (Craig, 1987).

Fish are eaten fresh or frozen; salmon also may be split and dried. Because of their important role as a large and stable food source, and as a fresh-food source during the midwinter months, fish may be shared at Thanksgiving and Christmas feasts and given to relatives, friends, and community elders. Fish also may appear in traditional sharing and bartering networks that exist among

North Slope communities. Fishing serves as a strong social function in the community because it often involves the entire family. Most (20-25) Nuiqsut families participate in some fishing activity; however, the bulk of the fishing appears to be done by less than 12 families (George and Nageak, 1986).

(c) Marine Resources: Nuiqsut residents hunt and use bowhead whales and seals. From one to five Nuiqsut whaling captains have registered each year to hunt the bowhead; in the past few years, the AEWC has alotted the community a quota of one whale a year. A number of Nuiqsut residents occasionally travel to Barrow to join Barrow whaling crews in the spring bowhead hunt, and Nuiqsut whalers occasionally join the Kaktovik whalers. Because of ice conditions and the lack of an adequate lead system in the spring, Nuiqsut whalers harvest bowheads only in the fall, from late August through October (Fig. III-33). From 1972 to 1982, an estimated annual average of 2,670 kilograms of meat was obtained from bowhead whales. Nuiqsut residents occasionally harvest seals from mid-March through May and in September and October (Stoker, 1983, as cited by ACI/Braund, 1984).

(d) Other Resources: Nuiqsut residents harvest other subsistence resources such as migratory birds, some moose, and an occasional polar bear. Birds are harvested year-round, with peak harvests in May to June and September to October (Fig. III-33). Moose are harvested from September though mid-December. The available information on the quantities harvested or their relative subsistence importance is sparse at this time. The best available indicator of relative importance is a study (ACI/Courtnage/Braund, 1984) which reported that 3.3 percent of respondents most often consumed birds; 93.4 percent of the respondents indicated that caribou is the meat most often consumed (Table III-13). Because the study was conducted during the duck-hunting season, respondents may have tended to list birds as the meat most often consumed during the year since it was the resource being consumed at the time.

3. Sociocultural Systems: This section provides a profile of the sociocultural systems that characterize the communities near the Sale 109 area. The topic of sociocultural systems encompasses the social organization and cultural values of the society. The communities near the Sale 109 area that might be affected by this lease sale are Barrow, Wainwright, Point Lay, Point Hope, Atqasuk, and Nuiqsut (see Fig. III-21). All of these communities are within the North Slope Borough (NSB). The ethnic, sociocultural, and socioeconomic makeup of the communities on the North Slope is primarily Inupiat. Sociocultural systems of the North Slope Inupiat are described and discussed in detail in the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a, Sec. III.C.2), which is incorporated by reference. The following summary is pertinent to Sale 109 and is augmented by additional material, as cited.

a. Introduction: The North Slope has a fairly homogeneous population of Inupiat (77% Inupiat in 1980). The percentage in 1980 ranged from 92 percent Inupiat in Point Hope to 71 percent Inupiat in Barrow (ACI/Courtnage/Braund, 1984). In 1985, the populations of each of the communities in the sale area were 3,075 in Barrow; 507 in Wainwright; 142 in Point Lay; 570 in Point Hope; 248 in Atqasuk; and 220 in Nuiqsut (see also Sec. III.C.1.c).

North Slope society responded to early contacts with outsiders by successfully changing and adjusting to new demands and opportunities (Burch, 1975; Worl, 1978; NSB Contract Staff, 1979). Since the 1960's, the North Slope has witnessed a period of "super change," a quickening pace of change brought on by the area's oil developments (Lowenstein, undated). In 1952, the anthropologist Spencer was dependent upon interpreters for his Barrow work (Spencer, 1959). Today, few North Slope residents lack English skills (Klausner and Foulks, 1982:48); and communications with the "outside" are no longer uncertain. All North Slope communities are tied to the larger world via telephone, cable television, and regularly scheduled commercial air transportation. Oil-related work camps have altered the seascape and landscape of the Prudhoe Bay-Kuparuk industrial complex, marking some areas as off limits to traditional pursuits like hunting. Large NSB Capital Improvement Programs (CIP) dramatically changed the physical appearance of the NSB communities. Blocks of modern houses, new schools, water-treatment plants, power plants, and community buildings stand out. Snow machines, three-wheeled all-terrain vehicles, and--in many communities--cars and pickups abound.

The introduction of modern technology has tied the Inupiat subsistence economy to a cash economy (Kruse, 1982). Nevertheless, oil-supported revenues help support a lifestyle that is still distinctly Inupiat; and the area's people feel that their culture remains intact (Sale 87 FEIS [USDOI, MMS, 1984a]; ACI/Braund, 1984, Table 113). Indeed, outside pressures and opportunities have sparked what may be viewed as a cultural revival (Lantis, 1973). North Slope residents exhibit an increasing commitment to area-wide political representation, local government, and the cultural preservation of such institutions as whaling crews and dancing organizations. People continue to hunt and fish; but aluminum boats, outboards, and three-wheelers now help blend these pursuits with wage work. Inupiat whaling remains a proud tradition that involves ceremonies, dancing, singing, visiting and cooperation between communities, and the sharing of foods.

The possible effects of the proposal on whales and whaling is a major scoping issue for residents of the North Slope (Kruse, Baring-Gould, and Schneider, 1983; ACI/Braund, 1983; USDOI, MMS, 1983b, Sale 87 Barrow Public Hearing Transcript). Whaling remains a primary subsistence activity for Barrow, Wainwright, and Point Hope (see Sec. IV.B.10)--an activity that has roots in Eskimo prehistory (Giddings, 1967). Whales are not only an important subsistence issue; they are the single-most important animal to the North Slope sociocultural system, which also has roots in prehistory (Lantis, 1938; Bockstoce et al., 1979; Worl, 1979).

The following sections describe the communities that may be affected by Sale 109. These community-specific descriptions discuss factors relevant to the sociocultural analysis--location of the community in relation to industrial activities, population, and current socioeconomic conditions. Social organization, cultural values, and other issues of all Sale 109 communities are discussed following these descriptions.

(1) <u>Barrow</u>: Although Barrow is outside of the Sale 109 area, Barrow would be one of the air-support bases for exploration because it is near the assumed pipeline landfall and shorebase site at Point Belcher.

Some of Barrow's subsistence-harvest areas are within the proposed Sale 109 area, and many of the subsistence resources harvested by Barrow residents migrate through the sale area.

Barrow is also the largest community on, and the regional center of, the North Slope. It is anticipated that the majority of the population increases that would occur as a result of this lease sale (20% during peak years [see Sec. IV.B.9]) would occur in Barrow. Barrow has already experienced dramatic population changes as a result of increased revenues from onshore oil development and production in Prudhoe Bay and other smaller oil fields; these revenues have stimulated the NSB CIP. In 1970, the Inupiat population of Barrow represented 91 percent of the total population (U.S. Census); by 1985, the proportion had dropped to 61 percent (1985 Barrow Housing and Employment Survey, as cited by Worl and Smythe, 1986). In 1985, non-Natives outnumbered Natives between the ages of 30 and 50. An increasing number of non-Native families also have established permanent residence in Barrow. Another significant feature of the Barrow population since 1970 is the increase in ethnic diversification. Caucasians comprise 28 percent and Filipinos comprise 5 percent of the total non-Native population. Other population groups include Blacks, Yugoslavians, Mexicans, and Koreans. The influx of non-Natives to Barrow has also brought an increase of mixed households since 1978, with an increasing number of Inupiat women choosing non-Natives as spouses (Worl and Smythe, 1986).

In the period 1975 to 1985, Barrow experienced extensive social and economic transformations. The NSB CIP stimulated a boom in the Barrow economy and an influx of non-Natives to the community. Inupiat women entered the labor force in the largest numbers ever and achieved positions of political leadership in the newly formed institutions. The proportion of Inupiat women raising families without husbands also increased during this period. The extended family, operating through interrelated households, is salient in community social organization (Worl and Smythe, 1986). During this same period, the social organization of the community became increasingly diversified with the proliferation of formal institutions and the large increase in the number of different ethnic groups. Socioeconomic differentiation is not new in Barrow--during the commercial-whaling period and the reindeer-herding period, there were influxes of outsiders and shifts in the economy. Other fluctuations have occurred during different economic cycles (trapping, U.S. Navy and Arctic Contractors employment, the recent CIP boom, and the periods of downturn in between [Worl and Smythe, 1986]). As a consequence of the changes Barrow has already experienced, Barrow may be more capable of absorbing additional changes as a result of this lease sale than would a smaller, homogeneous Inupiat community.

(2) <u>Wainwright</u>: Wainwright, which would be one of the air-support bases for exploration during this lease sale, is 20 to 25 kilometers from the pipeline landfall and shorebase site at Point Belcher; and its subsistence resources are harvested in the area of the highest oil-spill risk in the Sale 109 area.

Like other North Slope communities, the changes in Wainwright from 1975 to 1985--stimulated by the NSB CIP boom--have not been as dramatic as the changes in Barrow. Nonetheless, the CIP has led to retention of the population and the creation of new jobs, housing, and infrastructure. Although there has been an influx of non-Natives into Wainwright, unlike Barrow, most of these non-Natives are transient workers and cannot be considered permanently settled or even long-term residents. In 1983, approximately 30 percent of all Wainwright residents were non-Native. Of these approximately 100 residents, only a few would be in Wainwright 6 months to a year later. Even most of the eight Caucasian teaching couples had not been in Wainwright more than a year. The Caucasians in Wainwright tend to be nonpermanent, mobile residents who have relatively little interaction with the Native population--which has created a certain degree of racial tension in the community (Luton, 1985).

The Wainwright CIP has not only been central to the local economy, but it also has changed the face of the community and affected the quality of life. Residents now live in modern, centrally heated homes with running water, showers, and electricity. New buildings dominate the town, and upgraded roads have encouraged more people to own vehicles. Between July 1982 and October 1983, the number of pickup trucks and automobiles more than tripled in Wainwright (Luton, 1985).

(3) Point Lay, Point Hope, Atqasuk, and Nuiqsut: Point Lay, Atqasuk, and Nuiqsut are not located in the vicinity of proposed activities nor are they expected to experience any direct additional population growth or employment as a result of Sale 109. Indirect employment opportunities as a result of this sale are not expected to be large and would not have additional effects on the sociocultural systems of these communities. Effects on the sociocultural systems of these communities are only expected to occur as a result of increased NSB revenues and their effects on the subsistence-harvest patterns of these communities.

The following section describes the social organization, cultural values, and other issues for communities near the Sale 109 area.

b. Social Organization: The social organization of communities near the Sale 109 area is strongly kinship-oriented. Kinship formed "the axis on which the whole social world turned" (Burch, 1975). Historically, households were composed of large, extended families; and communities were kinship units. Today, there is a trend away from the extended-family household because of an increase in mobility, availability of housing, and changes in traditional kinship patterns. However, kinship ties in Inupiat society continue to be important and a central focus of the social organization.

The social organization of the North Slope Inupiat encompasses not only households and families but wider networks of kinspeople and friends. These various types of networks are related through various overlapping memberships and are also embedded in those groups that are responsible for the hunting, distribution, and consumption of subsistence resources.

An Inupiat household on the North Slope may contain a single individual or group of individuals who are related by marriage or ancestry. However, other individuals--related by birth, marriage, or friendship--may visit for extended periods and take their meals and sleep in this household. In fact, they may periodically visit a round of households where they stay for limited periods on a regular basis. In addition, households next door (or throughout the community) reciprocate various domestic functions, including the sharing of food preparation and meals, babysitting, and other activities. The members of an Inupiat household are fluid; relatives or friends may drop in and share meals and sleeping facilities for extended periods; and meals, babysitting, and other reciprocal activities regularly take place with other relatives and friends at their residences.

The interdependencies that exist among Inupiat households differ markedly from those found in the U.S. as a whole. In the larger non-Inupiat society, the demands of wage work emphasize a mobile and prompt work force. While modern transportation and communication technologies allow for contact between parents, children, brothers, sisters, and other extended-family members, more often than not independent nuclear households (father, mother, and children) or conjugal pairs (childless couples) form independent "production" units that do not depend on extended-family members for the day-to-day support of food, labor, or income. Naturally, many people depend on their families for emotional support via the telephone or--in times of crisis--via air transportation. They also know that their extended family might provide income for medical emergencies and help with bills during periods of unemployment. However, a key contrast between non-Native and Inupiat cultures occurs in their differing expectations--the Inupiat expect and need support from extended-family members on a day-to-day basis.

Associated with these differences, the Inupiat hold unique norms and expectations about sharing. Households are not necessarily viewed as independent economic units; and giving, especially by successful community members (e.g., hunters), is regarded as an end in itself, although community status and esteem accrue to the generous. Kinship ties are strengthened through sharing and exchange of subsistence resources (Nelson, 1969; Burch, 1971; Worl, 1979; ACI/Braund, 1984; ACI/Courtnage/Braund, 1984; and Luton, 1985). Kinship is also strengthened through cooperation in terms of group efforts and provision of cash and equipment for subsistence activities (ACI/Courtnage/Braund, 1984).

c. Cultural Values: Traditional Inupiat values were centered on the Inupiat's close relationship with natural resources, specifically game animals. In addition, the Inupiat also had a close relationship to the supernatural with specific beliefs in animal souls and beings who controlled the movements of animals. Other values included an emphasis on the community and its needs and support of other individuals. The Inupiat respected persons who were generous, cooperative, hospitable, humorous, patient, modest, and/or industrious (Lantis, 1959; Milan, 1964; Chance, 1966). Although there have been substantial social, economic, and technological changes in Inupiat lifestyle, subsistence continues to be the core or central organizing value of Inupiat sociocultural systems in the Sale 109 area. The Inupiat remain socially, economically, and ideologically loyal to their subsistence heritage. Indeed, "most Inupiat still consider themselves primarily hunters and fishermen" (Nelson, 1979). This refrain is repeated again and again by the residents of the North Slope (Kruse, Baring-Gould, and Schneider, 1983; ACI/Braund, 1984). Task groups are still organized to hunt, gather, and process subsistence foods. Cooperation in hunting and fishing activities also remains an important part of the Inupiat life. Whom one cooperates with is a major component of the definition of significant kin ties (Heinrick, 1963). Since subsistence tasks are, to a large extent, age and sex specific, subsistence task groups are even important to the definition of such relations as the roles of husbands and wives, children and parents, friends, etc. (Wolfe, 1981; Thomas, 1982; Jorgensen, 1984; and Little and Robbins, 1984). In addition, large amounts of subsistence foods are shared within the community. Whom one gives to and receives from also are major components of the definition of significant kin ties (Heinrick, 1963; ACI/Courtnage/Braund, 1984).

On the North Slope, "subsistence" is much more than an economic system; the hunt, the sharing of products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men. Good hunters are often respected leaders. Good health comes from a diet of products of the hunt. Young hunters still give their first game to the community elders. To be generous brings future success. These are but some of the ways in which subsistence and beliefs about subsistence join with sociocultural systems.

The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities that occur in Inupiat society, as discussed above. However, the value also is apparent in the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations (some families will dominate one type of government, e.g., the village corporation), employment, sports activities, and membership in voluntary organizations (Mother's Club, Search and Rescue, etc.) (ACI/Courtnage/Braund, 1984).

Bowhead whaling also remains at the center of Inupiat spiritual and emotional life; it embodies the values of sharing, association, leadership, kinship, arctic survival, and hunting prowess. The spring whale hunt off the Chukchi Sea lead system ties together these values with feasting and food preferences and symbolizes cultural integrity (see Bockstoce et al., 1979; ACI/ Courtnage/ Braund, 1984).

The ramifications of the whale hunt are more than emotional and spiritual. The organization of the crews does much to delineate important social and kin ties within communities and to define community-leadership patterns as well. The structured sharing of the whale helps determine social relations both within and between communities (Worl, 1979; ACI/Courtnage/Braund, 1984). Furthermore, the task group formation and structured sharing that surround other subsistence pursuits are likewise important to Inupiat society. For example, the organization of summer boat crews for seal, walrus, and bird hunting helps to define kin ties and leadership within communities. The sharing of the proceeds of these hunts establishes meaningful ties between individuals and families. What is said for summer boat hunting holds true for caribou hunting, fishing, and other subsistence pursuits. In these communities, the giving of meat to the elders does more than feed old people; it bonds giver and receiver together, joins them to a living tradition, and draws them into their community.

Today, this close relationship between the spirit of a people, their social organization, and the cultural value of subsistence hunting may be unparalleled in other American energy-development situations. The Inupiat people's continuing strong dependence on subsistence foods, particularly marine mammals, creates a unique set of potential effects from offshore oil development on the social and cultural system. A recent analysis of the Inupiat's concerns about oil development was based on a compilation of approximately 10 years of recorded testimony at North Slope public hearings for State and

Federal energy-development projects. The vast majority of concerns centered around the subsistence use of resources, including damage to subsistence species, loss of access to subsistence areas, loss of Native foods, or interruption of subsistence-species migration. These four concerns represent 83 percent of all the testimony taken on the North Slope (University of Alaska, ISER, 1983, Table 16).

d. Other Issues: Other issues important to an analysis of sociocultural systems are those that will affect or are already affecting Inupiat society. Section III.C.2 of the Sale 97 DEIS details the following issues: fiscal and institutional growth in the NSB; changes in employment; increases in income; decreases in Inupiaq fluency; and rising crime rates and substance abuse. A summary of these issues from the Sale 97 DEIS follows.

The Sale 87 FEIS (USDOI, MMS, 1984a, Sec. III.C.2) and Sale 97 FEIS (USDOI, MMS, 1987a, Sec. III.C.2) consider the NSB's fiscal and institutional growth. In addition, Smythe and Worl (1985) detail the growth and responsibilities of local governments. The NSB provides most government services for all six communities. These services include public safety, public utilities, fire protection, and some public-health services. The NSB grew steadily in the late 1970's and early 1980's. Further fiscal and institutional growth is expected to be limited in the foreseeable future because of economic constraints in limiting direct Inupiat participation in oil-industry employment and growing statewide budget constraints (Kruse, Baring-Gould, and Schneider, 1983). A massive NSB CIP in the early 1980's built schools, houses, roads, community buildings, fire stations, and health clinics, etc., and provided employment for the North Slope residents. The Arctic Slope Regional Corporation, formed under the ANCSA, runs several subsidiaries including Eskimos, Inc., and Tundra Tours. Most of the communities also have an Indian Reorganization Act (IRA) government as well as a city government. The IRA and village-corporation governments have not provided much in the way of services in the NSB.

The NSB CIP has caused the median yearly income of Natives to increase from $6,923 in 1970 to $32,515 in 1980 (per capita, not inflation adjusted) (Smythe and Worl, 1985). This increase was almost totally related to increases in Borough-related or Borough-created jobs. However, with oil revenues decreasing in 1985 and 1986, the CIP and other employment opportunities have decreased; and there has been considerable concern on the North Slope about future employment opportunities.

While decreases in Native-language fluency have been noted among younger NSB residents, North Slope Inupiat are still generally bilingual--about 87 percent speak Inupiaq with some fluency and, of those, only about 6 percent cannot speak English or speak it poorly. Although most people can speak Inupiaq, there seem to be a number of younger Inupiat who speak English exclusively to their children and who question their own fluency in Inupiaq when speaking (Galginaitis, 1985; Luton, 1985).

Recent statistics on homicides, rapes, and wife and child abuse present a sober picture of some aspects of life in NSB communities. Violent deaths account for more than one-third of all deaths on the North Slope. The Alaska Native Health Board (ANHB) notes, the "overwhelming involvement of alcohol (and drug) abuse in domestic violence, suicide, child abuse, birth defects, accidents, sexual assaults, homicide and mental illness" (ANHB, 1985). Lack of comparable data makes it impossible to compare levels of abuse and violence between aboriginal (prior to contact with Caucasians), traditional (from the time of commercial whaling through the fur trade), and modern (since World War II) Inupiat populations. Nonetheless, it is apparent from reading earlier accounts of Inupiat society that there has been a drastic increase in these social problems. Recent information from Barrow (Worl and Smythe, 1986) details the important changes in Inupiat society that have occurred during the last decade in response to these problems. Services provided by outside institutions and programs have recently begun to assume some responsibility for functions formerly provided by extended families. Today there is an array of social services available in Barrow that is more extensive for a community of this size than anywhere in the U.S. (Worl and Smythe, 1986).

The baseline of the present sociocultural system includes change and strain. The very livelihood and culture of North Slope residents come under increasingly close scrutiny and regulation. The physical landmarks and regularities of life, such as homes, schools, and roads, all evidence massive change and growth. In such a situation, the potential for "lost spirit" increases (Vesilind, 1983). This increase in stresses on social well-being and cultural integrity and cohesion comes at a time of economic well-being that is threatened by the decline of CIP projects across the North Slope (University of Alaska, ISER, 1983).

4. <u>Archaeological Resources</u>: The two major time sequences of archaeological resources of the proposed Sale 109 area are prehistoric and historic. "Archaeological resources" are any prehistoric or historic district, site, building, structure, or object (including shipwrecks); such resources include artifacts, records, and remains which are related to such a district, site, building, structure, or object (Section 301[5], National Historic Preservation Act, as amended 16 U.S.C. 470W[5]). Archaeological resources are any objects or features that are manmade or modified by human activity. Significant archaeological resources are either historic or prehistoric and generally include properties greater than 50 years old that (1) are associated with events that have made a significant contribution to the broad patterns of our history; (2) are associated with the lives of persons significant in the past; (3) embody the distinctive characteristics of a type, period, or method of construction; (4) represent the work of a master; (5) possess high artistic values; (6) present a significant and distinguishable entity whose components may lack individual distinction; or (7) have yielded, or may be likely to yield, information important in history. These resources represent the remains of the material culture of past generations of the region's prehistoric and historic inhabitants. They are basic to our understanding of the knowledge, beliefs, art, customs, property systems, and other aspects of the nonmaterial culture. The two major categories of prehistoric and historic archaeological resources identified in the Sale 109 area and shown in Figures III-34 and III-35 are offshore sites and onshore sites.

a. <u>Offshore (seaward from the 3-geographical-mile line)</u>: The geological record of the proposed Sale 109 area (see Appendix E, MMS Archaeological Analysis) suggests that water action and ice-gouging have left few,

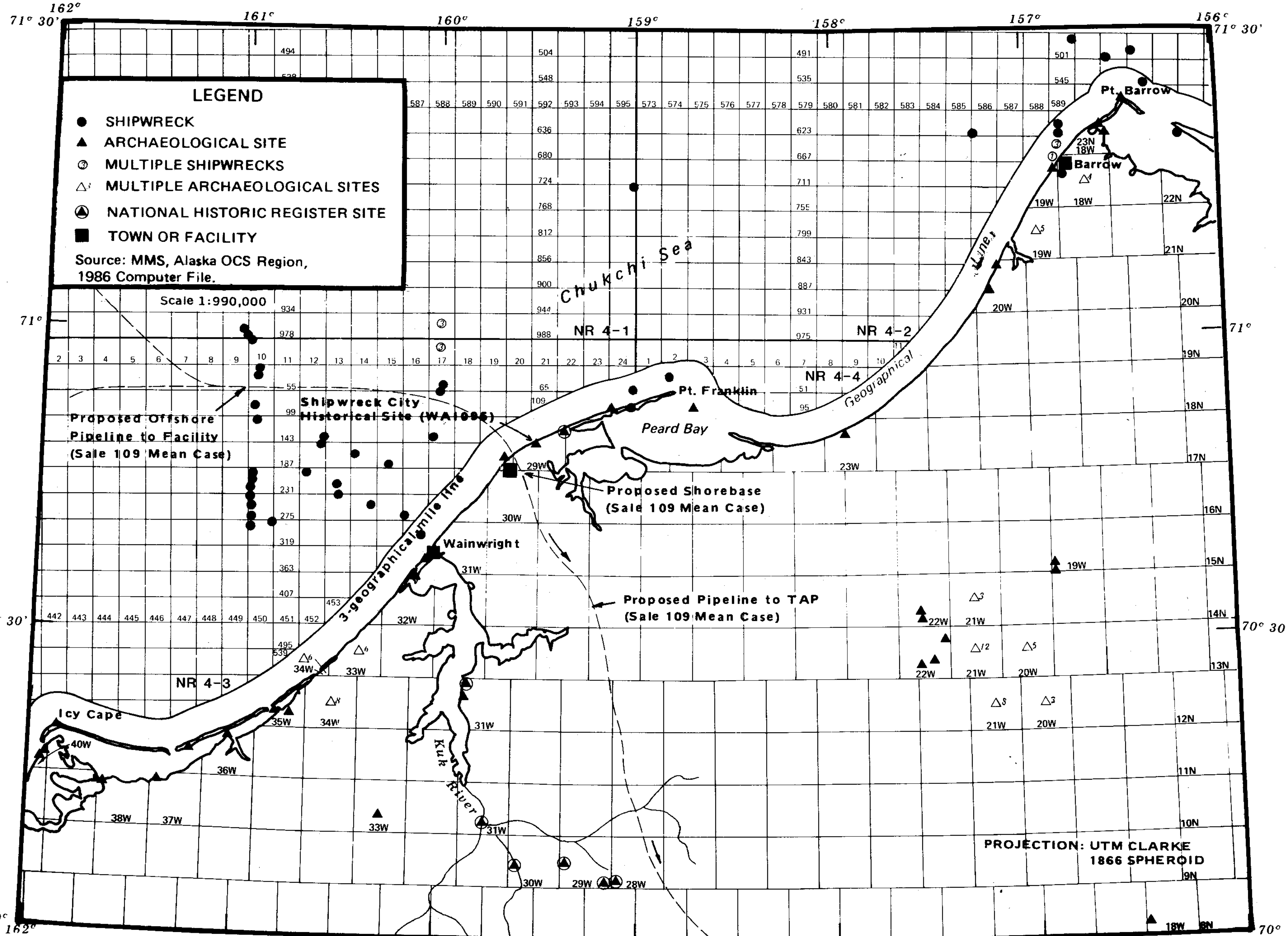


FIGURE III-34. APPROXIMATE LOCATIONS OF SHIPWRECKS, ARCHAEOLOGICAL SITES, AND PROPOSED INDUSTRIAL FACILITIES IN THE NORTHERN CHUKCHI SEA

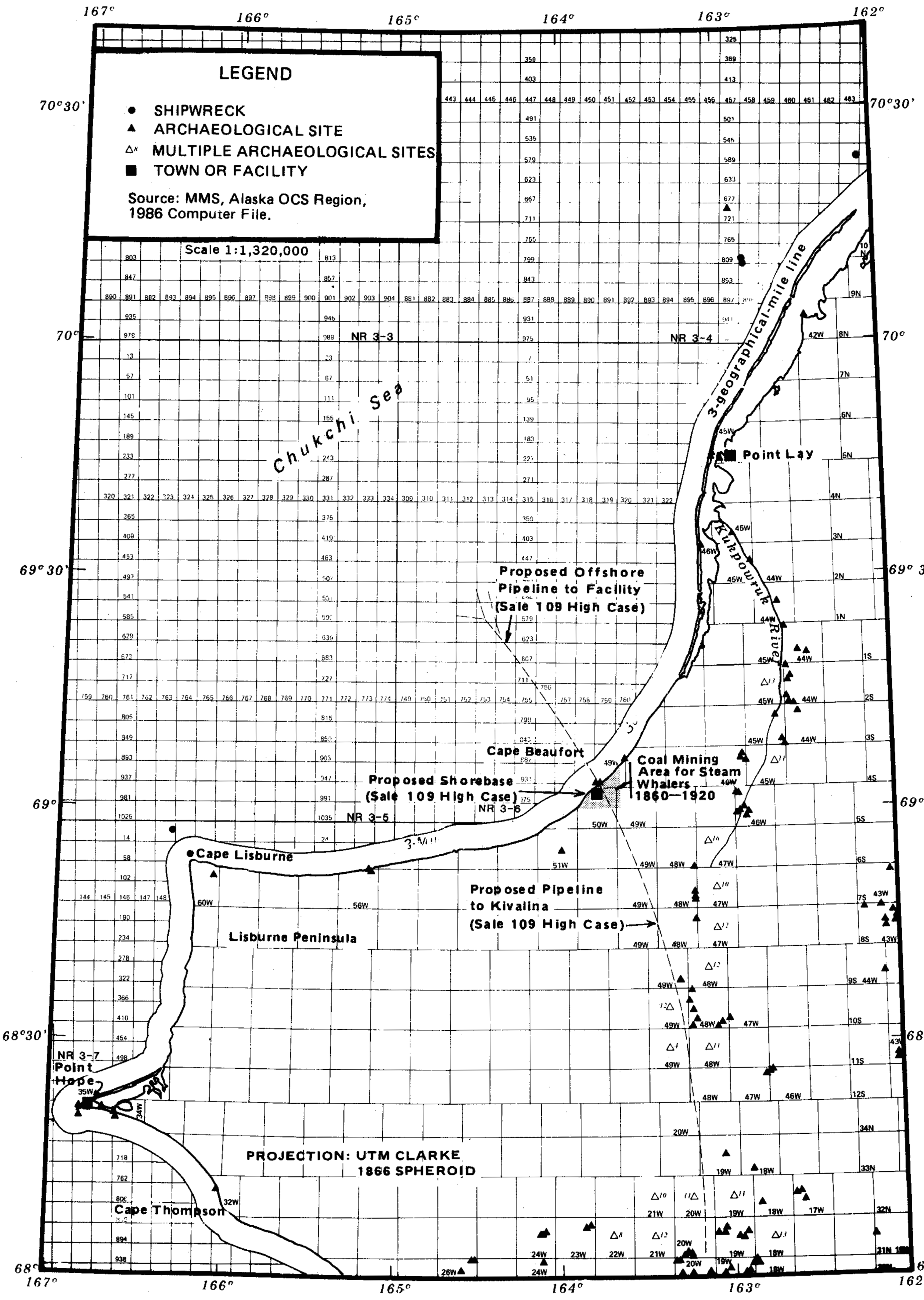


FIGURE III-35. APPROXIMATE LOCATIONS OF SHIPWRECKS, ARCHAEOLOGICAL SITES, AND PROPOSED INDUSTRIAL FACILITIES IN THE SOUTHERN CHUKCHI SEA if any, landforms with archaeological resource potential intact. Therefore, it is improbable that useful archaeological information about prehistoric times would be found.

Shipwrecks are more likely than prehistoric resources to be found (see Tornfelt, 1982, 1987 [In Press]) because historical objects are not subjected to as long a period of ice-gouging and because they may also be at a depth beyond ice gouging. At Point Belcher alone, 28 ships were frozen in the ice in September 1871, and 12 others during September 1876 (Figs. III-34 and III-35 and Appendix E, Shipwreck Update Analysis, Tables E-1 and E-2). Seventy-six whaling vessels--an average of more than six per year--were lost between 1864 and 1876 because of ice and the raids of the Shenandoah, which burned 21 whaling ships near the Bering Strait during the Civil War (Bockstoce, 1977; Whipple, 1979). At least a couple of these ships may have sunk in the lease area. No one can be certain that ice or water dynamics have destroyed all of these shipwrecks. It is possible that some of these wrecks still remain and can be found; the probability of finding a shipwreck is highest around Point Belcher, Icy Cape, and Point Hope. No surveys for locations of these shipwrecks have been made. Neither have any of the shipwrecks been accidentally or deliberately discovered; therefore, no exact locations are known. As near as can be determined, the blocks where shipwrecks might be located are shown in Figures III-34 and III-35 and listed in Table E-2 of Appendix E.

b. Onshore (inland and seaward to the 3-geographical-mile line): Onshore archaeological resources near the Chukchi Sea coast receive less damage from the receding shoreline than the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost (Lewbel, 1984). The Chukchi Sea coast is eroding on an average of about 0.3 meters per year. Although this erosion rate is considerably lower than that of the Beaufort Sea coast (1-2 m/yr), it accounts for a coast on which new archaeological sites periodically appear because of erosion. Known onshore archaeological resources exist in great numbers and quality. Villages, graves, whaling camps, and fishing/ hunting camps have been found (see Tornfelt, 1982, Summary). Detailed information may be found for some of the approximately 83 known archaeological sites onshore of the Sale 109 area by referring to the Alaska Heritage Resources Survey File (State of Alaska, DNR, 1986). State-listed sites WAI 008 to 015 are National Register sites as of March 18, 1980. Sites WAI 008, 010, and 011 are Kukmiut tradition; WAI 009 and 012 to 015 are Inupiat tradition. Twenty-one sites along the shore in the Wainwright Quadrant, 52 sites in the Point Lay Quadrant, and 10 sites in the Point Hope Quadrant exhibit just a small part of the archaeological-resource potential of the shore area along the Chukchi Sea coast (Figs. III-34 and III-35).

The Cape Krusenstern National Monument and the Bering Land Bridge National Preserve are particularly important for onshore archaeological resources. (see Fig. III-36).

(1) Cape Krusenstern National Monument: The core of this archaeologic district lies in the Cape Krusenstern National Monument, where the complex of approximately 114 marine beach ridges occurs. These beach ridges run roughly east-west, parallel to the present shoreline. They are composed of alluvium, are only about 3 meters above sea level, extend from 2.5

to 5 kilometers toward the sea, and are about 14.5 kilometers long. These beach ridges, formed of gravel deposited by major storms and regular wind and wave action, record in horizontal succession the major cultural periods of the Arctic over the last 4,500 years. The prehistoric inhabitants of northwest Alaska seasonally occupied the cape to hunt marine mammals, especially seals. As new beach ridges were formed, camps were made on the ridges closest to the water. Thus, over the centuries, a chronological "horizontal stratigraphy" was laid down in which the oldest cultural remains are found on the fossil-beach ridges farthest from the ocean, with more recent remains and modern camps found on beach ridges closer to the water. The discoveries made at Cape Krusenstern, especially when used in conjunction with those at Onion Portage in Kobuk Valley National Park, provide a definite, datable outline of cultural succession and development in northwest Alaska (USDOI, NPS, 1986a).

(2) Bering Land Bridge National Preserve: The Bering Land Bridge National Preserve contains archaeological resources that are valuable to the Nation because its record of the past was not disturbed by the great ice ages (USDOI, NPS, 1986b). The succession of sand dunes at Cape Espenberg may provide information on human migration and habitation similar to the information collected from Cape Krusenstern. The coast north and south of the ancient village of Shishmaref contains numerous sites and some shipwrecks.

5. Land Use Plans and Coastal Management Programs:

a. Land Status and Use: The complexity of land status in the North Slope Borough (NSB) was described in the FEIS's for Sales 87 and 97 (USDOI, MMS, 1984a, 1987a). Those descriptions are incorporated by reference and augmented by additional material, as cited, in the following paragraphs. Most land in the NSB and within the region of the Northwest Arctic Native Association (NANA) is held by a few major landowners. The Federal Government is the predominant landowner. Over one-half of the land in the NSB is within the National Petroleum Reserve-Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR), and 60 percent of the land in the NANA Region is within six Federal reserves (see Fig. III-36). Other major landholders include the State of Alaska, the eight Native village corporations in the NSB, the Arctic Slope Regional Corporation (ASRC), the NANA Regional Corporation, and the Kotzebue Native Corporation (Kikiktagruk Inupiat Corporation).

Much of the coastal area bordering the Chukchi Sea is in the NPR-A. The village corporations of Wainwright and Barrow have major inholdings within the NPR-A. Most of the remaining lands along the Chukchi Sea have been selected by Native corporations or the State.

In May 1986 the residents of the NANA Region approved the formation of the Northwest Arctic Borough (Fig. III-36), which was incorporated as a first-class borough in June 1986. Of the approximately 57,971 square kilometers included in the Northwest Arctic Borough, 5,310 were originally in the NSB. The adjustment in the boundaries of the NSB was recommended by the Local Boundary Commission to make the borough boundaries coincide with those of the ASRC and the NANA Regional Corporation.

Major land uses on the North Slope are divided between traditional subsistence uses of the land and hydrocarbon-development operations. Along the Chukchi Sea coast, traditional settlement patterns and subsistence uses of land

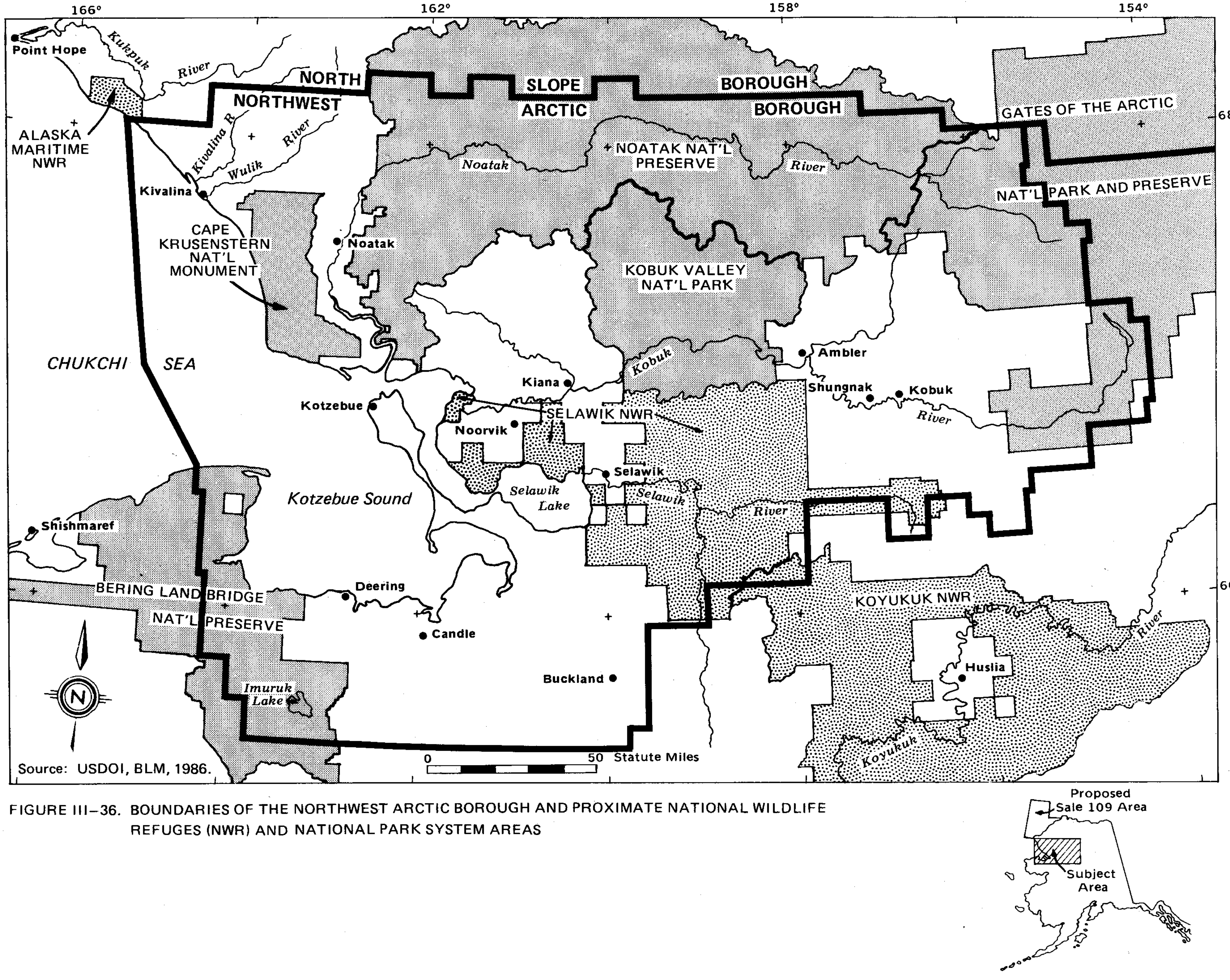


FIGURE III-36. BOUNDARIES OF THE NORTHWEST ARCTIC BOROUGH AND PROXIMATE NATIONAL WILDLIFE REFUGES (NWR) AND NATIONAL PARK SYSTEM AREAS prevail (these are discussed in Sec. III.C.2). Hydrocarbon-exploration, -development, and -production operations are prevalent in the mid-Beaufort Sea region of the North Slope. Existing and potential development are described in Appendix G and summarized in Table IV-2.

b. Land Use Planning Documents: Documents or programs that modify or control land use in the NSB include the Capital Improvements Program (CIP), the Comprehensive Plan, and the Land Management Regulations. Descriptions of these documents/programs are contained in Section III.D.3.c of the Beaufort Sea Sale 87 FEIS (USDOI, MMS, 1984a) and Section III.D.3 of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and are herein incorporated by reference. A summary of these programs, augmented by additional material, as cited, and a description of land use and coastal management documents in the NANA region are included in this section.

(1) NSB Capital Improvements Program: Improvements in the NSB CIP are designated for each of the eight NSB communities, for Borough-wide projects, and for Service Area 10. The boundaries of Service Area 10 extend from Harrison Bay to the Canning River and include the Kuparuk Industrial Center, Prudhoe Bay, Bullen Point, and the Oxbow Landfill.

Much of the emphasis in the CIP has been on housing; other projects include: those that meet household requirements for water, sewage disposal, power supplies, and services; roads; and conceptual master plans for service bases at Kuparuk and Bullen Point. Schools, health-care facilities, and fire-fighting equipment have been provided in each community. At the Borough level, the CIP emphasis is shifting from physical improvements to improvements in telecommunications that facilitate the diagnostic capabilities of health aides and provide the opportunity for people in outlying communities to express their opinions and concerns.

(2) NSB Comprehensive Plan and Land Management Regulations: The North Slope Borough Comprehensive Plan was adopted in December 1982 and became effective January 1, 1983. The premise of the comprehensive plan is to preserve and protect the land and water habitat essential to subsistence living and the Inupiat character of life. Based on that premise, goals, objectives, and policies have been developed to accommodate nonrenewable-resource development and to cooperate with those developing the resources.

Policies: Policies of the NSB Comprehensive Plan are subdivided into development policies that detail what is and is not allowable and public policies that describe how the NSB will implement the development policies. Regulations were enacted to implement the policies in the comprehensive plan. Developments included in the CIP are presumed to be consistent with the management plan and are subject only to coastal management consistency reviews.

Zoning Districts: Four zoning districts are included in the Comprehensive Plan and Land Management Regulations--Villages, Barrow, Conservation, and Resource Development. The purpose of the Resource-Development-District designation is to handle the cumulative impacts of large-scale development and to offer developers quick, inexpensive, predictable permit approvals. Development can occur in the Conservation District, or without a Master Plan in a

Development District, but requires a development permit and is subject to a close review to assure compliance with development policies. Rezoning from a Conservation District to a Resource Development District is possible and recommended if a series of activities is anticipated. To qualify for rezoning, a Master Plan must be developed and adopted as an amendment to the Comprehensive Plan and Land Management Regulations. Developments included in an approved Master Plan become "uses-by-right." One master plan (for the Endicott Project) has been approved, and the zoning-district designation has been changed by following these procedures. Approval followed an extensive review that included NSB staff analyses, public hearings and meetings, and a workshop with the developer. Because the NSB determined that the proposed plan would conflict with six "Best-Efforts Policies" and one "Minimization-of-Negative-Impacts Policy," stipulations were attached to mitigate the adverse effects and to encourage beneficial effects. Development of Lisburne and West Sak was pursued on a project-by-project basis rather than under a master plan.

Automated Geographic Information Systems: The Automated Geographic Information System is integrated into the NSB Comprehensive Land Use Program. Data are mapped at two scales (Fig. III-37). At the scale 1:250,000, 20 of the 25 USGS quadrangle maps for the NSB are complete. For this scale, data files include integrated terrain units (ITU's), which are a composite of vegetation, soils, geology, slope, and land use features; surface hydrology; political and administrative units; infrastructure; settlements and special features; energy and mineral resources; elevation provinces; historical and archaeological sites; NSB planning maps; and regional subsistence-land use. Areas mapped at the scale 1 inch to 1 mile (1:63,360) such as near the Red Dog deposit, include ITU, surface hydrology, infrastructure, political and administrative units, and habitats (adapted from the NSB planning maps). Data for the Dalton Highway are mapped at the scale of 1:63,360 and are restricted to manmade changes along the corridor.

(3) Plans in the NANA Region: Land use planning for the NANA region is achieved through the land management plans of the major landholders. Federal lands will be covered by the land management plans being developed for each of the six Federal reserves established in the NANA region through the Alaska National Interest Lands Conservation Act (ANILCA). To be consistent with the Congressional intent of ANILCA, these lands will be managed to preserve the natural resources within their boundaries. Overall planning for State-owned lands in the region commenced in 1985. This plan, the Northwest Alaska Area Plan, should be completed in 1988. The NANA Regional Corporation, another major landholder in the region, approved policies for land management in March 1983. The coastal management program for the NANA region cuts across ownership boundaries for those lands included in the coastal zone (see Sec. III.C.5.c[3]).

Because of the variety of planning and development efforts and the need to provide a consistent regional perspective for agencies and companies planning, funding, and developing in the NANA region, a Regional Strategy was prepared by the Maniilaq Association to guide overall development in the region based upon an assessment of the needs identified by the villages and placed in the context of four regional goals. The regional goals are to (1) raise the standard of living through balanced and phased economic development, (2) protect the environment and subsistence-based culture, (3) strengthen the

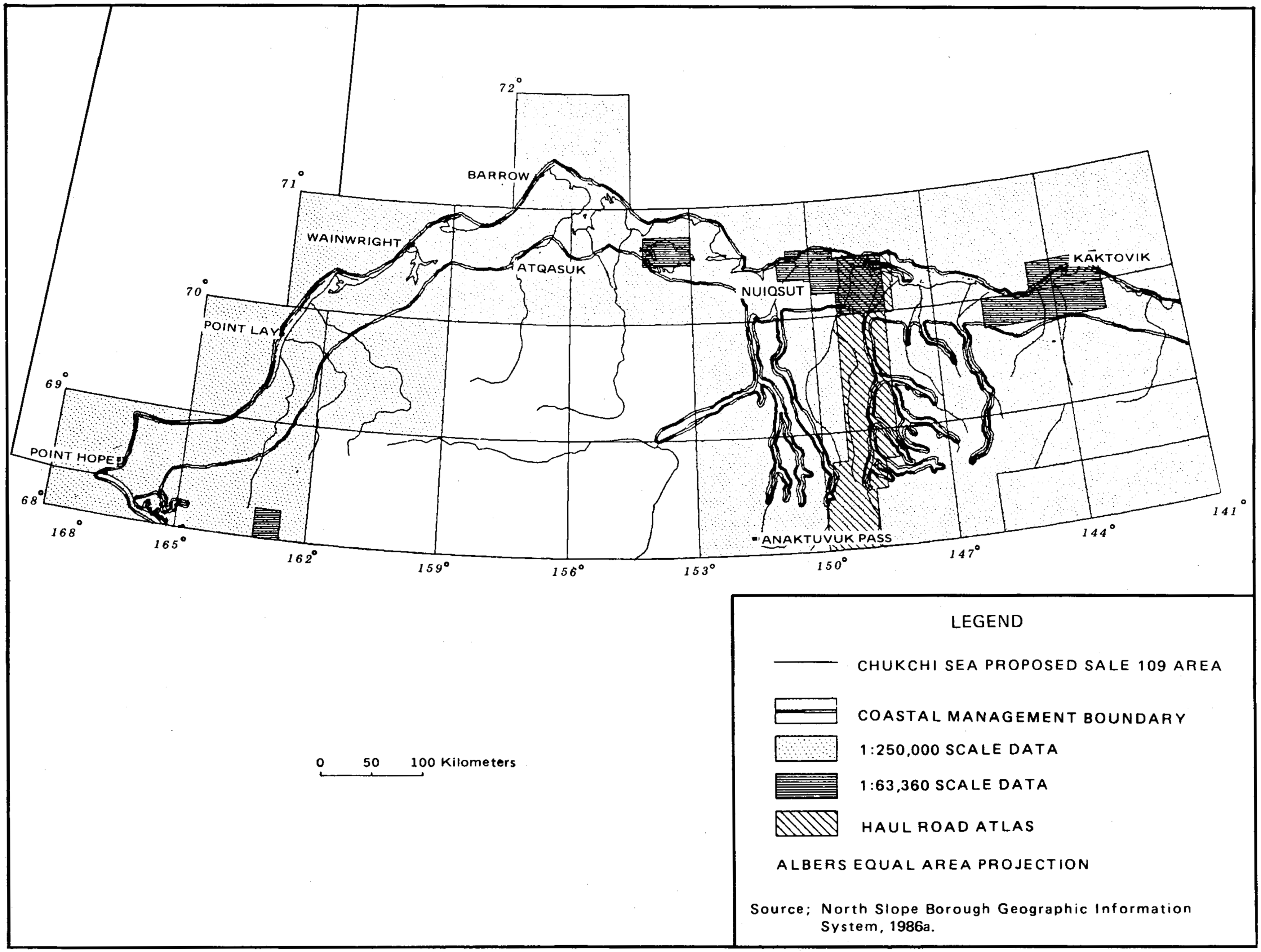


FIGURE III-37. NORTH SLOPE BOROUGH AUTOMATED DATA BASES spirit and pride of the Inupiat and reduce the causes of social problems brought on by rapid social and economic change, and (4) develop local management capability and local control to make self-determination a reality (Maniilaq Association, 1982, 1985). Regional-strategy conferences are held annually to review the past year, update the local situations, and establish objectives for the future.

Land resources is one of the five elements of the regional strategy for which a task force has been created. (The other elements are economic development, health and social services, education, and facilities.) One of the main thrusts of the land resources element is the coordination of the various planning efforts and planning boards operating in the region. Specific policies regulating land use practices were not developed through the regional strategy. However, the policies developed by the NANA Regional Corporation and the goals and objectives of the Coastal Management Program (CMP) have been placed in an Appendix of the Regional Strategy.

With the formation of the Northwest Arctic Borough, the land use responsibilities assumed by the Maniilaq Association will be shifting to the Northwest Arctic Borough. A Planning Commission appointed in October 1986 likely will base its Comprehensive Plan on the Regional Strategy developed by the Maniilaq Association.

c. Coastal Management Programs:

(1) State Coastal Management Policies: Alaska's CMP (ACMP) is based upon the Alaska Coastal Management Act. Supplementing the legislation are guidelines, standards, a series of maps depicting the boundaries of the State coastal zone, and an EIS prepared by the U.S. Department of Commerce.

Policies contained in Alaska's CMP parallel those of the Federal Coastal Zone Management Act (CZMA). Standards developed by the Coastal Policy Council (CPC) expand upon the statute. The standards provide more specific policies covering coastal habitats, resources, uses, and activities. The policies that may be relevant to activities hypothesized in this EIS are summarized in the following paragraphs.

Coastal Habitats: Eight coastal habitats were identified in the standards--offshore; estuaries; wetlands and tidelands; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes; and important uplands. Each habitat has a policy specific to maintaining or enhancing the attributes that contribute to its capacity to support living resources. For example, "offshore areas must be managed so as to assure adequate water flow, circulation patterns, nutrients, and oxygen levels and avoid the discharge of toxic wastes, silt, and destruction of productive habitat" (Standards of the ACMP: 6 Alaska Administrative Code [AAC] 80.130[C][1] and [2]).

Activities and uses that do not conform to the standards may be permitted if there are (1) overriding public needs, (2) no feasible prudent alternatives, and (3) appropriate mitigation measures incorporated to maximize conformance. Habitat policies frequently are cited in State consistency reviews.

Coastal Resources: Two policy areas come under the heading of coastal resources: (1) air, land, and water quality; and (2) historic, prehistoric, and archaeological resources. In the first instance, the Alaska CMP defers to the mandates and expertise of the Alaska Department of Environmental Conservation (DEC). The standards incorporate by reference all the statutes, regulations, and procedures of the DEC that pertain to protecting air, land, and water quality (6AAC 80.140). Concerns for air and water quality are cited frequently during State reviews for consistency.

The policy addressing historic, prehistoric, and archaeological resources requires only identification of the "areas of the coast which are important to the study, understanding, or illustration of national, state, or local history or prehistory" (6AAC 80.150).

Uses and Activities: Eight topics are addressed under this heading: coastal development, geophysical-hazard areas, recreation, energy-facility siting, transportation and utilities, fish and seafood processing, timber harvesting and processing, mining and mineral processing, and subsistence. Uses and activities of particular relevance to the activities hypothesized for this OCS lease sale include coastal development, geophysical hazards, energy-facility siting, transportation and utilities, mining and mineral processing, and subsistence.

Coastal development along the shoreline is guided by a list of priorities for waterfront development and by Federal statutes and regulations implemented by the U.S. Army Corps of Engineers. Priority for locating in coastal areas is given first to developments that are water-dependent, second to developments that are water-related, and last to activities that are neither water-dependent nor water-related but that have no feasible or prudent inland location.

Policies for geophysical hazards require the identification of areas of known hazard and highly probable hazard in areas of high development potential. Developments in these areas must be sited, designed, and constructed to minimize property damage and protect against loss of life (6AAC 80.050).

Both the Federal CZMA and the State CMP require that uses of State and Federal concern be addressed and, in some way, accommodated in the local CMP. Major energy facilities fall into this category. As a result, before a local coastal district can restrict or exclude these facilities in its coastal program, the district must demonstrate that the use is not compatible with the proposed site and that the district consulted with affected government agencies and identified reasonable alternative sites (Alaska Statute [AS] 46.40.070[c]). Major energy facilities include "marine service bases and storage depots, pipelines and rights-of-way, drilling rigs and platforms, petroleum or coal separation, treatment, or storage facilities, liquid natural gas plants and terminals, oil terminals and other port development for the transfer of energy products, petrochemical plants, refineries and associated facilities, hydroelectric projects, other electric generating plants, transmission lines, uranium enrichment or nuclear fuel processing facilities, and geothermal facilities" (6AAC 80.900[22]).

The CPC developed 16 criteria to guide energy-facility-site selection. These criteria address constraints imposed by environmental, economic, cultural, and social considerations; harbor configurations and locations; and existing infrastructure (6AAC 80.070[b]). Mitigating measures may be required to ensure conformance with this standard.

State standards for transportation and utilities require that routes and facilities constructed in the coastal area be compatible with local CMP's. Moreover, routes and facilities must be located inland from beaches and shorelines unless the route or facility is water-dependent or there is no feasible and prudent inland alternative (6AAC 80.080).

Mining and mineral processing standards include a policy covering sand and gravel extraction. The state standard allows such extraction from coastal waters, intertidal areas, barrier islands, and spits if there is no feasible or prudent alternative that will meet the public need.

In developing district policies, the district must recognize and assure opportunities for subsistence use of coastal areas and resources. Areas that are used primarily for subsistence purposes must be identified and may be designated as special subsistence zones to the extent that this designation is compatible with the other districts' management plans for fish and game resources that are shared. Potentially conflicting uses or activities occurring within this designated area may be permitted only after a study is conducted to determine that possible adverse effects and safeguards are implemented to assure continued subsistence usage (6AAC 80.120).

(2) <u>North Slope Borough District CMP</u>: The NSB CMP was adopted by the Borough in 1984. Following several revisions, the NSB CMP was approved by the Alaska CPC in April 1985 and sent to the USDOC as an amendment to the ACMP. The USDOC rejected the State's request in August 1986. The State is reviewing options for rectifying the shortcomings identified by the USDOC. The following paragraphs describe the NSB CMP that was approved by the Borough and the CPC. The coastal management boundary adopted by the North Slope Borough and CPC varies slightly from the interim boundary of the ACMP. In the mid-Beaufort sector, the boundary was extended inland on several waterways to include anadromous-fish-spawning and overwintering habitats. Along the Chukchi Sea coast, it was extended inland to include the Kukpuk River and a 1.6-kilometer corridor along each bank.

The NSB CMP was developed to balance exploration, development, and extraction of nonliving natural resources and maintenance of and access to the living resources upon which the Inupiat traditional cultural values and way of life are based. The State-approved NSB CMP contains four categories of policies: (1) "Mandatory Policies" that include both "prohibited development (considered improper uses)" and "required features for applicable development," (2) "Best-Efforts Policies" that include both "feasible and prudent policies" and "required features," (3) "Minimization-of-Negative-Impacts Policies," and (4) "Beneficial-Impacts Policies."

Those activities or developments that are prohibited under Mandatory Policies generally could cause severe harm to subsistence resources or activities or disturb cultural and historic sites. Required features of the Mandatory Policies address reasonable use of vehicles, vessels, and aircraft; engineering criteria for offshore structures; drilling plans; oil-spill-control and

-cleanup plans; pipelines; causeways; residential development associated with resource development; and air quality, water quality, and solid-waste disposal.

Best-Efforts Policies allow for exceptions if there is (1) "a significant public need for the proposed use and activity" and (2) developers have "rigorously explored and objectively evaluated all feasible and prudent alternatives. . ." and briefly documented why the alternatives have been eliminated from consideration. If an exception to a Best-Efforts Policy is granted, the developer must take "all feasible and prudent steps to avoid the adverse impacts the policy was intended to prevent." Feasible and prudent Best-Efforts Policies apply when developments could (1) cause significantly decreased productivity of subsistence resources or ecosystems, (2) displace beluga whales in Kasegaluk Lagoon, or (3) restrict access of subsistence users to a subsistence resource. They also create restrictions on various modes of transportation, mining of beaches, or construction in certain floodplains and geologic-hazard areas. Required features of Best-Efforts Policies are applicable except when the development has met the two criteria for Best-Efforts Policies and the developer has taken all feasible and prudent steps to maximize conformance with the policy. Developments and activities regulated under these policies include coastal mining, support facilities, gravel extraction in floodplains, new subdivisions, and transportation facilities. Siting policies include the State habitat policies, and noninterference with important cultural sites or essential routes for transportation to subsistence resources.

All applicable developments must minimize "negative impacts." Regulated developments include recreational uses, transportation and utility facilities, and seismic exploration. Protected features include permafrost, subsistence activities, important habitat, migrating fish, and wildlife. Geologic hazards must be considered in site selection, design, and construction.

Under Beneficial-Impacts Policies, development can receive positive reviews if it incorporates features that provide benefits to residents such as preferred employment and housing practices, lower-cost fuel or power to adjacent villages, and conservative practices that protect subsistence resources.

The NSB has adopted administrative procedures for implementing these policies based on the permit process established under Title 19 of the Borough's Land Use Regulations and the consistency-review process of Title 46 of the Alaska Statutes.

(3) NANA Coastal Resource Service Area (CRSA) CMP: NANA residents initiated the process for developing a district program in 1978 when they formally requested the formation of a CRSA. Following the elections that created the CRSA and selected the CRSA Board, the CRSA Board worked through several iterations of their planning document before approving the district CMP in July 1985. In May 1986, the Coastal Policy Council adopted the plan as a part of the ACMP. The Northwest Arctic Borough assumed responsibility for the program in October 1986. A preliminary finding by the USDOC states that the NANA program is not approvable.

The final boundary modifies the onshore portion originally established by the ACMP. In order to include uplands where activity potentially could affect anadromous-fish streams, the Board extended the boundary to include the watersheds of several important drainage systems. Near the Lisburne Peninsula, this includes the watersheds of the Kivalina, Wulik, and Noatak Rivers.

The Northwest Arctic Borough CMP complements the Regional Strategy described previously (Sec. III.C.5.b[3]). Although the goals for the two programs are similar, the emphasis of the two programs is different. Whereas the Regional Strategy focuses on social, cultural, and economic dimensions, the CMP concentrates more fully on natural-resources issues.

Driving the CMP process in the Northwest Arctic Borough is the local desire to provide a framework for the NANA people to become integrated into the decision-making process so they can determine their desired quality of life and lifestyle options. Through this self-determination process, the NANA people hope to provide for economic development that is compatible with the traditional subsistence economy. Numerous administrative policies were developed to promote a cooperative planning process to accomplish this.

Enforceable policies typically focus on subsistence uses and resources because subsistence harvest of coastal lands and waters traditionally has been the primary and highest priority for use of all lands and waters within the coastal area. The intent of this emphasis in the enforceable policies is to ensure that all other uses and activities take all reasonable steps to mitigate adverse effects on subsistence resources and the use of subsistence resources.

Three sets of policies were developed. The first set, the General-Use Policies, are those with which all activities and uses in the district must comply. These policies are considered to be minimum standards that must be met throughout the district. They are supplemented in a second set of policies developed for each of 15 areas designated as Special-Use Areas. Of the areas so designated, three are near the Lisburne Peninsula: Cape Krusenstern, the Red Dog Mine transportation corridor, and the area north of Kivalina. A third set of policies was developed for each of eight Restricted/Sensitive-Use Areas. Again, three are near the Lisburne Peninsula: the Wulik River Arctic Char Overwintering Area, the Noatak River Chum Salmon Spawning Area, and the Upper Kivalina River.

In addition, three areas were nominated as Areas Meriting Special Attention (AMSA's): the City of Kotzebue, the Ambler/Bornite District, and Eschscholtz Bay. At this time, the NANA CRSA Board does not intend to initiate the formal AMSA planning process; and these areas are subject only to the appropriate sets of policies described above.

IV. ENVIRONMENTAL CONSEQUENCES

A. Basic Assumptions for Effects Assessment

This section quantifies effects that could result from proposed Sale 109. All figures are relative to the mean-case resource estimate (2.68 billion barrels of oil) since the mean case is used for quantification of probable levels of developmental activity (Sec. II.A). (See Appendix C for a summary of potential effects resulting from the high- and low-resource cases.) There are, however, many areas in which it is difficult to quantify effects due to the variable factors that affect any potential development.

For each effects analysis, all pertinent U.S. laws, Federal regulations, and Alaska OCS Orders are assumed to be in effect. The Alaska OCS Orders and some laws would mitigate certain effects. Further, the discussion of cumulative effects contained in each effects section is based on the interrelationship of this proposed action with other major current and proposed projects. The projects considered in preparing the cumulative-effects assessment are discussed later in this section.

Potentially affected communities should not use this EIS as a "local planning document." Site-specific planning cannot yet be done, and it would be several years hence before such specific projections could be made. The facility locations and scenarios described in this document are only representative of the locations and scenarios that seem likely at this time, and they serve simply as a basis for identifying characteristic activities and resulting effects for this EIS. These locations and scenarios do not represent an MMS recommendation, preference, or endorsement of facility sites or development schemes.

The basic assumptions used in assessing the effects of Sale 109 are summarized in Table IV-1. The activities associated with projected exploration, development, production, and transportation of Chukchi Sea hydrocarbons are described in more detail in Section II.A of this EIS.

The level of activities is based on the mean-case resource estimate for Sale 109 (Table II-2). Resource estimates also are provided for the low case and the high case (Table II-2). The low-case estimate represents a quantity of hydrocarbons that is smaller than that of the mean case but more likely to be discovered. The high-case estimate represents a quantity of hydrocarbons that is larger than that of the mean case but less likely to be discovered. Associated discoveries represented by the high case would be spread over a longer period of time. Thus, the mean-case resource estimate was selected to form the basis for the analysis because it (1) represents the average quantity of oil that is estimated to be large enough for economic recovery and (2) offers a reasonable chance for discovery.

Definitions Assumed For Effects Assessment: The definitions shown in Table S-2 at the beginning of this EIS were developed to help determine the relative extent of effect. The words MAJOR, MODERATE, MINOR, and NEGLIGIBLE--defined in the table--appear in capital letters in Section IV to ensure a common understanding of the terms. These words are capitalized to designate their precise application in this context, rather than to emphasize the level of effect.

Table IV-1
Chukchi Sea Sale 109
Summary of Mean-Case Scenario Assumptions for the Proposal and Deferral Alternatives
(Page 1 of 3)

PHASE Facility or Event	Alternatives I, IV, and V Number or Amount	Alternatives I, IV, and V Timeframe	Alternatives VI Number or Amount	Alternatives VI Timeframe
EXPLORATION				
Shorebase--Located Near Wainwright Airport				
Total Hectares	10	1988	10	1988
Exploration Work Force--Peak Year	719	1994	650	1994
Total Exploration/Delineation Wells (20 exploration, 23 delineation)	43	1989-1996	36	1989-1996
Drilled by Drillships (2)	14	1989-1994	11	1989-1994
Drilled by Bottom-Founded Units (2)	29	1991-1996	25	1991-1996
Drilling Muds and Cuttings Disposed--Dry Metric Tons				
Muds per Well				
Exploration	599	1989-1994	599	1989-1994
Delineation	454	1991-1996	454	1991-1996
Cuttings per Well				
Exploration	1,361	1989-1994	1,361	1989-1994
Delineation	1,179	1991-1994	1,179	1991-1994
Total Muds and Cuttings (exploration and delineation)				
Muds	22,408	1989-1996	18,954	1989-1996
Cuttings	54,340	1989-1996	45,720	1989-1996
Seismic Activity (shallow-hazard)				
Total Number of Days	301	1988-1995	191	1988-1995
Total Trackline Kilometers	7,979	1988-1995	6,598	1988-1995
Kilometers per Site-Specific Survey (50% wells)	63	1988-1995	63	1988-1995
Kilometers per Block-Wide Survey (50% wells)	303	1988-1995	303	1988-1995
Total Support Activities for Exploration Phase				
Helicopters (maximum)	6	1991-1994	6	1991-1994
Maximum Flights per Month Between Shorebase (or Barrow Airport) and Platform (1 flight/day/platform)	124	1991-1994	124	1991-1994
Ice-Management Vessels--per Year	6	1989-1996	6	1989-1996
Barges--per Year	1-8	1989-1996	1-8	1989-1996
DEVELOPMENT				
Shorebase--Located at Point Belcher				
Total Hectares	25-30	1996-1998	25-30	1996-1998
Total Cubic Meters of Gravel	500,000	1995-1998	500,000	1995-1998
Construction of an Airstrip	1,900	1996	1,900	1996
Construction of a Road Between Point Belcher and Wainwright--Kilometers	20-25	1995	20-25	1995
Possible Dredging of a Channel in Peard Bay (depth in meters)	5	1995	5	1995

Table IV-1
Chukchi Sea Sale 109
Summary of Mean-Case Scenario Assumptions for the Proposal and Deferral Alternatives

PHASE Facility or Event	Alternatives I, IV, and V Number or Amount	Alternatives I, IV, and V Timeframe	Alternatives VI Number or Amount	Alternatives VI Timeframe
DEVELOPMENT (continued)				
Development Work Force--Peak Year	5,047	1998	4,500	1998
Platforms--Bottom-Founded	9	1997-1998	7	1997-1998
Wells	153	1997-1999	128	1997-1999
Drilling Muds and Cuttings Disposed--Dry Metric Tons				
Maximum Total Muds	68,005	1997-1999	56,832	1997-1999
Maximum Total Cuttings	212,363	1997-1999	177,664	1997-1999
Muds per Well (depends on amount recycled)	91-444	1997-1999	91-444	1997-1999
Cuttings per Well	1,388	1997-1999	1,388	1997-1999
Seismic Activity				
Total Number of Days	300	1995-1998	233	1995-1998
For Platforms				
Total Trackline Kilometers (3-dimensional, deep-penetration)	8,783	1996-1997	6,831	1996-1997
Area Covered per Platform--Square Kilometers	57	1996-1997	57	1996-1997
For Pipelines				
Total Trackline Kilometers (shallow-hazard)	1,609	1995-1997	1,609	1995-1997
Total Support Activities for Development Phase				
Helicopters	4-5	1997-1999	3-4	1997-1999
Flights per Day per Platform	1-3	1997-1999	1-3	1997-1999
Total Flights per Month	270-810	1997-1999	90-360	1997-1999
Work Boats	8-10	1997-1999	6-8	1997-1999
Round Trips per Day per Platform	1-2	1997-1999	1-2	1997-1999
Total Round Trips per Month	270-540	1997-1999	180-480	1997-1999
Barges--Peak Year	68	1998	58	1998
PRODUCTION				
Production Work Force--Peak Year	2,392	2003-2010	2,150	2003-2010
Peak Oil Production				
Yearly--Million Barrels	225	2000-2005	188	2001-2005
Daily--Barrels	616,438	2000-2005	515,068	2001-2005
Total Oil Produced--Million Barrels	2,680	1999-2017	2,240	1999-2017
Total Support Activities for Production Phase				
Helicopters	3	1999-2017	3	1999-2017
Maximum Flights per Month Between Shorebase and Platforms	75	1999-2017	60	1999-2017
Support/Supply Boats	3	1999-2017	3	1999-2017
Barges per Year--Average	13	2000-2017	13	2000-2017

Table IV-1
Chukchi Sea Sale 109
Summary of Mean-Case Scenario Assumptions for the Proposal and Deferral Alternatives

PHASE Facility or Event	Alternatives I, IV, and V Number or Amount	Alternatives I, IV, and V Timeframe	Alternative VI Number or Amount	Alternative VI Timeframe
TRANSPORTATION				
Pipelines (pipelines from the platforms would converge offshore and come onshore at Point Belcher)				
Onshore Pipeline to TAP Pump Station No. 2--Kilometers	640	1995-1998	640	1995-1998
Support Road--Kilometers	640	1995-1998	640	1995-1998
Helicopter Pads	10-12	1995-1998	10-12	1995-1998
Major River Crossings (Approx.)	10	1995-1998	10	1995-1998
Offshore Trunk Pipelines--Kilometers	400	1996-1998	400	1996-1998
Area Disturbed During Offshore-Pipeline Laying 1/				
Trenching--Hectares	946	1996-1998	946	1996-1998
Dumping--Hectares	1,892	1996-1998	1,892	1996-1998
Total Hectares	2,838	1996-1998	2,838	1996-1998
Maximum Volume of Fill Material--Cubic Meters	28,090,000		28,090,000	
OIL SPILLS				
Assumed for Analysis				
Offshore 2/				
<1,000 Barrels	777 3/		650 4/	
≧1,000 Barrels	7		5 or 6	
≧100,000 Barrels	0		0	
Onshore 5/				
2-23 Barrels (average size 6 barrels)	121		121	
24-239 Barrels (average size 98 barrels)	45		45	
>239 Barrels (average size 1,500 barrels)	22		22	

Source: MMS, Alaska OCS Region.

1/ Assumptions used to arrive at the area disturbed during pipeline laying are as follows:
(a) Side slopes assumed 1:2 (Hemphill, 1986, oral comm.).
(b) 5 kilometers placed between the 10- and 20-meter isobaths, trench depth = 3 meters (Han-Padron, 1985).
(c) 20 kilometers placed between the 20- and 30-meter isobaths, trench depth = 5 meters (Han-Padron, 1985).
(d) 375 kilometers placed between the 30- and 50-meter isobaths, trench depth = 6 meters (Han Padron, 1985).

2/ Oil-spill assumptions include all offshore spills north of the Bering Strait during exploration and production.

3/ Total volume of small spills is 3,140 barrels; the average spill size is 4.0 barrels.

4/ Total volume of small spills is 2,630 barrels; the average spill size is 4.0 barrels.

5/ Calculated from projected pipeline-spill statistics for the National Petroleum Reserve-Alaska (USDOI, BLM, NPR-A, 1983).

Major Projects Considered in Cumulative-Effects Assessment: The regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA) require that consideration be given in the EIS to the cumulative effect "on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7).

Projects described in Appendix G are placed in three categories ranging from those that already exist to those that could occur at some point in the more distant future. Major projects are illustrated in Graphic No. 3 and categorized in Table IV-2 according to their proximity to the Chukchi Sea: (1) the Chukchi Sea region, (2) the mid-Beaufort Sea region, and (3) the eastern Beaufort Sea region. The Chukchi Sea region includes onshore lands west of the Colville River and offshore areas between the Beaufort Sea OCS Planning Area and the Bering Strait. The mid-Beaufort Sea region includes the onshore areas between the Colville and the Canning Rivers, all State submerged lands between Barrow and the Canning River, and the Beaufort Sea OCS Planning Area. The eastern Beaufort Sea region is defined as the area east of the Canning River. Although development in this region is far removed from the Chukchi Sea, it may affect some of the resources analyzed in this EIS. (The parenthetical numbers shown with the project names in Table IV-2 correspond to respectively numbered projects in Appendix G.)

1. Oil-Spill-Risk Analysis: This analysis considers both the likelihood of oil spills occurring and the likelihood that such spills would contact important resource areas. The analysis looks at risk in the Chukchi Sea from proposed Sale 109, from three deferral alternatives, and from the cumulative case with the proposal. Cumulative oil-spill risk from the oil-exploration and -production industry elsewhere offshore of Alaska is described and discussed in detail in Sections IV.A and IV.B of the Gulf of Alaska Sale 88 FEIS (USDOI, MMS, 1984b), the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c), and the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a). These sections are herein incorporated by reference. The following summary is pertinent to the Sale 109 cumulative case and is augmented by additional material, as cited.

a. Estimated Quantity of Resource: The likelihood that oil spills would occur can be estimated from the assumed volume of oil produced and transported. The estimated oil resource used for the oil-spill-risk calculations is the mean-case resource estimate (2.68 billion barrels). There is an important qualification in the way this estimate is used in this EIS. That is, the mean-case estimate is assumed to be leased, found, and produced. The projected number of spills and, accordingly, the results of the oil-spill-risk analysis reflect the expected oil-spill risk based on the mean-resource estimate. There is only a one-in-five chance that commercial quantities of oil would be discovered as a result of proposed Sale 109.

Only future OCS sales scheduled within a year of Sale 109 are included in the cumulative oil-spill-risk analysis. Thus, the cumulative case for the Chukchi Sea includes oil production and transportation from proposed Sale 109 and from the western portion of proposed Sale 97 in the Beaufort Sea Planning Area. No offshore Chukchi Sea lease sales have been held by the State of Alaska, and

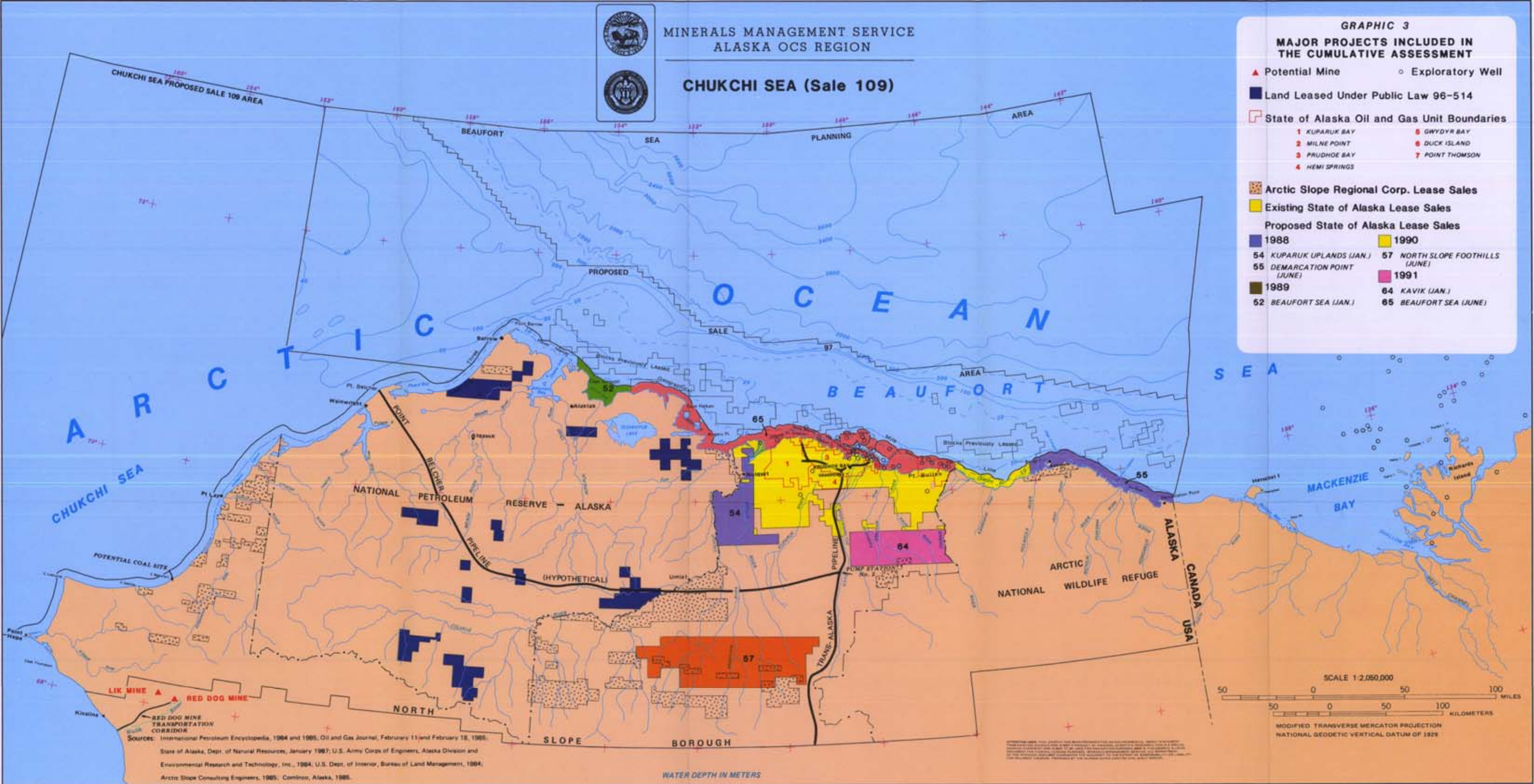

MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION
CHUKCHI SEA (Sale 109)
GRAPHIC 3
MAJOR PROJECTS INCLUDED IN THE CUMULATIVE ASSESSMENT
▲ Potential Mine
○ Exploratory Well
Land Leased Under Public Law 96-514
State of Alaska Oil and Gas Unit Boundaries
1 KUPARUK BAY
2 MILNE POINT
3 PRUDHOE BAY
4 HEMI SPRINGS
5 GWYDYR BAY
6 DUCK ISLAND
7 POINT THOMSON
Arctic Slope Regional Corp. Lease Sales
Existing State of Alaska Lease Sales
Proposed State of Alaska Lease Sales
1988
54 KUPARUK UPLANDS (JAN.)
55 DEMARCATION POINT (JUNE)
1989
52 BEAUFORT SEA (JAN.)
1990
57 NORTH SLOPE FOOTHILLS (JUNE)
1991
64 KAVIK (JAN.)
65 BEAUFORT SEA (JUNE)
CHUKCHI SEA PROPOSED SALE 109 AREA
BEAUFORT SEA PLANNING AREA
PROPOSED SALE 97 AREA
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
MACKENZIE BAY
Barrow
Wainwright
Pt. Belcher
Pt. Lay
Point Hope
Kivalina
Umiat
Atqasuk
Nuiqsut
Pt. Barrow
Blocks Previously Leased
NATIONAL PETROLEUM RESERVE - ALASKA
POINT BELCHER PIPELINE (HYPOTHETICAL)
TRANS-ALASKA PIPELINE
PUMP STATION No. 1
POTENTIAL COAL SITE
LIK MINE
RED DOG MINE
RED DOG MINE TRANSPORTATION CORRIDOR
NORTH SLOPE BOROUGH
ARCTIC NATIONAL WILDLIFE REFUGE
ALASKA
CANADA
USA
Pt. Bullen
52
54
55
57
64
65
SCALE 1:2,050,000
MILES
KILOMETERS
MODIFIED TRANSVERSE MERCATOR PROJECTION
NATIONAL GEODETIC VERTICAL DATUM OF 1929
WATER DEPTH IN METERS
Sources: International Petroleum Encyclopedia, 1984 and 1985; Oil and Gas Journal, February 11 and February 18, 1985; State of Alaska, Dept. of Natural Resources, January 1987; U.S. Army Corps of Engineers, Alaska Division and Environmental Research and Technology, Inc., 1984; U.S. Dept. of Interior, Bureau of Land Management, 1984; Arctic Slope Consulting Engineers, 1985; Cominco, Alaska, 1985.

Table IV-2
Major Projects Considered in Cumulative-Effects Assessment

Project Name[1/]	General Location	Resource Estimate[2/]	Developmental Timeframe[3/] Exploration	Development Construction	Peak Daily Production[4/]	Current Status 1986
Chukchi Sea Region						
North Slope Borough Capital Improvements Program (CIP) (2)	North Slope Borough	Not relevant	Not relevant	1983-1985+	Operation: 1983-1985+	Includes projects at villages, Prudhoe Bay, and Kuparuk.
Red Dog Mine (9)	145 km north of Kotzebue and 115 km east of Kivalina	77 million metric tons, primarily of zinc/lead reserves	Complete	1986-1989	1992-2019 4,782 dry metric tons	Construction of the port facility began in the summer of 1986. Production is scheduled to begin in 1990.
National Petroleum Reserve-Alaska (NPR-A) (12)	Northwest Alaska, west of Colville River	1.85 (oil) 3.26 (gas)	1944-1989	1987-1989	1990-1991 132,000 bbls/day	No commercial reserves have been discovered. Annual lease sales are scheduled.
Arctic Slope Regional Corporation (ASRC) Leasing (16)	Primarily northwestern Alaska, south and west of NPR-A	--	1973 and thereafter	--	--	Low-level exploration ongoing; no discoveries. Drilling up to three wells in ANWR.
Discovered Resources (Mining) (10)	Generally in the De Long Mountain area	--	--	--	--	With the development of the transportation system for the Red Dog deposit, other zinc/lead deposits--such as the Lik--may become commercial. Coal resources along the Chukchi Sea coast have been recommended for development.

Table IV-2
Major Projects Considered in Cumulative-Effects Assessment

Project Name[1/]	General Location	Resource Estimate[2/]	Developmental Timeframe[3/] Exploration	Development Construction	Peak Daily Production[4/]	Current Status 1986
Chukchi Sea Region (continued)						
Future State of Alaska Leasing (18)	35 km south of Barrow to Cape Beaufort and in Kotzebue Sound	Low to moderate petroleum potential	1987 and thereafter	--	--	State Lease Sales 45, 53, 58, and 60 were dropped from the 1987 5-year lease schedule pending more favorable leasing conditions.
Future OCS Leasing (19)						No leases currently are scheduled for this area.
a. Chukchi Sea	Offshore Chukchi Sea	2.7 (oil)	1990 and thereafter	--	--	Information for Sale 109 also would apply to Sale 126 proposed for 1991.
b. Hope Basin	Kotzebue Sound and Chukchi Sea	0.17 (oil)	1992 and thereafter	--	--	OCS Sale 133 is a frontier-exploration sale proposed for 1992.
Mid-Beaufort Sea Region						
Trans-Alaska Pipeline (TAP) (1)	Prudhoe Bay to Valdez	Not relevant	Not relevant	1973-1977	Design capacity: 2,000,000 bbls/day	The 1,288-km pipeline and related facilities occupy 42.4 km². Current flow rate is 2 MMbbls/day.
Prudhoe Bay Unit (PBU) Oil Production (3)	Prudhoe Bay onshore	9.6 (oil)	1965-1969	1969-1985	1977-2006 1.5 MMbbls/day	Peak production ongoing until 1990; declining thereafter. More than 5 Bbbls had been recovered by June 1987.
Lisburne Field (4)	Prudhoe Bay Unit	0.35-0.45 (oil)	1968-1983	1984-1991	1986-2017 100,000 bbls/day	Production began in 1987.

Table IV-2
Major Projects Considered in Cumulative-Effects Assessment
(Page 3 of 5)

Project Name[1]	General Location	Resource Estimate[2]	Developmental Timeframe[3]: Exploration	Developmental Timeframe[3]: Development Construction	Developmental Timeframe[3]: Peak Daily Production[4]	Current Status 1986
Mid-Beaufort Sea Region (continued)						
Kuparuk River Field (5)	Approx. 40 km west of Prudhoe Bay, onshore	0.4-1.3 (oil)	1970-1979	1981-1986	1982-2002 250,000 bbls/day	Phase I production commenced in December 1981. Full-field water-flood recovery began in 1986.
West Sak (6)	Within Kuparuk River Unit	2.0-4.0 (oil)	1970-1975	1984-Post-1986	1985-2015+ 200,000 bbls/day if developed; 2,500 bbls/day during pilot project	Pilot project is completed. Development will not occur until oil prices improve and become more stable.
Endicott (7)	19.3 km east of Prudhoe Bay offshore	0.3-0.98 (oil)	1977-1982	1985-1987	1988-2000+ 100,000 bbls/day	Roads and islands are constructed. Pipeline should be completed in 1987.
Milne Point (8)	North of Kuparuk River Unit	0.03-.08 (oil)	1970-1984	1984-1985	1986-2000+ 30,000 bbls/day	Production began in 1985 and was suspended in 1986. Milne pipeline ties into the Kuparuk pipeline.
Discovered Resources (Oil Fields and Gas Fields) (10)	Mid-Beaufort Sea	--	--	--	--	Until gas infrastructure is available, gas fields such as Point Thomson and Gubik won't be developed. Others such as Gwydyr Bay, Ugnu Sands, and Simpson Lagoon need either technological advances or increases in oil prices before they can be developed.

Table IV-2
Major Projects Considered in Cumulative-Effects Assessment
(Page 4 of 5)

			Developmental Timeframe[3]			
Project Name[1]	Location	General Resource Estimate[2]	Exploration	Construction	Development Production[4] Peak Daily	Current Status 1986
Mid-Beaufort Sea Region (continued)						
Seal Island (11)	Beaufort Sea	0.3 (oil)	1981-1986	1987-1990	1989-2014 5,000 bbls/day	Recent drilling from Northstar Island has been suspended.
Previous State Sales (14)	Uplands and offshore in Mid-Beaufort Sea region	1.0	1983-1988	1988-1993	1989-2014 47,800 bbls/day; 1990-2016 425 MMcf/day	Seal Island and Endicott are primarily on State-leased land.
Previous Federal Offshore Lease Sales (15)	Barrow to Canada within 200-m isobath	0.6 (oil)	1981-1992	1992-1995	1995-2014 50,000 bbls/day	Exploration drilling is underway.
Future OCS Leasing Beaufort Sea (19)	Offshore Beaufort Sea	0.65	1988 and thereafter	1995 and thereafter	1996-2014+ 150,000 bbls/day	Information applies for Sale 97 and future Beaufort Sea sales.
Future State of Alaska Leasing (18)	Offshore Beaufort Sea, onshore east of PBU	Moderate to high petroleum potential	1986 and thereafter	--	--	State Lease Sales 51, 52, 54, 57, 64 and 65 are both onshore and offshore. Little information is available. Sale 61 was dropped from the 5-year lease schedule in January 1987.
Eastern Beaufort Sea Region						
Arctic National Wildlife Refuge (ANWR) (13)	North of Brooks Range, east of Canning River	--	1983 and thereafter	Prohibited	Prohibited	Three wells are being drilled on ASRC lands. ANILCA prohibits development or additional exploratory drilling until authorized by Congress.

Table IV-2
Major Projects Considered in Cumulative-Effects Assessment
(Page 5 of 5)

Project Name 1/	General Location	Resource Estimate 2/	Developmental Timeframe 3/ Exploration	Development Construction	Peak Daily Production 4/	Current Status 1986
Canadian Beaufort Sea (ESSO, Dome, Gulf acreage) (17)	Offshore Mackenzie Bay, Canada	9.2 (oil)	1973-1990	1982-2000+ and thereafter	1987-2000+ 180,000 to 1.3 MMbbls/ day	Major discoveries subject to delineation. EIS on development and production completed, but no development announced yet.
Future State of Alaska Leasing (18)	Submerged lands between the Canning River and Demarcation Point	Moderate to high petroleum potential	1987 and thereafter	--	--	State Lease Sales 50 and 55.

Source: MMS, Alaska OCS Region.

-- Denotes no data available.

1/ The numbering in parentheses following the projects in this table corresponds with the listing and further description of projects in Appendix G of this EIS.

2/ Resource estimates for oil are expressed in billions of barrels of recoverable oil; gas estimates are expressed in trillions of cubic feet.

3/ Developmental timeframes are approximate. Dates are fixed with timing of first commercial field development. Timeframes for subsequent fields are not indicated.

4/ Production estimates, when available, are expressed in barrels of oil per day (MMbbls = million barrels) and cubic feet of gas per day (MMcf = million cubic feet).

three planned sales have been deleted from the State's leasing schedule. Furthermore, the MMS considers that these sales would have held negligible oil resource; therefore, they pose negligible oil-spill risk, and they are not included in the cumulative-risk analysis. Oil tankered southward from the Canadian Beaufort Sea through the Chukchi Sea also is included in the analysis. The Canadian Beaufort Sea/Mackenzie Delta area has an estimated 9.2 billion barrels of discovered and undiscovered resource. Current development strategies of Canadian oil companies indicate that initial shipments of this oil would be to Pacific-rim markets, via the U.S. Beaufort, Chukchi, and Bering Seas (OGJ, 1987a). Subsequent, larger volumes of crude would be transported to inland Canada via a pipeline south through the Mackenzie River Valley. If economically successful, the initial tankering could be expanded to a year-round basis through use of icebreaking tankers. This EIS hypothesizes that, starting no sooner than 1990 but continuing for the remaining life of Canadian Beaufort Sea fields, one tanker a week--both in summer and in winter--might be routed westward through the U.S. Beaufort Sea to Asian markets, for a total westward tankering of a potential 1.7 billion barrels. For the purpose of this analysis, 1.7 billion barrels--or 18 percent--of this Canadian crude is assumed to be tankered through the Chukchi Sea.

b. Probability of Oil-Spill Occurrence: The procedures and statistics used by the MMS to calculate frequencies and probabilities of spillage, including validation of projections of spillage for Alaskan conditions, are described and discussed in detail in Section IV.A.1.b of the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c) and are herein incorporated by reference; the following summary is augmented by additional material, as cited. The expected numbers of spills of 1,000 barrels or more are calculated as proportionate to the volume of oil discovered, produced, and transported, and to the number of port calls by tankers, if any (Table IV-3). The probabilities of such spills occurring are calculated from the expected numbers through use of standard (Poisson) statistical distributions governing the occurrences of rare, random events. Frequency of smaller spills is calculated as proportionate to the number of drilling days during exploration and to the amount of oil produced and transported during production.

Transportation Assumptions: In the analysis of the mean case for proposed Chukchi Sea Sale 109, the transportation scheme assumes transport of oil by offshore and onshore pipelines to a connection with the trans-Alaska pipeline (TAP). From there, the oil is transported south by pipeline to Valdez and then shipped to the continental U.S. by tankers. In the oil-spill-risk analysis, the OCS offshore pipeline comes ashore at Point Belcher. Oil estimated to be produced from the western portion of proposed Sale 97 is assumed to be transported by the same pipeline system.

The modeled study area and the proposed Sale 109 area are shown in Figure IV-1. The hypothetical launch points that represent possible platform locations, pipeline routes, and Canadian-tanker routes are shown in Figure IV-2. Note that all transportation scenarios are hypothetical and are put forth only to aid in analyzing possible effects. Use of any transportation routes would depend upon finding commercial quantities of oil, where that oil is found, and subsequent environmental and economic analyses of transportation modes and routes.

Table IV-3
Spill-Rate Constants Used in Oil-Spill-Risk Analysis,
Based on Historical OCS Spill Rates

	Spills Per Billion Barrels	
	1,000 barrels or greater	100,000 barrels or greater
Platforms	1.0	0.036
Pipelines	1.6	0.065
Tankers		
At sea	0.9	0.19
Per port call	0.2	0.042

Source: MMS, Branch of Environmental Modeling.

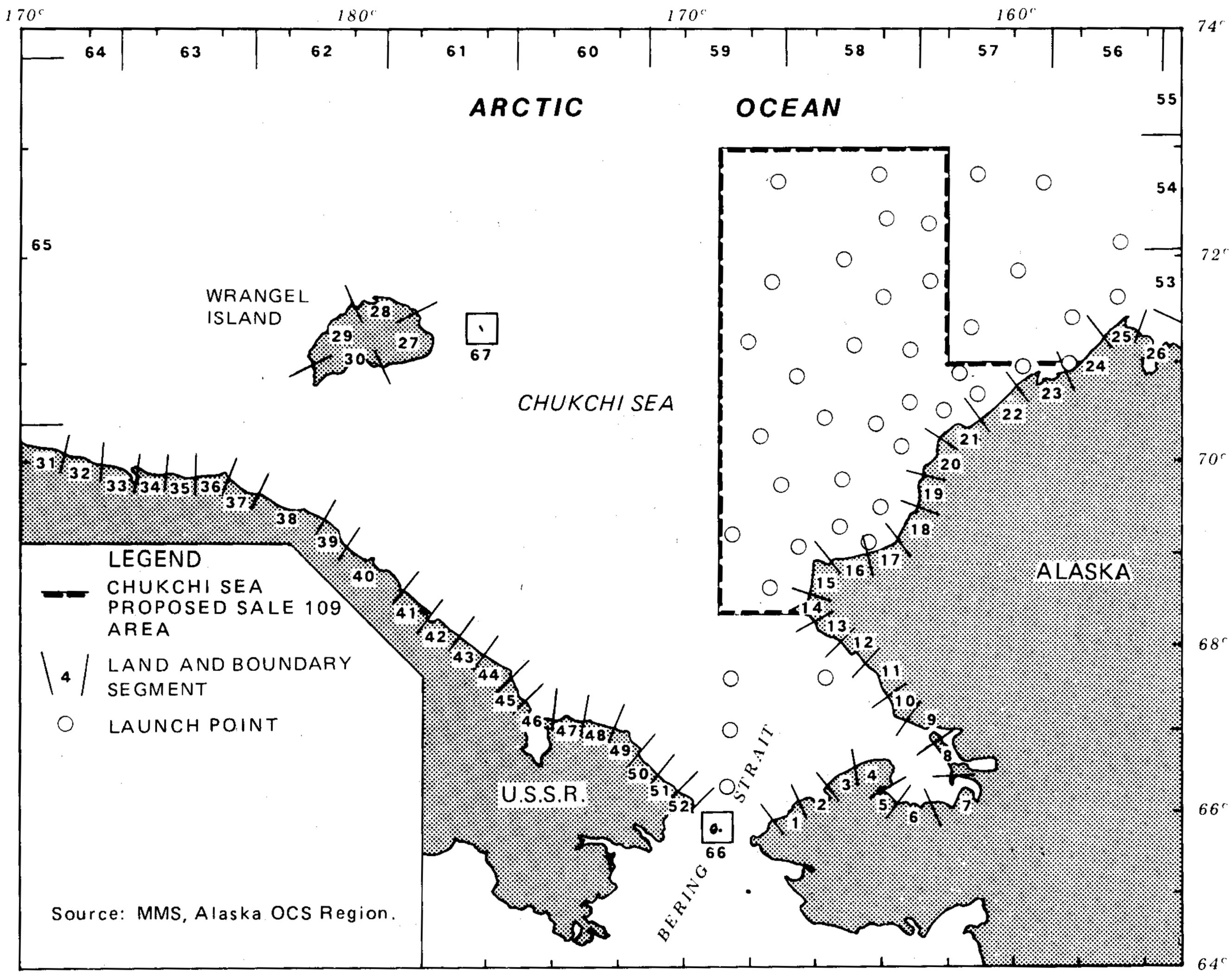


FIGURE IV–1. STUDY AREA BOUNDARIES AND LAND/BOUNDARY SEGMENTS USED IN THE OIL-SPILL-RISK ANALYSIS FOR SALE 109

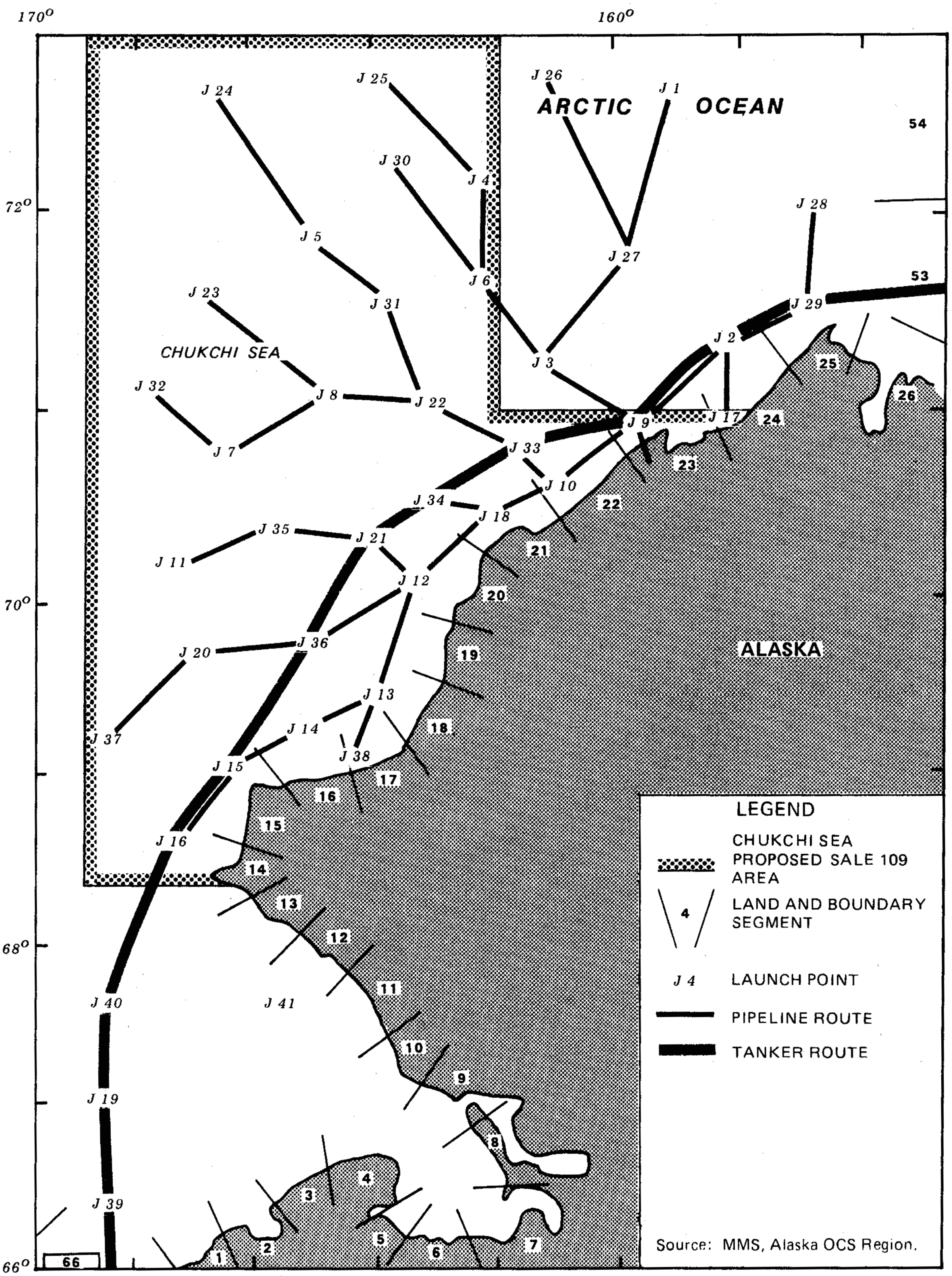


FIGURE IV–2. DETAIL SHOWING HYPOTHETICAL LAUNCH POINTS REPRESENTING POSSIBLE PLATFORM LOCATIONS, PIPELINE ROUTES, AND CANADIAN TANKER ROUTES IN THE STUDY AREA FOR THE MEAN–CASE RESOURCE ESTIMATE

An assumption is made for the oil-spill-risk analysis that only 25 percent of the at-sea risk of oil spills from Canadian tankers would occur in the sale area. This assumption is reflected in the number of spills projected for Canadian tankering. Only a fraction of the entire Canadian tanker route, which neither originates nor ends in U.S. waters, lies within the sale area. An additional 25 percent of spillage is assumed to occur in the Beaufort Sea in EIS's for the Beaufort Sea Planning Area, and an additional 25 percent in the Bering Sea in EIS's for Bering Sea Planning Areas. The remaining 25 percent of spillage is assumed to occur elsewhere--in the Pacific Ocean on the route to market.

In addition to the proposed action (Alternative I), three block-deferral alternatives are considered in this oil-spill-risk analysis: The Eastern Deferral Alternative (Alternative IV), the Southern Deferral Alternative (Alternative V), and the Coastal Deferral Alternative (Alternative VI). These alternatives are described in Section II.B.2.

Projected Spillage: Spill frequencies were calculated for proposed Sale 109. Table IV-4 shows the statistically expected number of spills of 100,000 barrels or greater and of 1,000 barrels or greater (including those spills in the larger category) that could occur as a result of the proposed sale, the deferral alternatives, and the cumulative case. These projections assume that the mean resource is discovered and produced.

These two large-size categories for spills are of special interest. To place these sizes in perspective to the type of accident usually involved, spills in the larger category (100,000 barrels or greater) are usually associated with catastrophes such as large blowouts or shipwrecks. Spills of 1,000 barrels or greater typically include these and other serious events, such as structural failures and collisions. The choice of spill size to use depends upon the analysis to be performed and how many spills of that size are projected to occur. For most analyses in this EIS, effects of a 1,000-barrel-or-greater spill are emphasized because of the range in most likely number of five to seven such spills projected to occur in the oil-spill-risk analysis of the proposal, deferral alternatives, and cumulative case. However, if a particular effect could occur only from a more massive oil slick, then only larger spills are examined.

In addition to the possible occurrence of these large spills of 1,000 barrels or greater, more frequent spillage of smaller volumes is also anticipated. Worldwide, oil spills of 50 barrels or less from platforms annually contribute 0.02 to 0.03 million barrels, and operational discharges 0.05 to 0.08 million barrels (National Research Council [NRC], 1985). Therefore, small spills of 50 barrels or less constitute only 4 to 10 percent of the total industry discharge and are not usually a major concern. This point is evidenced in the offshore-Alaska data from State and Federal leases. During exploration in northern Alaska waters, spills of less than 1,000 barrels occur once for about every 57 days of drilling activity. These spills of less than 1,000 barrels, however, have been very small, averaging 0.25 barrel in size. At a similar rate for the proposal, during the drilling of 43 exploration and delineation wells over 8 years, on the order of 67 such spills could occur; but the total spilled would be only about 18 barrels.

Table IV-4
Projected Spillage and Probabilities of Spillage in the Oil-Spill-Trajectory Model
Over the Expected Production Life of Proposed Chukchi Sea Sale 109,
Deferral Alternatives, and Cumulative Case with the Proposal

	Volume of oil (billion barrels)	Expected number of spills from platforms		Expected number of spills from transportation		Total number of spills		Probability of one or more spills (platforms)		Probability of one or more spills (transportation)		Probability of one or more spills (total)	
		1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater
Chukchi Sea Sale 109													
Proposed Action	2.68	2.7	0.10	4.3	0.17	7.0	0.27	0.93	0.09	0.99	0.16	0.99+	0.24
Eastern Deferral Alternative	2.68	2.7	0.10	4.3	0.17	7.0	0.27	0.93	0.09	0.99	0.16	0.99+	0.24
Southern Deferral Alternative	2.68	2.7	0.10	4.3	0.17	7.0	0.27	0.93	0.09	0.99	0.16	0.99+	0.24
Coastal Deferral Alternative	2.24	2.2	0.08	3.6	0.15	5.8	0.23	0.89	0.08	0.97	0.14	0.99+	0.20
Cumulative Case Proposed Sale 97	0.05 1/	0.1	0.00	0.1	0.00	0.1	0.01	0.05	0.00	0.08	0.00	0.12	0.01
Canadian Tankering	1.7	--	--	0.38	0.08	0.38	0.08	--	--	0.32	0.08	0.32	0.08
Total Cumulative (including proposal)	4.43	2.7	0.10	4.7	0.26	7.5	0.36	0.93	0.09	0.99	0.23	0.99+	0.30

Source: MMS, Alaska OCS Region and Branch of Environmental Modeling.

1/ Chukchi Sea portion of proposed Sale 97.

-- Not applicable.

Note: Please See Table IV-1 for assumed numbers of spills.

Spills of less than 1,000 barrels would be more frequent during the production years, but the anticipated volumes of such spills would still be very small. Since 1971, the offshore-oil industry in Alaskan State waters has experienced spills at a rate of 265 spills per billion barrels produced and transported. None of the reported spill sizes has been as large as 1,000 barrels, and the average size has been 4.4 barrels. Extrapolation of this rate and average size to the proposal gives a projection of 710 spills of less than 1,000 barrels each over the production years, totaling 3,120 barrels. Total spillage projected for the proposal during both exploration and production years from such small spills would be 777 spills totaling 3,140 barrels. Because of estimated oil reserves and development scenarios identical to those of the proposal, the numbers and combined volume of small spills for both Alternatives IV and V are also projected at 777 spills totaling 3,140 barrels. Alternative IV, with slightly fewer exploration and delineation wells and less production, is projected to have 650 small spills totaling 2,630 barrels.

Probability of Spillage: The likelihood that one or more large oil spills would occur under the proposed action or any of the deferral alternatives is high as a consequence of the high projected resources. For each of the proposal and deferral alternatives, the MMS projects a greater than 99.5-percent chance that one or more oil spills of at least 1,000 barrels would occur over the life of the field.

Most Likely Number of Spills: In this EIS, analysts use the "probability of one or more spills" occurring or contacting a resource. For situations where the probability of two or more spills becomes greater than the probability of one spill, the analysts also refer to and use the "most likely number of spills."

The statistically most likely number of spills is simply the number of spills with the highest probability of occurrence. The relationship between the statistically most likely number of spills (mode) and probability distribution for various numbers of spills is shown in Figure IV-3 for the proposal and Alternatives IV and V, in Figure IV-4 for the cumulative case with the proposal, and in Figure IV-5 for Alternative VI.

The most likely number of spills of at least 1,000 barrels resulting from the proposed action, Alternative IV, or Alternative V is seven. Alternative VI would reduce this most likely number of spills to five, although the 16-percent chance of six spills occurring is almost as great as the 16.6-percent chance of five spills occurring. Therefore, the EIS uses a range of five or six spills to represent the most likely number of spills of at least 1,000 barrels for Alternative VI. A most likely number of seven spills is also projected for the cumulative case: almost all spill risk in the cumulative case is from proposed Sale 109.

Size of a 1,000-Barrel-or-Greater Spill: The logarithmic-mean size of a 1,000-barrel-or-greater spill is 8,000 barrels for platform spills, 7,500 barrels for pipeline spills, and 20,000 barrels for tanker spills. In this EIS, a spill size of 10,000 barrels is used as a standard example of a spill of 1,000 barrels or greater.

Exploration Spills: The purpose of this EIS is to project the effects of all phases of oil development rather than just exploration. The oil-spill-risk

```
                        SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  7.0
PROBABILITY OF ONE OR MORE = GREATER THAN 99.5%
MOST LIKELY (MODE) =  7

                                   10%  20%  30%  40%  50%  60%  70%  80%  90%
                              +----+----+----+----+----+----+----+----+----+----+
PROB. OF  1 =  0.6%   1 I
PROB. OF  2 =  2.2%   2 I*
PROB. OF  3 =  5.2%   3 I***
PROB. OF  4 =  9.1%   4 I*****
PROB. OF  5 = 12.8%   5 I******
PROB. OF  6 = 14.9%   6 I*******
PROB. OF  7 = 14.9%   7 I*******
PROB. OF  8 = 13.0%   8 I*******
PROB. OF  9 = 10.1%   9 I*****
PROB. OF 10 =  7.1%  10 I****
PROB. OF 11 =  4.5%  11 I**
PROB. OF 12 =  2.6%  12 I*
PROB. OF 13 =  1.4%  13 I*
PROB. OF 14 =  0.7%  14 I
```

```
                       SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.27
PROBABILITY OF ONE OR MORE =  24%
MOST LIKELY (MODE) =  0

                                    10%  20%  30%  40%  50%  60%  70%  80%  90%
                               +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 76.34%  0 I**************************************
PROB. OF  1 = 20.61%  1 I**********
PROB. OF  2 =  2.78%  2 I*
```

Source: USDOI, MMS, Branch of Environmental Modeling.

FIGURE IV–3. THE RELATIONSHIP OF EXPECTED NUMBER TO MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR THE PROPOSAL, ALTERNATIVE IV, AND ALTERNATIVE V

```
                    SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  7.5
PROBABILITY OF ONE OR MORE = GREATER THAN 99.5%
MOST LIKELY (MODE) =  7

                             10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  2 =  1.6%   2 I*
PROB. OF  3 =  3.9%   3 I**
PROB. OF  4 =  7.3%   4 I****
PROB. OF  5 = 10.9%   5 I*****
PROB. OF  6 = 13.7%   6 I*******
PROB. OF  7 = 14.7%   7 I*******
PROB. OF  8 = 13.7%   8 I*******
PROB. OF  9 = 11.4%   9 I******
PROB. OF 10 =  8.6%  10 I****
PROB. OF 11 =  5.8%  11 I***
PROB. OF 12 =  3.7%  12 I**
PROB. OF 13 =  2.1%  13 I*
PROB. OF 14 =  1.1%  14 I*
PROB. OF 15 =  0.6%  15 I


                   SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.36
PROBABILITY OF ONE OR MORE =  30%
MOST LIKELY (MODE) =  0

                              10%  20%  30%  40%  50%  60%  70%  80%  90%
                         +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 69.77%   0 I***********************************
PROB. OF  1 = 25.12%   1 I*************
PROB. OF  2 =  4.52%   2 I**
PROB. OF  3 =  0.54%   3 I
```

Source: USDOI, MMS, Branch of Environmental Modeling.

FIGURE IV–4. THE RELATIONSHIP OF EXPECTED NUMBER TO MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR THE CUMULATIVE CASE WITH THE PROPOSAL

```
                     SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  5.8
PROBABILITY OF ONE OR MOkE = GREATER THAN 99.5%
MOST LIKELY (MODE) =  5

                          10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  1 =  1.8%   1 I*
PROB. OF  2 =  5.1%   2 I***
PROB. OF  3 =  9.9%   3 I*****
PROB. OF  4 = 14.3%   4 I*******
PROB. OF  5 = 16.6%   5 I********
PROB. OF  6 = 16.0%   6 I********
PROB. OF  7 = 13.3%   7 I*******
PROB. OF  8 =  9.6%   8 I*****
PROB. OF  9 =  6.2%   9 I***
PROB. OF 10 =  3.6%  10 I**
PROB. OF 11 =  1.9%  11 I*
PROB. OF 12 =  0.9%  12 I



                    SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.23
PROBABILITY OF ONE OR MORE =  21%
MOST LIKELY (MODE) =  0

                          10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 79.45%  0 I****************************************
PROB. OF  1 = 18.27%  1 I*********
PROB. OF  2 =  2.10%  2 I*
```

Source: USDOI, MMS, Branch of Environmental Modeling.

FIGURE IV–5. THE RELATIONSHIP OF EXPECTED NUMBER TO MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR ALTERNATIVE VI analysis is based on the mean, unrisked resource estimate assumed to be both discovered and produced. Because pipelines are used during production and not during exploration, exploration spills would be only platform and minor supply-related spills. The number of smaller spills has already been estimated for exploration (67 spills totaling 18 barrels).

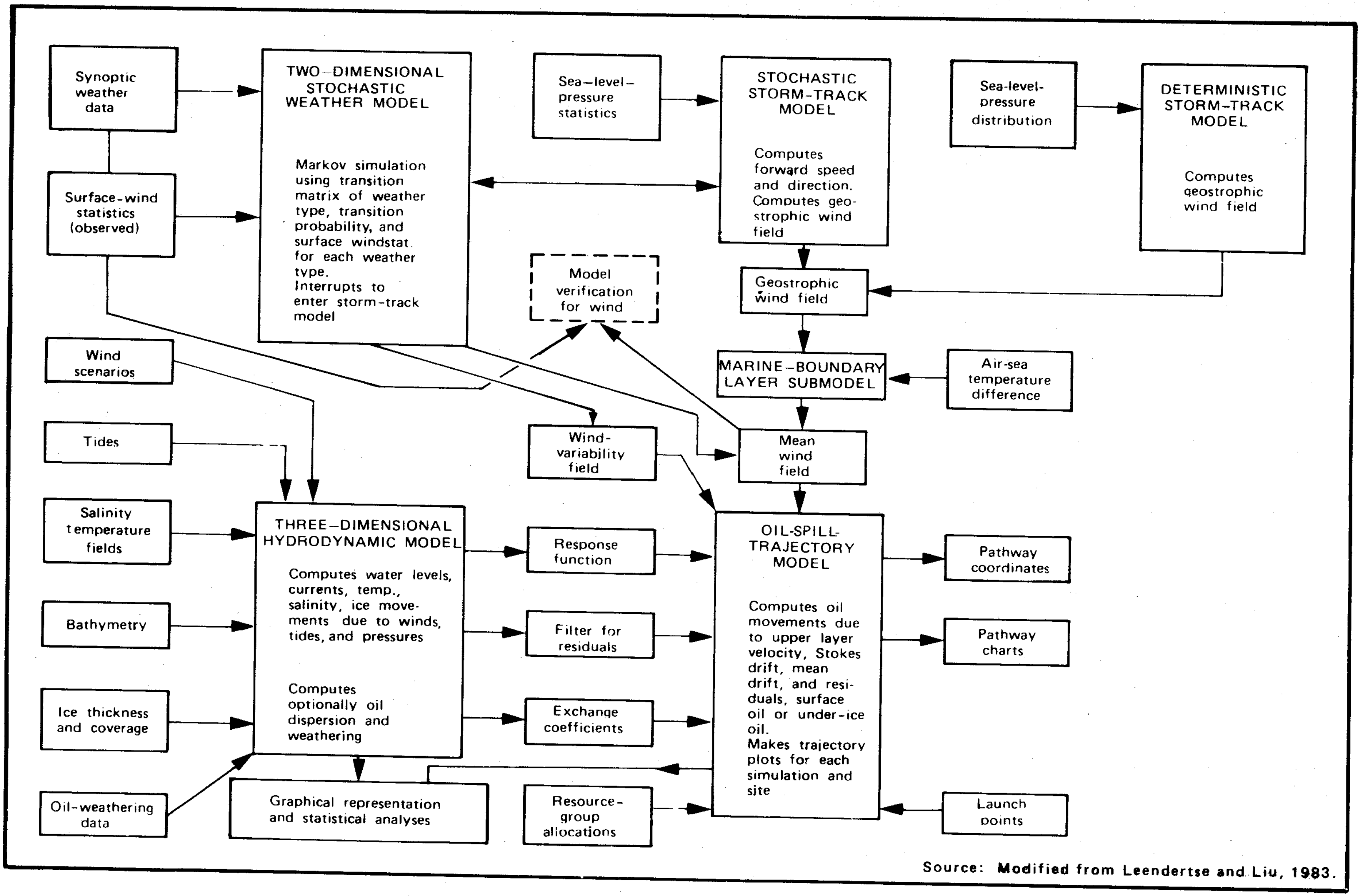
For spills of 1,000 barrels or greater, platforms account for about 38 percent of the spill risk in the proposal and deferral alternatives. The order-of-magnitude frequency for such spills during exploration in the OCS is about one-twelfth of the total platform-spill-occurrence rate during exploration plus production. Thus, the likelihood of a spill of 1,000 barrels or greater during exploration is on the order of 30 times less probable (12/0.38) than the likelihood during exploration plus production described in this EIS. On a per-exploration-well basis (including delineation), the projected spill rate for the proposal would be five spills of 1,000 barrels or greater per 1,000 wells drilled. (Only 43 such wells are projected for the proposal.) Note also that this estimate per-exploration-well is unrisked; it assumes that commercial quantities of oil are present and found. The marginal probability of commercial quantities of oil being discovered within the proposed sale area is 20 percent.

c. Oil-Spill-Trajectory Simulations: Oil-spill trajectories for the proposal, the cumulative case, and the deferral alternatives were simulated by the Rand Corporation in Santa Monica, California. Rand's description of models and model documentation as contained in Section IV.A.1.c of the Sale 100 FEIS (USDOI, MMS, 1985c), are incorporated by reference; a summary of this description as augmented by additional material, as cited.

Essential components of the models and their interrelationships are shown in Figure IV-6. Aspects of weathering, toxicity, and oil dispersion are considered and taken into account in this EIS, but not as part of the trajectory analysis (see Sec. IV.A.2.a). The actual modeled trajectories are center-of-mass trajectories. The Rand Corporation transmitted 12-hour trajectory positions to the MMS Branch of Environmental Modeling (BEM) in Reston, Virginia. The BEM applied trajectories to land/boundary segments and to biological resources identified by the MMS in order to determine the environmental-risk factors.

Summer Trajectories: The modeled summer is the period from June 16 through October 31, a total of 138 days. At the beginning of summer, the average ice concentration near the 70th parallel is approximately 4 oktas. The strongest stratification of the water column occurs at this time. Trajectories were computed using the data and a three-dimensional model that reflected this stratified marine condition. Trajectories were computed from 46 hypothetical launch points (including five launch points to the west of the dateline that are not used for the Sale 109 analysis). Under equally likely probability, oil was launched every 5 days from the 46 hypothetical launch points, providing 30 trajectories per launch point, for a total of 1,380 summer trajectories.

The MMS emphasizes that the trajectories simulated by the model represent only pathways of hypothetical oil slicks. They do not involve any direct consideration of cleanup, dispersion, or weathering processes that could determine the quantity or quality of oil that might eventually come in contact



Source: Modified from Leendertse and Liu, 1983.

FIGURE IV–6. ESSENTIAL COMPONENTS OF THE TWO–DIMENSIONAL STOCHASTIC–WEATHER SIMULATION MODEL; ALSO SHOWING INTERRELATIONSHIP BETWEEN THE THREE–DIMENSIONAL HYDRODYNAMIC MODEL AND THE OIL–SPILL–TRAJECTORY MODEL with targets. An implicit analysis of weathering and decay can be considered by knowing the age of simulated oil spills when they contact targets. For this analysis, three time periods were selected as relevant to the summer arctic: 3 days--to represent diminished toxicity of the spill; 10 days--during which cleanup could be a mitigating factor (to a very limited extent, see Sec. IV.A.2.e) and to represent the typical duration of an open-water slick; and 30 days--to represent the difficulty of tracking or locating spills after this time (see also Sec. IV.A.2).

Winter Trajectories: For the winter period, starting at the beginning of November, the average ice concentration over the Chukchi Sea is lower than in the beginning of summer. This is reasonable because, during the cooling process, vertical homogeneity has to be reached before ice can form. The vertical mixing associated with this cooling process reduces the stability of the water column, giving rise to a different set of hydrodynamic behaviors (momentum transfers, etc.) for oil-trajectory computations. The three-dimensional circulation model takes into account this more-homogeneous water column in winter, resulting in a different coupling of the wind and water forces that drive the movement of oil and ice in winter than in summer. In general, ice and oil movements in the northern Chukchi Sea closely follow the predominant direction of the Arctic Gyre. In the southern Chukchi Sea, particularly near the Bering Strait, ice and oil can move north or south depending upon the weather sequence. The ice-floe concentration varies from 4 oktas to 8 oktas, then to 4 oktas, to account for the seasonal variability of ice/ice interactions over the area. The latitudinal difference in ice concentrations between the northern and southern Chukchi Sea is also taken into account.

For winter, 45 trajectories were run from each of the 41 hypothetical launch points in U.S. OCS waters, for a total of 1,845 winter trajectories. Trajectories were launched in a staggered fashion, representing an equally likely chance of occurrence throughout the entire 7.5-month-winter season.

Over most of the winter period, oil would rapidly--within hours or days--freeze into the sea ice and move with the ice. Such oil would remain frozen throughout the winter. When the oil was released from the ice in late spring (first-year ice) or the subsequent or later summer(s), it would be relatively unweathered because of its encapsulation by ice (see Sec. IV.A.2.a). The oil would still have the characteristics of freshly spilled oil, including its initially higher concentrations of toxic components. Because of this lack of weathering of spilled oil in the arctic winter, the trajectories were continued through the entire winter season for up to the entire 7.5 months of winter, rather than for the 30 days during which trajectories were followed in the summer. However, note that the oil-spill-trajectory model does not actually include the time-dependent freezing of the oil into the ice. In the model, the oil is assumed to be layered, unfrozen underneath the ice. Movement of oil with ice or with underlying water then depends on relative ice and water velocity--which are both modeled. In general, unfrozen oil will move with the ice about 99 percent of the time because of the low relative velocity of ice and water. Only under landfast ice will relative water velocity be sufficient to move oil on the underside of the ice.

Cumulative risks posed to the Chukchi Sea from development elsewhere (south of the Bering Strait and east of Point Barrow) have been addressed in prior oil-spill-risk analyses in prior EIS's for OCS oil-and-gas-lease sales. Proposed sales and leased tracts in the Norton and Navarin Basins pose no oil-spill risk to the Chukchi Sea. Development of existing Federal, State, and Canadian leases in the Beaufort Sea poses some risk to the offshore resources of the northern Chukchi Sea, but not to any coastline west of Barrow.

Conditional Probabilities: Results of the trajectory simulations are presented in terms of conditional and combined probabilities. The probability that, if an oil spill occurred at a specific launch point, it would contact either a land/boundary segment or a resource target is termed a conditional probability. Conditional probabilities assume that a spill occurs; they do not consider the likelihood of a spill occurring--a function of the presence and amount of oil and the transportation assumption. In calculating conditional probabilities, the assumption is made that a spill has occurred from the respective launch point. The conditional probabilities give the percentage chance that oil from that hypothetical launch point would contact specific land/boundary segments and biological resources. The conditional probabilities are useful in identifying those areas that pose the highest chance of contact to specific targets and land/boundary segments, should spills occur.

Two sets of conditional probabilities are used in this EIS: (1) contacts with summer spills during the open-water season (Appendix A, Tables A-3 through A-8) and (2) contacts with winter spills during winter (Appendix A, Tables A-9 through A-14). Conditional probabilities have an appreciable Monte Carlo error range at the 90-percent level of significance (Appendix A, Table A-2). For summer conditional probabilities for individual launch points, this range is from about +5 to +16 percent. For winter conditional probabilities for individual launch points, this range is from about +3 to +12 percent.

Combined Probabilities: In the analysis, the conditional probabilities were combined with the expected spill rates, transportation scenarios, and the unrisked mean-resource estimates to yield overall, combined probabilities for spills of 1,000 barrels or greater and for spills of 100,000 barrels or greater. Thus, these probabilities include both the likelihood that a spill would occur and whether the spill would contact land/boundary segments or resource targets. The associated Monte Carlo error for combined probabilities--because all trajectories and spill information for all spill points are incorporated--is much lower than that for conditional probabilities, ranging from +1 to +2 percent.

Trajectory analysis for spills of less than 1,000 barrels would be meaningless because of the very short persistence and very small average size of such spills (see Sec. IV.A.1.b). These spills have not been included as a category in the trajectory analysis, but their occurrence and possible effects are considered elsewhere in Section IV, where relevant.

Combined probabilities for land/boundary segments for the proposed sale and each deferral alternative are discussed in Section IV.A.2.b, and the combined probabilities for biological resources are discussed in Sections IV.B through IV.H. Land/boundary segments are identified in Figure IV-1 and resource targets in Figures IV-19, IV-20, IV-22, and IV-29 (see Secs. IV.B.5, IV.B.6, IV.B.7, and IV.B.10 respectively) for target figures. Tables of combined probabilities are provided for the proposal, the cumulative case with the proposal, and the Coastal Deferral Alternative (Alternative VI) in Appendix A, Tables A-15 through A-22.

Because the mean resource is identical to that of the proposal, combined probabilities for both the Eastern Deferral Alternative (Alternative IV) and the Southern Deferral Alternative (Alternative V) are identical to those for the proposal. For these deferral alternatives, analyses made solely on the basis of combined probabilities cannot provide an adequate comparison of relative environmental risks from oil spills. Therefore, the oil-spill risks of the Eastern and Southern Deferral Alternatives are analyzed on the basis of the conditional probabilities, which assume that oil has been spilled.

2. Aspects of Spilled Oil:

a. Fate and Behavior of Spilled Oil: The fate and behavior of oil spills in arctic waters are discussed and described in detail in Section IV.A.2.a and Appendix C of the Sale 97 FEIS (USDOI, MMS, 1987a). This information is incorporated by reference; a summary pertinent to proposed Sale 109, as augmented by additional material as cited, follows.

Both surface and subsurface spills form surface slicks and weather similarly. A spill of 10,000 barrels in the Chukchi Sea could physically cover 1 to 2 square kilometers, and a spill of 100,000 barrels could cover less than 10 square kilometers. Winds, movement of the slick, and other forces would tend to spread the oil discontinuously over an area 10- to 100-fold greater than this actual area of oiled surface (Table IV-5). Dissolution would account for only about 5 percent of slick mass; most spilled oil evaporates, grounds on the shoreline, or eventually forms tar balls or pancakes (Fig. IV-7). The presence of broken ice (1) would retard spreading and (2) may promote both of the competing processes of vertical dispersion and mousse formation, if sufficient small-scale turbulence existed among the smaller pieces of ice. Oil spilled under winter ice would pool and freeze to the underside of the ice. Most of the Sale 109 area is covered by first-year ice, but with appreciable multiyear ice dispersed in the pack. The relative concentration of multiyear ice increases northward as it enters the Arctic Gyre and moves farther from the polynyas along the Alaskan coast of the Chukchi Sea (Lewbel, 1984). First-year arctic ice can store up to 150,000 to 300,000 barrels of oil per square kilometer in under-ice relief. Multiyear ice can store 1.8 million barrels per square kilometer. Thus, in either first-year or multiyear ice, oil would not spread appreciably along the underside of the ice before being frozen into the ice. The spill would then move as part of the ice pack.

Oil in first-year ice would either melt out at the southern ice edge as the pack retreated, or otherwise migrate through brine channels in the ice and pool on top of the ice in late May or June. Multiyear ice does not contain brine channels, and oil would melt out of multiyear ice more slowly than it would from first-year ice. Most oil would be released through the first summer following the spill, but some oil would not be released until the subsequent summer(s).

b. Likelihood of Shoreline Oiling: If an oil spill occurs, three important but nonbiological questions arise: (1) will the oil reach the shore; (2) if so, how much shoreline would be contaminated; and (3) how long

Table IV-5
Spill-Size Examples for Summer Spills in Open-Water Portions of the Chukchi Sea Planning Area

Calculations are based on the oil-weathering model of Payne et al. (1984b). The examples are of a Prudhoe Bay-type crude, which is considered the best analog for undiscovered crude in the Chukchi Sea Planning Area.

Time After Spill	10,000-Barrel Spill		100,000-Barrel Spill	
	3 Days	10 Days[1/]	3 Days	10 Days
Open-Water Spill (12-knots windspeed, 2°C, 0.5-m waves)				
Oil Remaining (%)	80	68	84	75
Thickness (mm)	1.2	0.6	2.6	1.3
Area of Slick (km^2)[2/]	1.1	1.8	5.1	8.7
Discontinuous Area (km^2)[3/]	33	50	110	500

Source: MMS, Alaska OCS Region.

1/ After 10 days, spilled oil would generally be dispersed into individual mousse lumps or tar balls and would not be discernable as a distinct slick (see Fig. IV-7).
2/ This is the area of oiled surface.
3/ Calculated from Equation 6 of Table 2 in Ford (1985). This is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of the given volume.

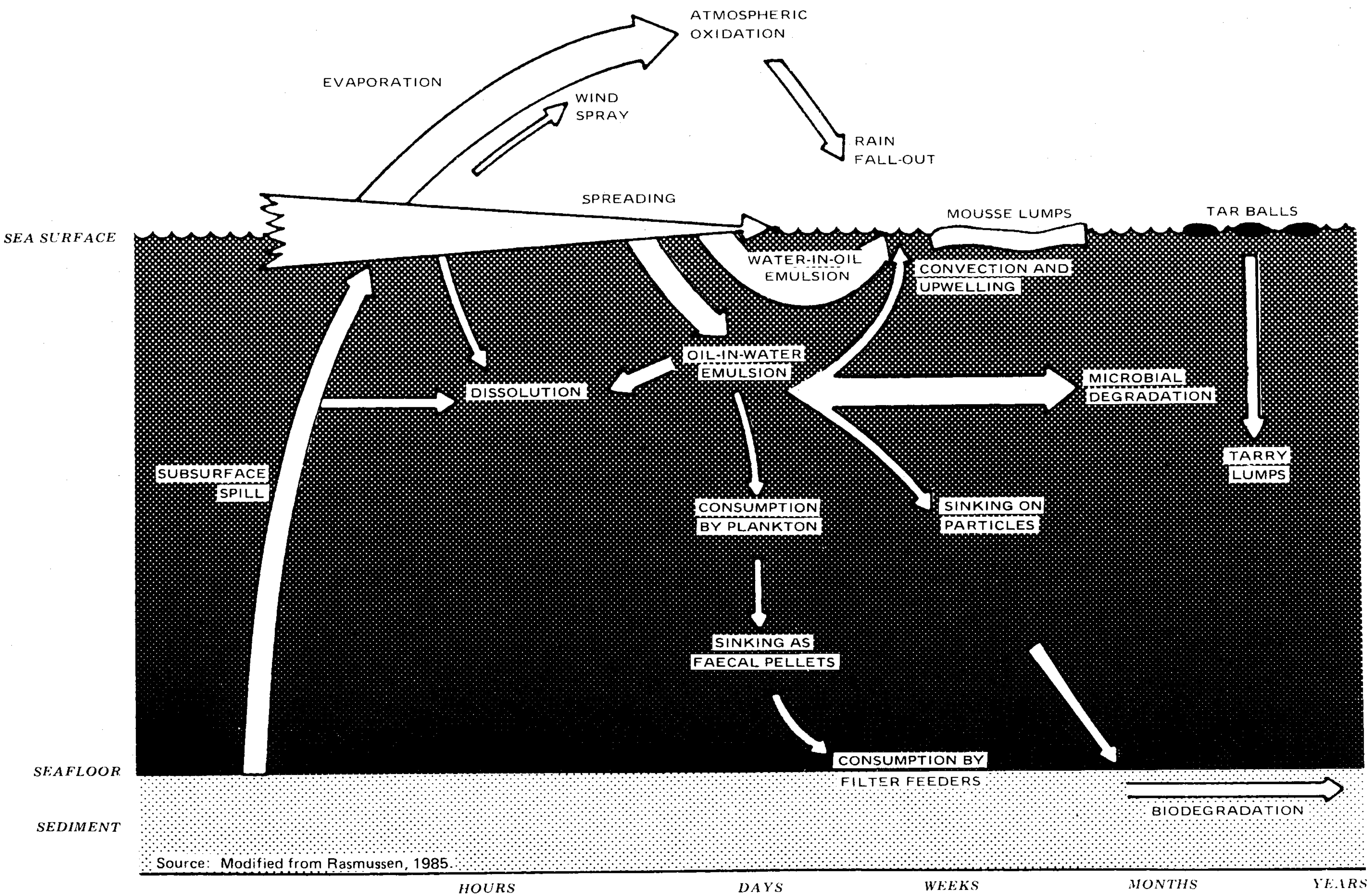


FIGURE IV-7. FATE OF OIL SPILLS IN THE OCEAN would the contamination persist? The first of these issues is addressed below, the latter two in Sections IV.A.2.c and IV.A.2.d, respectively.

In winter, landfast ice would keep offshore spills away from the shoreline; and any oil that reached the shore would not penetrate into the frozen beach. In the oil-spill-trajectory model, winter contact of land by oil occurs through a combination of mechanisms: (1) land can be oiled in ice-override events, (2) oil can be stripped from the underside of ice by currents and moved shoreward, (3) oil may freely drift ashore early and late in winter if landfast ice is absent, and (4) land contact is assumed if the distance of the center-of-mass of the oil-spill trajectory is closer to land than the estimated radius of the slick. Note that mechanism (2) in the oil-spill-trajectory model exaggerates the likelihood of land contact because the model ignores the probable rapid freezing of the oil into ice over most of the winter (see Sec. IV.A.1.c). For Chukchi Sea shorelines, summer spills are a more relevant concern than winter spills. The following discussion, therefore, emphasizes spills that could occur during the summer.

Conditional Probabilities: The conditional probabilities show that if a spill occurred, the likelihood of contact to land would be very low in summer (Appendix A, Tables A-3 through A-8). Conditional probabilities of contact to land are less than 0.5 percent for all hypothetical launch points through 10 days. In the proposed Sale 109 area, a spill generally would tend to move offshore, not onshore. Only Launch Points J17, J10, J13, and J38 have a significant chance of contact to land through 30 days in summer. Two of these launch points (J17, J10) lie within the area deferred by the Eastern Deferral Alternative (Alternative IV); all four lie within the area deferred by the Coastal Deferral Alternative (Alternative VI). Most of the limited likelihood of contact to land that does occur appears to be on north-facing shorelines and entirely from these launch points that are all within 30 kilometers of shore.

Combined Probabilities: For the proposal, the combined probabilities that one or more spills of 1,000 barrels or greater would occur and contact the shores of the sale area in summer are very low (Table IV-6). The risk to land is among the lowest calculated for any previous or proposed Alaska OCS Region oil-and-gas lease sale. There is a less-than-0.5-percent chance that a spill of 1,000 barrels or greater would occur and contact land within 10 days in summer. Only Land Segments 21 and 16 have a significant combined probability of contact with an oil spill of 1,000 barrels or greater through 30 days in summer (Fig. IV-8). There is a 70-percent chance that at least one spill of 1,000 barrels or greater would occur in winter and contact land sometime during the winter (Table IV-7). In winter, most of this combined probability of land contact is to Wrangel Island, with a much lower chance of contact for Alaskan- or Russian-mainland shores (Fig. IV-9).

For the proposal, there is very low likelihood that a spill of 100,000 barrels or greater would occur and contact land. There is a less-than-0.5-percent chance that a spill of such size would occur in summer and contact land within 30 days, and a 7-percent chance that such a spill would occur in winter and contact land at any time during winter. Only Land Segments 27 and 28--on Wrangel Island--have a greater-than-0.5-percent combined probability of being contacted by a spill of 100,000 barrels or greater.

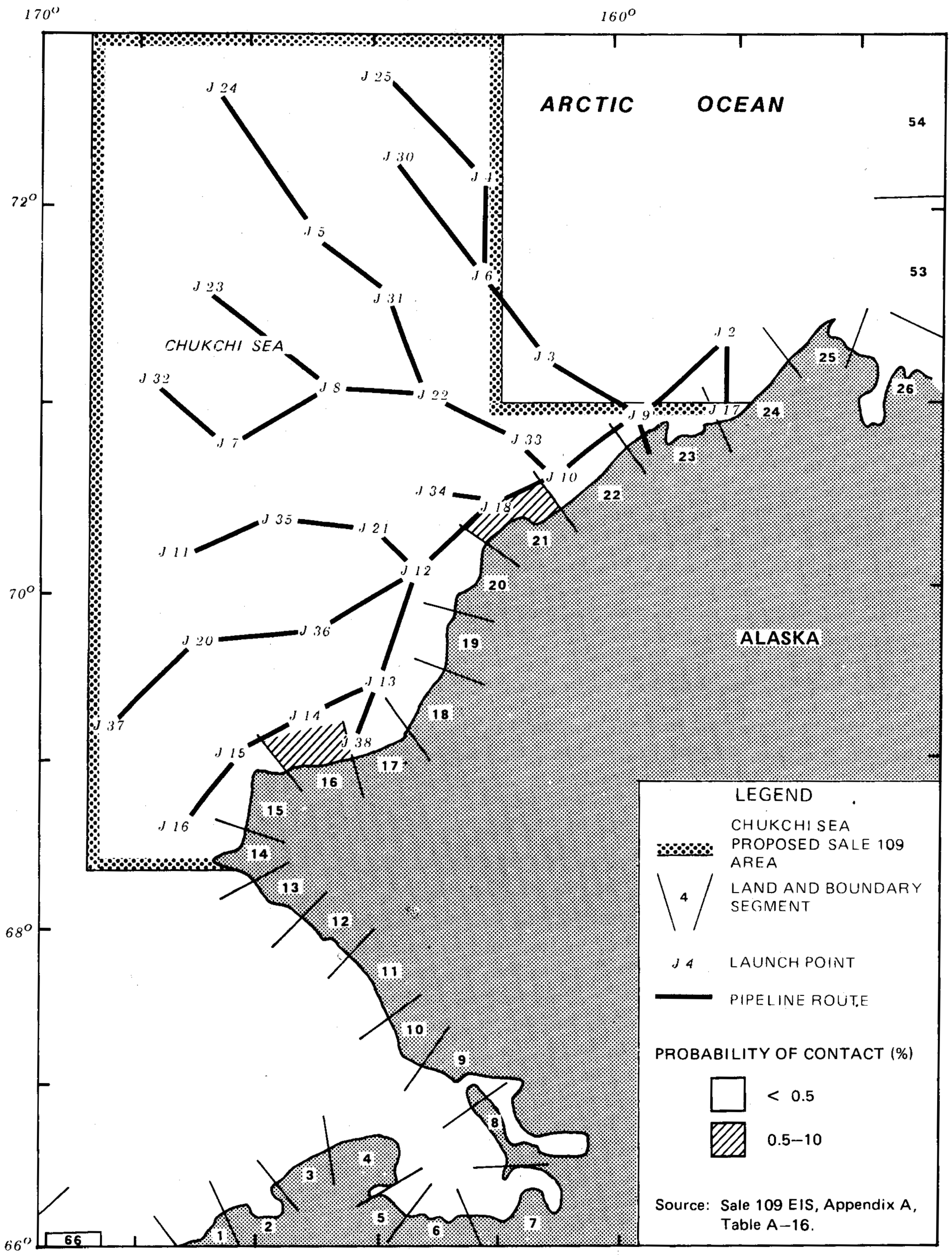


FIGURE IV–8. PROBABILITIES FOR THE PROPOSAL THAT AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER WOULD OCCUR IN SUMMER AND CONTACT INDIVIDUAL LAND OR BOUNDARY SEGMENTS WITHIN 30 DAYS. LAND AND BOUNDARY SEGMENTS NOT SHOWN HAVE LESS THAN A 0.5–PERCENT CHANCE OF BEING CONTACTED.

Table IV-6
Combined Probabilities (Percentage Chance) that One or More Oil Spills Would Occur and Contact Land During Summer Over the Production Life of the Field 1/2/

	3 Days		10 Days		30 Days	
	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater
Proposal	n	n	n	n	7	n
Cumulative Case (Proposal, Sale 97, and Tankering from Canadian Beaufort Sea)	n	n	n	n	8	n
Alternative IV Eastern Deferral	n	n	n	n	7	n
Alternative V Southern Deferral	n	n	n	n	7	n
Alternative VI Coastal Deferral	n	n	n	n	2	n

Source: Appendix A of this EIS.

Table IV-7
Combined Probabilities (Percentage Chance) that One or More Oil Spills Would Occur and Contact Land During Winter Over the Production Life of the Field 1/2/

	3 Days		10 Days		All Winter	
	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater
Proposal	n	n	n	n	70	5
Cumulative Case (Proposal, Sale 97, and Tankering from Canadian Beaufort Sea) Development	n	n	3	1	74	7
Alternative IV Eastern Deferral	n	n	n	n	70	5
Alternative V Southern Deferral	n	n	n	n	70	5
Alternative VI Coastal Deferral	n	n	n	n	63	4

Source: Appendix A of this EIS.

1/ Based on the unrisked estimate, which assumes that the mean-resource estimates for the proposed action and each alternative will be discovered and produced.
2/ n=less than 0.5 percent.

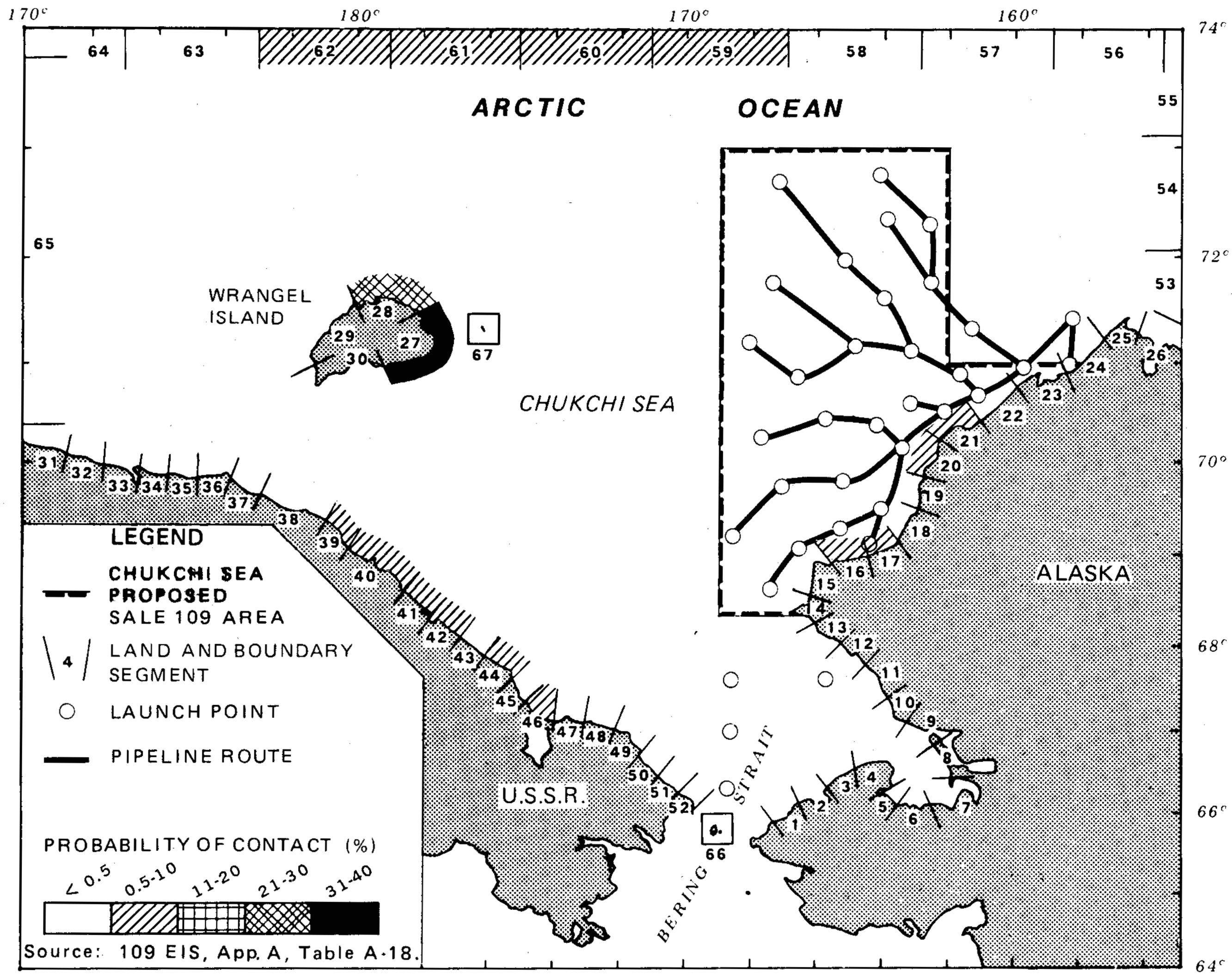


FIGURE IV–9. PROBABILITIES FOR THE PROPOSAL THAT AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER WOULD OCCUR IN WINTER AND CONTACT INDIVIDUAL LAND OR BOUNDARY SEGMENTS

Almost all chance of land contact in the oil-spill-risk analysis for the cumulative case is attributable to the proposed action. In the cumulative case, there is a less-than-0.5-percent chance that a spill of 1,000 barrels or greater would occur in summer and contact land within 10 days, and an 8 percent chance within 30 days. The distribution of summer land contacts is identical to those for the proposal in summer. In winter, there is a 74 percent chance that a spill of 1,000 barrels or greater would occur and contact land. The Canadian tankering of crude in the cumulative case provides a slight additional likelihood of land contact to the Siberian coast north of the Bering Strait (Fig. IV-10).

The assumed quantities and distributions of oil resource for the Eastern Deferral Alternative (Alternative IV) and for the Southern Deferral Alternative (Alternative V) are the same as those for the proposal. Therefore, the combined probabilities of contact for both of these alternatives are the same as those for the proposal. For either alternative, there is a less-than-0.5-percent chance of land contact with a spill of 1,000 barrels or greater through 10 days in summer, and a 70-percent chance through winter. The cumulative case with either alternative would have a less-than-0.5-percent chance of contact through 10 days in summer and a 74-percent chance of contact through winter.

The combined probabilities of a 100,000-barrel-or-greater spill occurring and contacting land for either the Eastern or Southern Deferral Alternatives would also be the same as those for the proposal--less than a 0.5-percent chance in 10 days in summer for both alternatives and the cumulative case with either alternative, 5 percent for either alternative in winter, and 7 percent for the cumulative case with either alternative in winter.

The combined probabilities for the Coastal Deferral Alternative (Alternative VI) indicate a slight but significant reduction in likelihood that oil spills would contact land. The combined probability that a spill of 1,000 barrels or greater would occur and contact land is less than 0.5 percent through 10 days in summer and 63 percent through winter. This alternative would remove all significant likelihood of one or more spills of 1,000 barrels or greater occurring and contacting Land Segments J16, J17, or J20 in summer or winter (Figs. IV-11 and IV-12). Because the risk to these land segments in the cumulative case with the proposal is also caused by the proposal, these land segments would also not be at risk in the cumulative case with this alternative.

The Coastal Deferral Alternative does not significantly reduce the likelihood from that for the proposal of one or more spills of 100,000 barrels or greater occurring and contacting land. The likelihood of such contact in summer was already negligible for the proposal and the probability reduction in winter was only 1 percentage point--from 5 percent for the proposal to 4 percent for this deferral alternative. A 1-percent decrease in likelihood would also be expressed in the cumulative case with this alternative.

c. Extent of Shoreline Oiling: The extent of shoreline oiling from offshore oil spills is discussed and described in detail in Appendix C of the Sale 97 FEIS (USDOI, MMS, 1987a). This information is incorporated by reference; a summary pertinent to proposed Sale 109, as augmented by additional material as cited, follows.

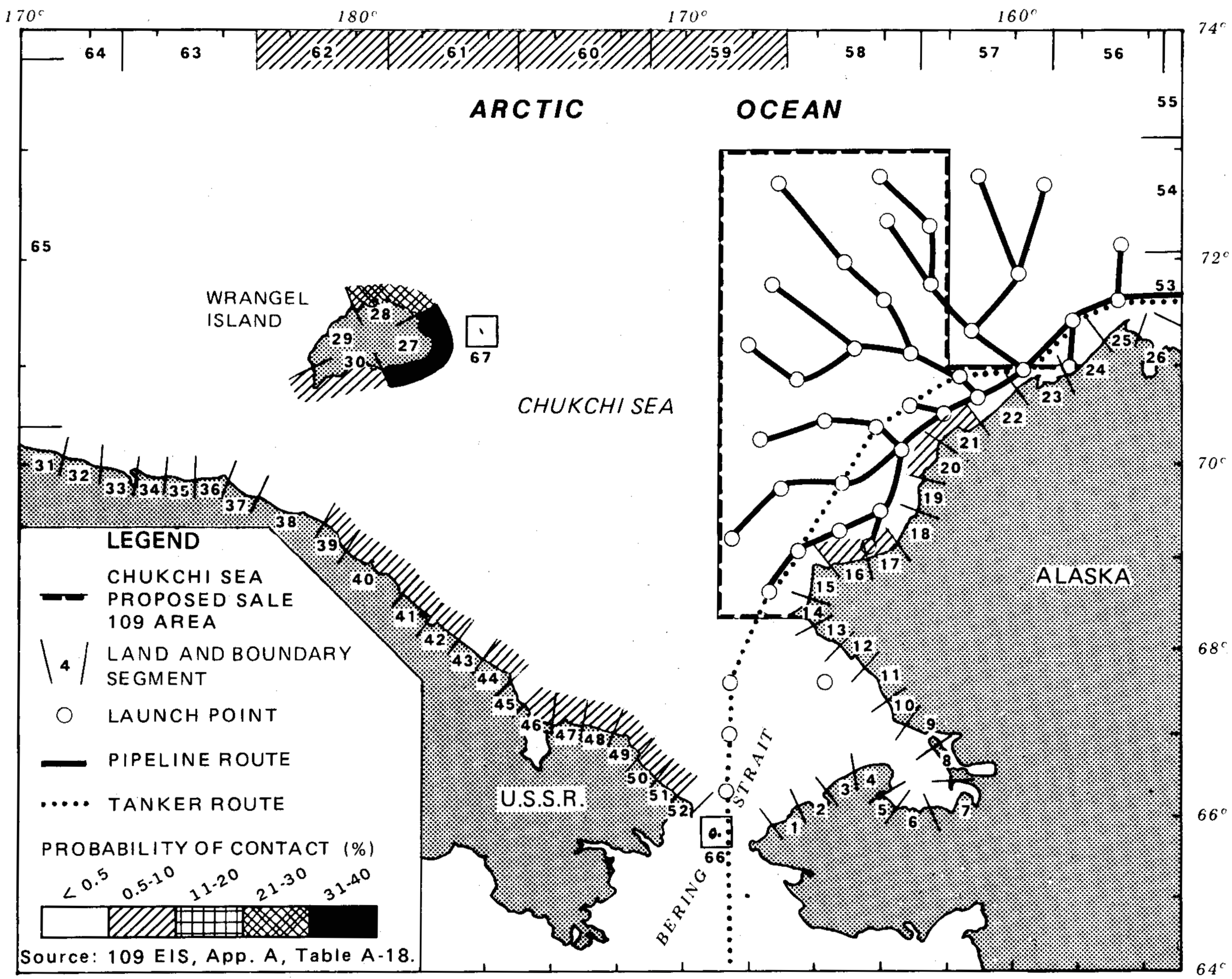


FIGURE IV—10. PROBABILITIES FOR THE CUMULATIVE CASE WITH THE PROPOSAL THAT AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER WOULD OCCUR IN WINTER AND CONTACT INDIVIDUAL LAND OR BOUNDARY SEGMENTS

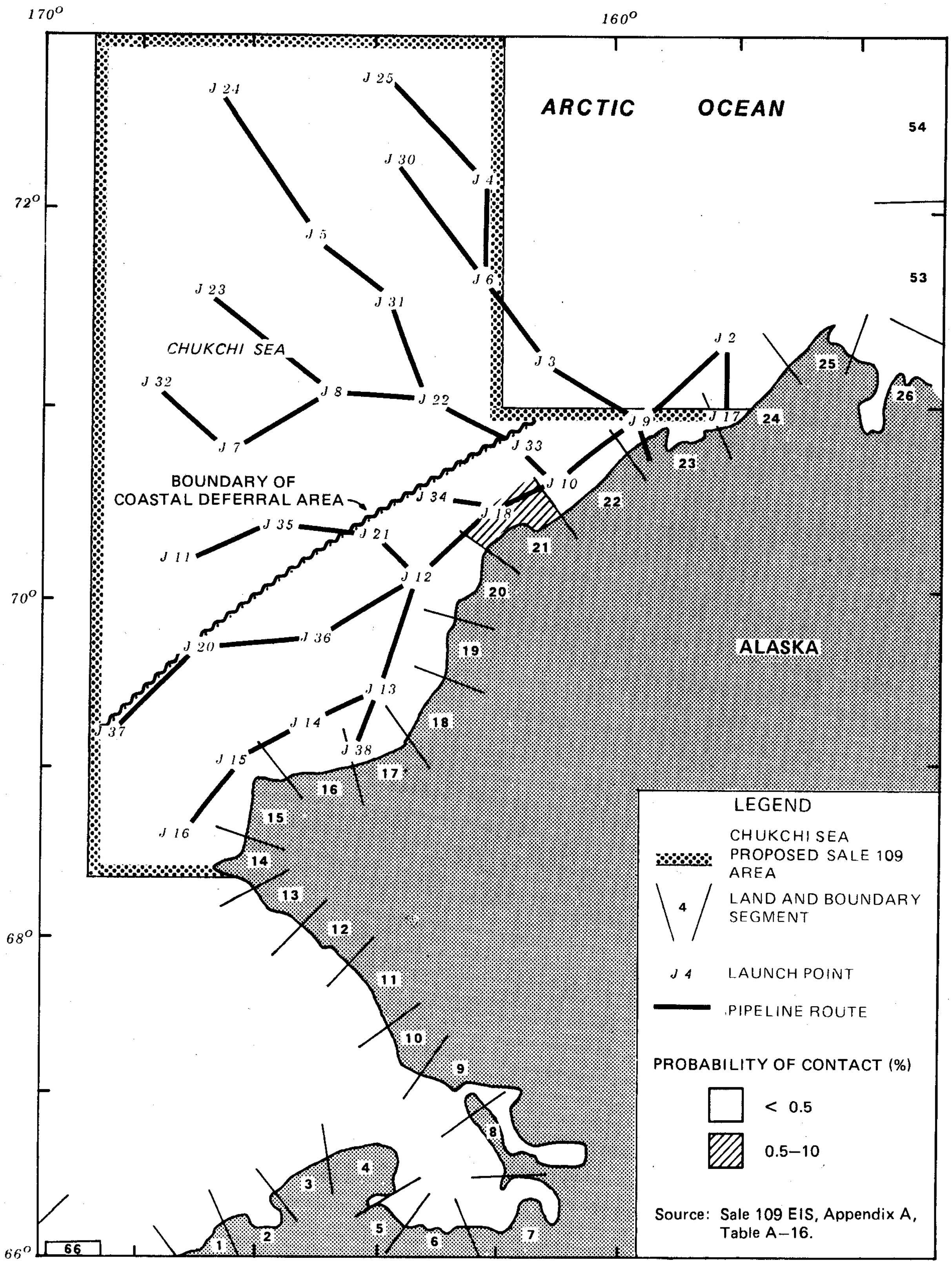


FIGURE IV–11. PROBABILITIES FOR THE COASTAL DEFERRAL ALTERNATIVE THAT AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER WOULD OCCUR IN SUMMER AND CONTACT INDIVIDUAL LAND OR BOUNDARY SEGMENTS WITHIN 30 DAYS. LAND AND BOUNDARY SEGMENTS NOT SHOWN HAVE LESS THAN A 0.5–PERCENT CHANCE OF BEING CONTACTED.

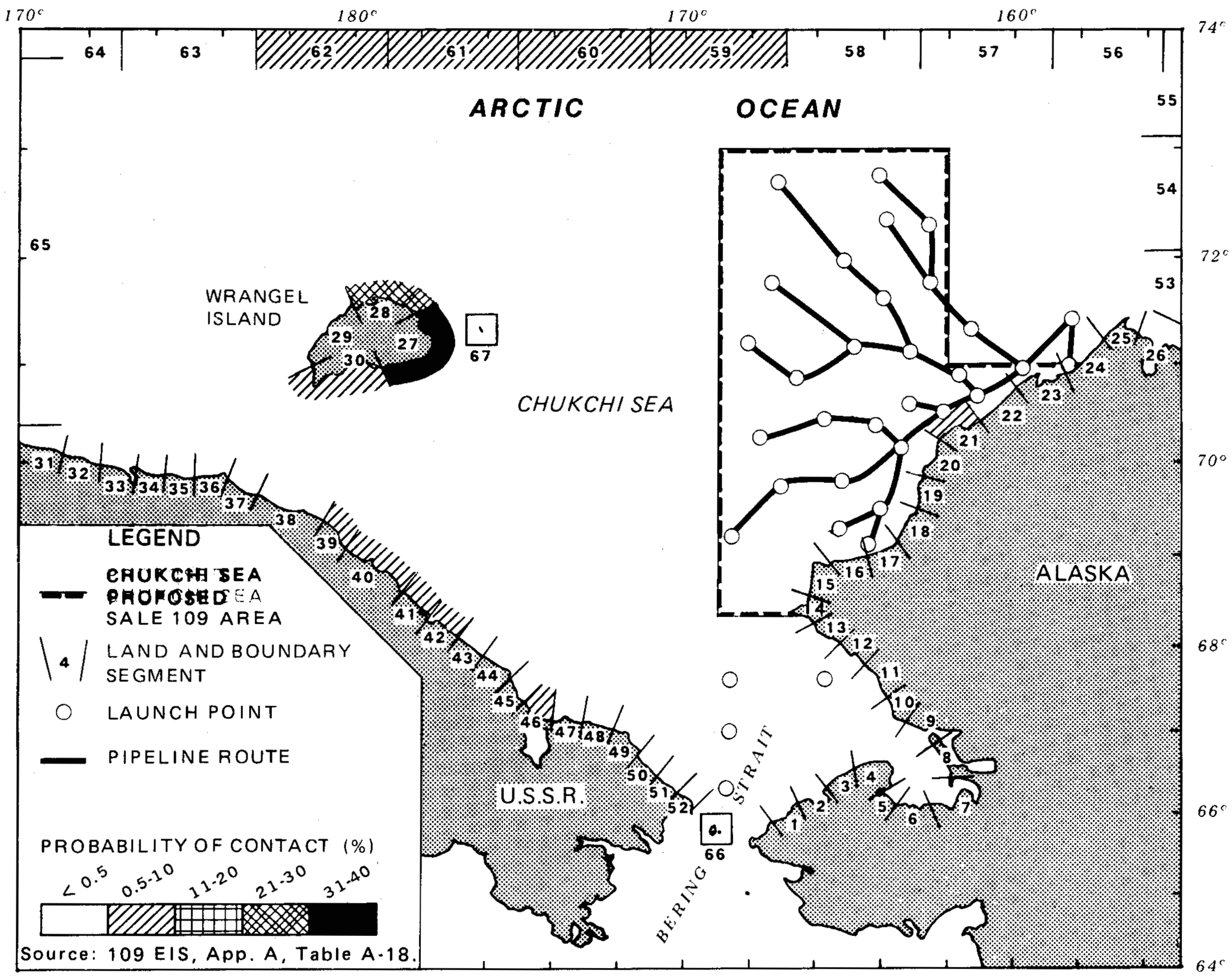


FIGURE IV–12. PROBABILITIES FOR THE COASTAL DEFERRAL ALTERNATIVE THAT AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER WOULD OCCUR IN WINTER AND CONTACT INDIVIDUAL LAND OR BOUNDARY SEGMENTS

An offshore spill that reaches shore is not likely to reach the shoreline in its entirety: contact could occur along a single location, depending on the nature of winds and longshore current. If a spill of 10,000 barrels occurred and contacted land, about 30 kilometers of shoreline could be oiled--about the length of an individual land segment in Figure IV-1. For a spill of 100,000 barrels, on the order of 90 kilometers of shoreline--about three lengths of three land segments--would be expected to be oiled, if oiling occurred. However, it would be possible for a spill to contact several-fold longer or shorter stretches of coastline than these averages or, more likely, not contact any shoreline at all.

For the purposes of this EIS, we assume that spills of the size of interest--1,000 barrels or greater--are capable of contacting sections of coastline on the order of 30 kilometers long, or roughly the effective length of one land segment. (The actual number of kilometers composing an individual land segment is usually much more then the effective width of that land segment because of shoreline complexity; that is, the presence of lagoons, bays, islands, and headlands.) Because the trajectory model tracks only the center of mass of the spill, we account for spreading or smearing of the spill along the coast by assuming that the entire land segment and possibly its closest neighbors could have been contacted.

Long-duration spills are depicted less precisely in the oil-spill-risk analysis than are instantaneous spills. The oil-spill-risk analysis can still be used to represent the relatively rare occurrence of a long-duration spill. For such spills, the center of mass of the spill is still depicted accurately. However, the spreading of the oil over different trajectories through time would result in more frequent contacts of oil with land, but each contact would involve only a fraction of the total spill. For such spills, the conditional probabilities of contact from an individual hypothetical launch point represent the fraction of the total spill that would contact the target or land segment, disregarding weathering and cleanup. (The conditional probability would normally represent the likelihood that the target or land segment was contacted by the entire spill.)

d. Persistence of Stranded Oil: A general description of the oil-retention characteristics of the U.S. Arctic shoreline is contained in Section IV.A.1.d of the Sale 87 FEIS (USDOI, MMS, 1984a). This information is incorporated by reference; a summary pertinent to proposed Sale 109, as augmented by additional material, as cited, follows.

A discussion of persistence necessarily relates to that oil remaining after cleanup or to situations where cleanup could cause more damage than would the original spill if it were left in place. Marshes, low tundra shores, and low vegetated barriers may be areas where most cleanup operations--removal of contaminated soil and vegetation or even heavy foot traffic--could cause permanent scars in the landscape and ecosystem. Newer techniques, such as low-pressure hosing combined with clipping of oiled vegetation, provide both ecologically and technologically sound means of cleaning some of these areas. Thus, cleanup is a viable option to mitigate the problems caused by shoreline oiling and oil persistence.

Persistence of oil on various types of shorelines has been investigated both by evaluating small, deliberate spills on experimental test plots and by monitoring oil persistence following accidental spills of various compositions and magnitudes. In these studies, the persistence of oil is always highly correlated with shoreline type, largely because of the importance of physical processes in both weathering and natural removal of oil. High rates of thermal erosion along the coast and underlying permafrost are additional factors that remove oil and limit oil penetration, thus reducing potential oil persistence in the arctic.

Based on these empirical data, several studies (Hayes and Ruby, 1979; Woodward-Clyde Consultants, 1981; Robilliard et al., 1985) have rated the oil-retention potential of the U.S. Chukchi Sea coastline. This relatively diverse, arctic coastline ranges from rocky cliffs to low peat shores. In the southern portion of the Sale 109 area, the greater fetch and longer open-water season suggest that persistence of beached oil would be appreciably shorter than for northern portions of the sale area (see Owens et al., 1983). Based on empirical data and surveys of the U.S. Chukchi Sea coastline, the retention potential for oil on the coast can be rated from low to very high (Fig. IV-13).

Ratings reflect not only the retention capacity of the substrate, but also the ineffectiveness of the lack of natural, physical oil-removal processes. In general, the lower environmental temperatures and short thaw season in the arctic result in greater persistence of spilled oil. Least persistence would occur in exposed rocky headlands and eroding, wave-cut platforms. Greatest persistence would occur in marshes, tidal flats, or low tundra (peat) shores.

Empirical studies on shoreline oiling suggest cold-climate persistence of 15 to 30 years in mixed sand and gravel beaches, and over 100 years in sheltered marshes if very heavy oiling occurs (Gundlach, Domeracki, and Thebeau, 1982). However, the longer the open-water season and the greater the fetch, the shorter the time that oil would persist. For the half of the U.S. Chukchi Sea coastline rated either high or very-high in oil persistence, oil not cleaned up or oil remaining after cleanup could take many decades to naturally cleanse.

Of the two land segments most at risk in summer from the proposal, Land Segment 17 (Cape Sabine) is an area of low-oil-retention capability and the other, Land Segment 21 (Icy Cape), is an area averaging high-retention capability but with appreciable shoreline with very-high-retention capability. However, these shorelines with high and very-high ratings for Icy Cape are mostly lagoon shorelines, protected from at-sea spills by barrier islands or spits. Oiling would be more likely to occur to the seaward side of these barriers. Because such barriers generally have moderate oil-retention capabilities and are more amenable to cleanup techniques than lagoon shores, persistence of oiling could be less than indicated by the average land-segment rating for Icy Cape.

e. Oil-Spill Cleanup: Cleanup of oil spills in arctic waters is discussed and described in detail in Appendix C of the Sale 97 FEIS (USDOI, MMS, 1987a). This information is incorporated by reference; a summary pertinent to proposed Sale 109, as augmented by additional material, as cited, follows.

Oil-spill cleanup on the OCS is the responsibility of the spiller. The Federal Government will step in only if it considers the response of the spiller to be inadequate. The basic philosophy of both the Government and the oil and gas industry is to prevent spills. Considerable attention is given to preventive measures such as better technology and better training. However, preparations for spill response are still made, just in case.

Contingency Plans: Lessees are required to develop oil-spill-contingency plans as part of their exploration and development plans prior to drilling. To date, more than a dozen oil-spill-contingency plans have been submitted and approved for exploration of existing leases in the neighboring Beaufort Sea Planning Area. By having on hand prior knowledge of the nature of the spilled material, slick dynamics, and the characteristics of the threatened environment, plus available equipment and manpower, the responsible party (the spiller) can order and evaluate selected actions.

Spill response on the OCS is approached by arranging and ranking lines of defense to prevent spilled oil from affecting the identified vulnerable environment. The first line of defense is always offshore containment. For large continuous spills, containment devices such as booms are often integrated into skimming or other recovery systems. Open-water collection of spilled oil (without containment) is usually not successful.

Containment is useful in stopping the spread of the oil and in providing extra time for deployment of more equipment and manpower. In the presence of sea ice, which can act as a natural containment barrier, in situ burning may be an effective treatment. For a blowout, well ignition is a drastic but potentially effective contingency measure. If conventional cleanup equipment cannot recover the oil before spill contact with important resources is likely to occur, it may be appropriate to use chemical agents to disperse the slick--if permission for their use can be obtained from the U.S. Coast Guard On-Scene Coordinator.

Formation of a cooperative for the Sale 109 area is anticipated to occur after the proposed lease sale, when the individual companies would know whether they had won leases, how many, and where. After oil and gas lease sales elsewhere on the Alaska OCS, industry formed spill-cleanup-equipment cooperatives, usually as Cost-Participation Areas (CPA's) under the umbrella organization Alaska Clean Seas. Cooperatives are cost-effective and, therefore, willingly formed by leaseholders. Such a cooperative for Sale 109 leases could be formed or the area of interest of the Alaskan Beaufort Sea Oilspill Response Body (ABSORB)--a CPA of Alaska Clean Seas--could be expanded to include Sale 109 leases. Other CPA's or cooperatives in Alaska have locally stockpiled considerably more equipment than the minimum required by Federal regulations, thereby providing additional protection.

Applicability of Oil-Spill-Response Techniques in the Sale 109 Area: Figure IV-14 summarizes techniques and equipment and the ice conditions under which they could be used in the Sale 109 area. "Good" applicability does not necessarily imply effective recovery or removal of spilled oil. Effectiveness of spill response is addressed later in this discussion.

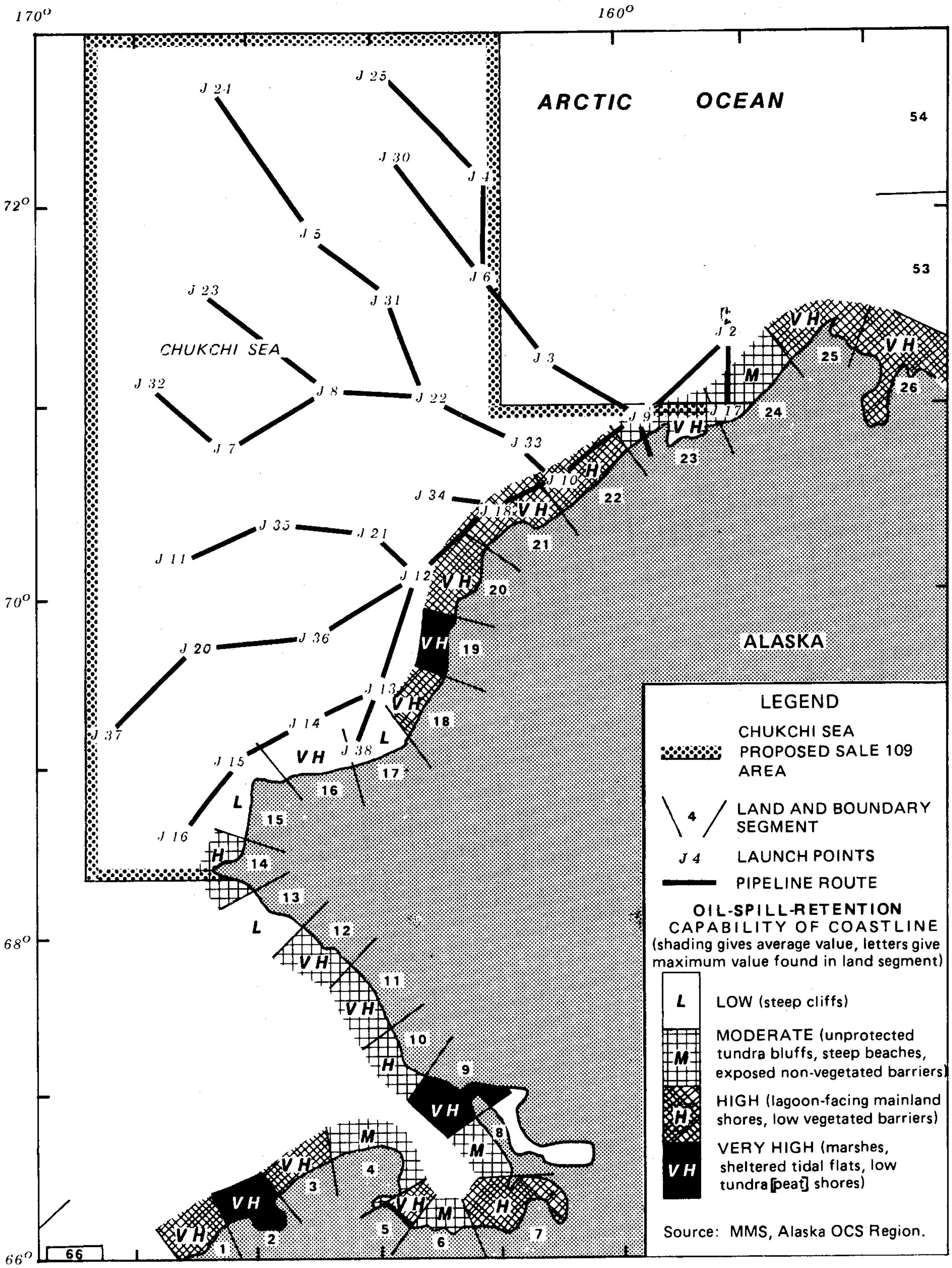
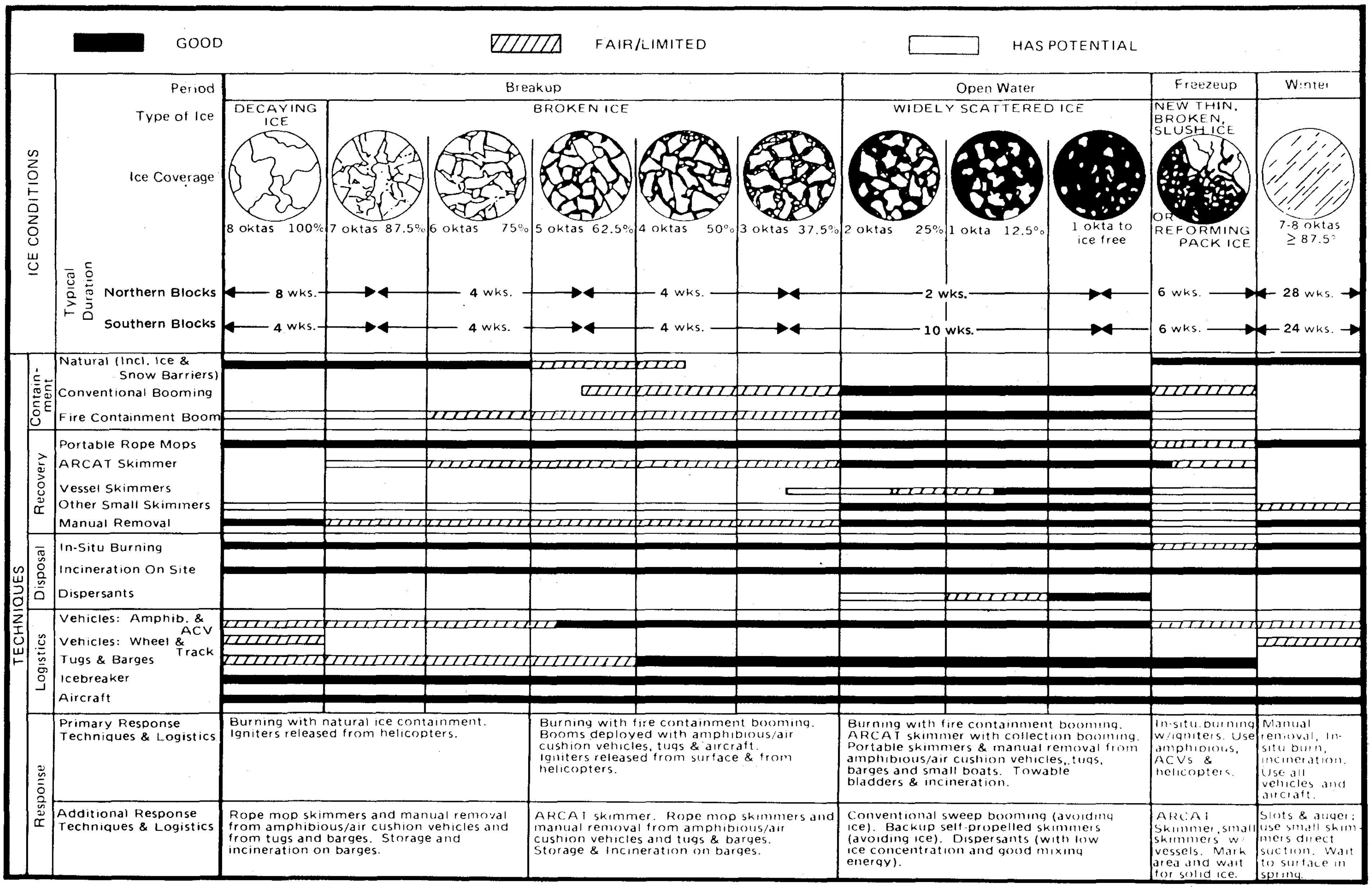


FIGURE IV–13. OIL–SPILL–RETENTION CAPABILITY OF LAND SEGMENTS ALONG THE U.S. CHUKCHI SEA COASTLINE



Sources: Alaska Clean Seas, 1984; LaBelle et al. 1983.

FIGURE IV–14. APPLICABILITY OF OIL–SPILL–RESPONSE TECHNIQUES IN THE PROPOSED SALE 109 AREA

Locally Available Spill-Cleanup Equipment: The MMS Alaska OCS Region requires a lessee who wishes to drill to have an initial spill-recovery capability of 1,000 barrels per day. To date, during drilling of exploration wells in the neighboring Beaufort Sea, this requirement has been met with the equipment warehoused at Deadhorse by ABSORB and with equipment positioned on-site by individual lessees. Descriptions of this equipment and a discussion of the capabilities of specific pieces of equipment are provided in Murrell et al. (1987). In the Chukchi Sea, immediate response-equipment needs during exploration will most likely be met by equipment stored on-site--on the drillship, supply barge, or an accompanying icebreaker. In the development and production phases, spill-response equipment would likely be warehoused at the supply base and pipeline landfall hypothesized to be at Point Belcher. Additional equipment would be stockpiled on individual production platforms.

Mobilization Time: The MMS Alaska OCS Region requires that initial mobilization and deployment of response equipment be undertaken within 6 to 12 hours of a spill, geography permitting. However, the spiller must be prepared to respond before the spill reaches shore (in less than 6 hours, if necessary). This initial timeframe is for relatively small spills, although the MMS has not specifically defined size. Only on-site equipment and that which could be transported by helicopter from Point Belcher could meet this deployment guideline for most of the sale area (Fig. IV-15). The limited geographic and temporal presence of open water and slow vessel speeds in broken ice would preclude timely transport of spill equipment by sea. However, in the past, the Alaska OCS Region has invoked the "geography-permitting" clause, permitting a longer response time if it were not possible for a spill at the drill site to reach land in the timeframe of 6 to 12 hours. This clause was invoked, for example, for exploration of some Sale 60 leases in Shelikof Strait, Alaska (OCS Environmental Assessment EA No. AK 82-3 [USDOI, MMS, 1982b]). For most locations in the Sale 109 area, spilled oil would not be anticipated to reach shore in less than several days, if at all (see Sec. IV.A.2.b).

For larger spills--those that could exceed the local cleanup-response capability--the MMS Alaska OCS Region requires that additional equipment be made available on-site within 48 hours. Additional response equipment to handle a large spill would be available from a multitude of sources.

Equipment transported by plane or helicopter from Deadhorse or Barrow would be capable of meeting both the equipment-deployment criteria set by the MMS for 6-to-12-hour and 48-hour responses. Additional equipment from elsewhere in Alaska, Canada, or the lower 48 states could also be airlifted to Barrow or Point Belcher to meet the 48-hour criteria. Additional, slower-arriving equipment would still be useful in case of a major spill; but the MMS does not consider such equipment in judging whether oil-spill-contingency plans meet the MMS 48-hour-response criteria. Once spill-cleanup equipment reached Barrow or Point Belcher, it could be transported relatively quickly to the spill site only if it could be carried by helicopter, and then only if weather permitted. A helicopter could reach any point in the sale area within about 3 hours from either Point Belcher or Barrow.

Effectiveness of Oil-Spill Cleanup at Sea: The 6-to-12-hour and 48-hour response times required of drilling lessees by the MMS Alaska OCS Region are mobilization and deployment requirements. Cleanup would continue as long as necessary, without any timeframe or deadline. For example, a winter spill in pack ice might require initial on-site response followed by further cleanup of oil melting out and pooling on top of the ice in late spring or summer.

The review of the historical record of oil-spill cleanup at sea in open water as contained in Section IV.B.5 of the Gulf of Mexico Final Regional EIS (USDOI, MMS, 1983a) is incorporated by reference; a summary of this review follows.

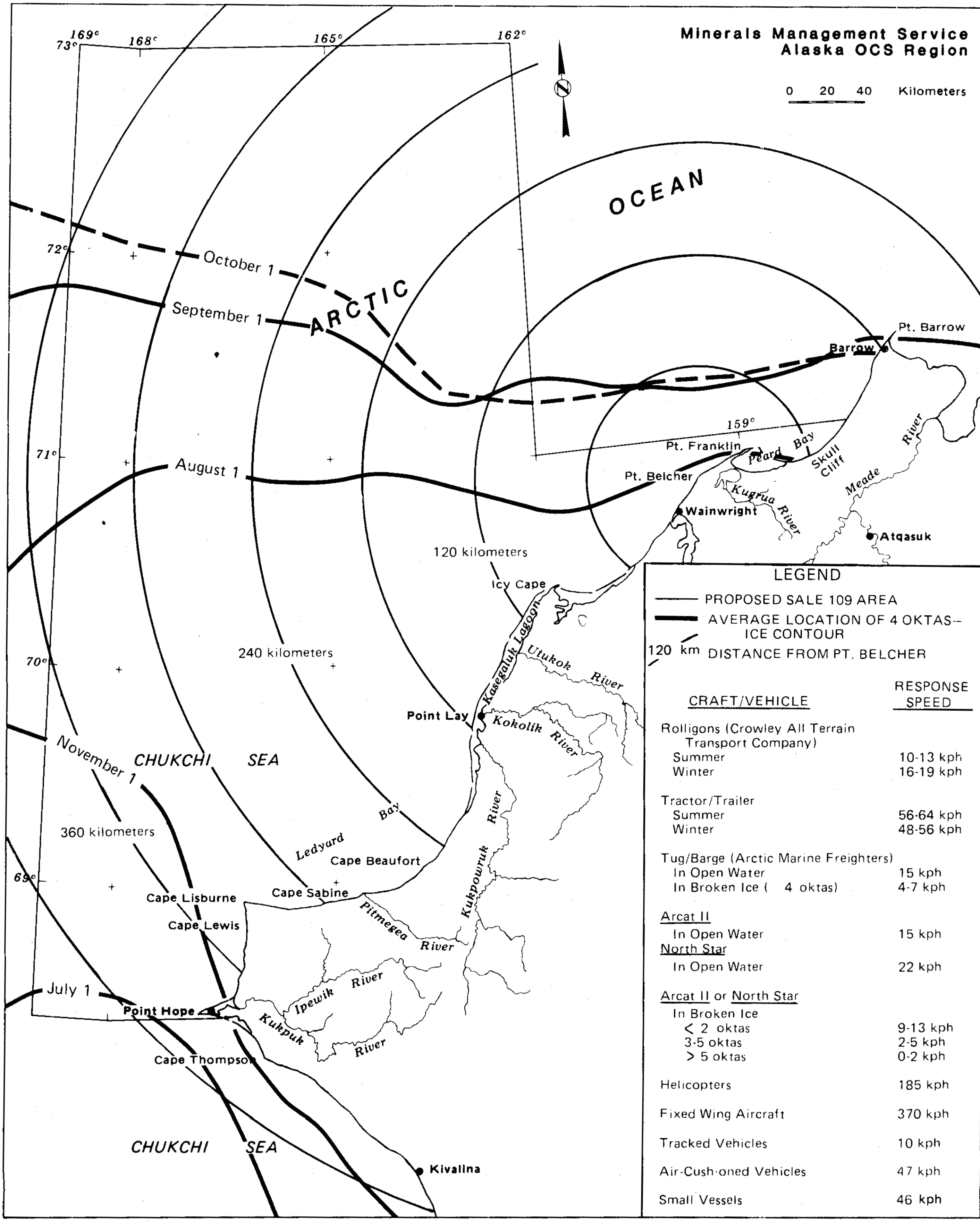
Offshore containment and cleanup are major, difficult tasks. Weather, sea conditions, and crew fatigue become critical factors; and cleanup at sea is generally only marginally effective. Recovery of oil using mechanical equipment usually ranges between 5 percent and 15 percent of that spilled. Inshore containment and cleanup operations generally occur in calmer waters and closer to logistical bases. Inshore operations are, therefore, more effective, with recovery of spilled oil on the order of 20 to 50 percent.

The effectiveness of mechanical recovery and in situ burning of spilled oil at sea decreases rapidly with increasing sea state (roughness of the sea), while the effectiveness of dispersants and natural dispersion increases. Mechanical cleanup becomes nonfunctional between International Sea States 3 and 4. During the months of July through September in the open-water portion of the Chukchi Sea, sea states of 4 or greater occur 18 to 32 percent of the time (Fig. IV-16). The presence of pack ice during the remainder of the year would eliminate both high sea states and standard uses of most mechanical-cleanup equipment.

Mechanical cleanup in open water is usually much more effective on low- or medium- viscosity oils than on high-viscosity oils. A low-viscosity oil would be a diesel or a fresh, light crude. A medium-viscosity oil would be a lubricating oil or a light, flowing emulsion. A high-viscosity oil would be a weathered crude, bunker oil, or thick emulsion. An oil such as Prudhoe Bay crude would initially have low viscosity, but would quickly weather and form an emulsion in about 4 hours in the open water in the Sale 109 area, based on the weathering model of Payne et al. (1984). Mechanical cleanup, therefore, would be difficult in the Sale 109 area, even in the absence of ice.

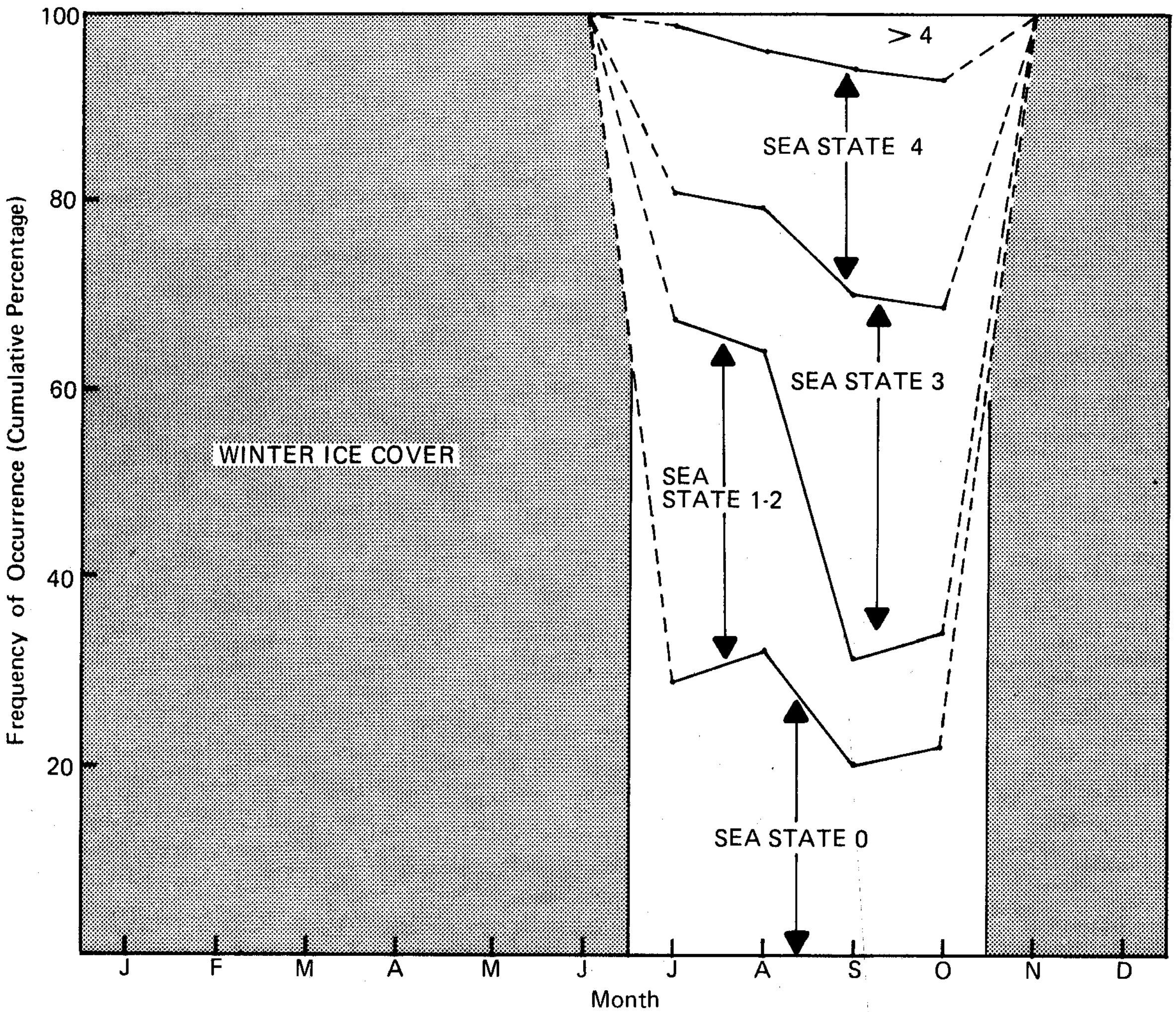
Dispersants are also more effective on less viscous oils and lose all effectiveness when oil viscosity reaches 2,000 centistokes, or about 8 hours after spillage of a Prudhoe Bay-like crude in open water in the sale area (calculated from the model of Payne et al., 1984). Dispersants may be of use for fresh oil in long-duration blowouts, but would not be effective on a crude such as Prudhoe Bay crude in other spill events.

Uncontained burning is also a possible spill remedy. Experiments suggest that burn efficiencies on the order of 50 to 60 percent may be possible if the spill can be immediately set on fire (Laperriere, 1984). However, any delay in ignition would decrease combustion efficiency. (Thus, it is a more promising technique for long-term blowouts than for other spill events.) If a blowout were either deliberately or accidentally set on fire at the wellhead, burn efficiencies can be high. In the West Cameron 180 blowout in 1971, the blowout caught fire and thousands of barrels of crude were burned over 55 days (Dannenberger, 1980). Of these thousands of barrels, it was estimated that only 450 barrels of oil were actually released to the sea.



Sources: LaBelle et al., 1983; MMS, Alaska OCS Region.

FIGURE IV–15. DISTANCES FROM PT. BELCHER, RESPONSE SPEEDS FOR VARIOUS CRAFT AND VEHICLES, AND LOCATION OF THE 4 OKTAS ICE–CONTOUR



Source: Derived from Wave Data for Marine Areas A and C in Brower, Diaz, and Prechtel, 1977.

FIGURE IV–16. CUMULATIVE FREQUENCY OF OCCURRENCE OF DIFFERENT INTERNATIONAL SEA STATES IN OPEN WATER IN THE CHUKCHI SEA PLANNING AREA BY MONTH

Effectiveness of Oil-Spill Cleanup in Ice: When a spill is dispersed far from its source or when ice is moving, containment and cleanup are more difficult. Planning an effective surface response with mechanical equipment to spills in pack ice would require that an icebreaker (or icebreaking supply ship) be locally stationed in both winter and summer and dedicated at least partially to oil-spill response.

In situ burning of spilled oil during heavy ice periods may be a more promising approach. Exposed oil would be ignited whenever possible. Existing response capabilities are more effective on landfast ice than on broken or pack ice. Spills in the latter two kinds of ice would be easiest to burn if the spill were contained within a small area close to its source. The ice itself can be useful in restricting the spreading of the oil, keeping the oil thicker and more amenable to burning. Experiments conducted to date indicate that in situ burning in first-year ice could be a more effective technique for spill response than is mechanical recovery in open water. In situ burning in multiyear ice is less likely to be successful because of delayed and slower melting of the oil out of the ice. Logistical problems, including spill movement into Russian waters, would likely reduce effectiveness of in situ burning below the 5-to-15-percent capability demonstrated for mechanical cleanup in open water. Thus, potential oil-spill response in the Sale 109 area should not be considered an overriding mitigative factor in either open-water or icy conditions.

f. Toxicity of Oil in the Marine Environment: In general, the determination of the ultimate effect and the recovery of an ecosystem from petroleum contamination depends on the physical and chemical form of the oil and the state of the ecosystem at the specific time of the oil spill. The dispersion of oil in water, its movements, chemical modifications, effects on aquatic organisms, and persistence in the sea are all influenced by: (1) type and characteristics of the oil (for example, viscosity and percent aromatics); (2) amount and duration of oil spilled; (3) state of the sea, in particular the tidal cycle and wave activity; (4) location of the spill, including the physiography of the area and the distance from shore; (5) the geographical and topological configuration of the affected coast, including textural characteristics of shore sediments; (6) climatic conditions, in particular temperature, wind, and solar radiation; (7) biota of the area; (8) season of the spill; (9) previous exposure of the area to oil; (10) exposure to other pollutants; and (11) effectiveness of mitigating measures taken by appropriate Federal and State agencies.

(1) Crude-Oil Characteristics: The toxicity of petroleum on marine organisms is dependent upon the concentration and composition of its individual hydrocarbons at the time of contact. The relative effect of the oil will shift as spilled oil weathers due to the change in its chemical composition.

Crude oil is a complex mixture of alkanes (aliphatic), naphthenes (cycloparaffinic), aromatics, and asphaltics (asphaltenic and heterocyclic compounds containing oxygen, sulfur, or nitrogen). The low-molecular-weight components are more toxic but are rapidly lost through evaporation and solution during the first days of a spill. High-molecular-weight aliphatics are the least toxic, although they may have an anesthetic or narcotic effect if concentrations are great enough. Oil spilled or encapsulated under the ice would retain all of the hydrocarbon components, including the low-molecular-weight fractions, until exposure to the atmosphere occurs.

In general, the relative toxicity of an oil is proportional to its aromatic content. Studies have shown low-molecular-weight aromatic hydrocarbons (benzenes and toluenes) to be moderately toxic to a variety of animals. Intermediate-molecular-weight aromatic hydrocarbons (naphthalenes) have been found toxic to phytoplankton and many species of aquatic animals. However, the benzenes and naphthalenes are quickly lost to the atmosphere or diluted into the water column.

(2) <u>Comparative Toxicity of Different Oil Forms in Water</u>: Although laboratory toxicity tests show that the deleterious effects of oil are related to its chemical components, the form of oil at sea is just as, if not more, important in determining toxicity. That portion of the oil that dissolves, the water-soluble fraction (WSF), appears to be the most highly toxic to organisms, possibly due to the easier uptake of oil in this form (Ottway, 1976; Winters and Parker, 1977). Water-in-oil emulsions of spilled oil are likely to cause biological damage due to physical effects, while oil-in-water emulsions probably cause more biological damage due to toxic effects. Oil in dispersed droplets usually exhibits slightly less toxicity than the WSF's. Therefore, although high-molecular-weight aromatics in oil are least degraded and show high toxicity in laboratory tests, the relative toxicity of the low-molecular-weight aromatics may be more important due to their initial enrichment in the WSF.

(3) <u>Comparative Toxicity of Oil Types</u>: Toxicities vary between oil types because the concentration and composition of individual hydrocarbons within the oil vary. In general, refined oils are considered more toxic than crude oils due to their high aromatic-hydrocarbon concentrations and their greater ability to mix into the water column as a result of their less viscous nature. In general, spills of crude oil, residual fuel, and lubricating oil are more likely to cause biological damage by virtue of their viscous physical properties when considered over a length of time, while spills of refined oil, including gasoline and kerosene, are likely to cause biological damage by virtue of their toxic nature over a relatively short period of time (Ottway, 1976).

(4) <u>Biological Differences</u>: The severity of oil pollution on different organisms in various habitats varies from no effect to responses of avoidance, decreased activity, physiological stress, and death. Different species react differently, and different lifestages of an organism show different sensitivities to petroleum hydrocarbons. Lethal effects of the soluble aromatic hydrocarbons from bioassays range from 1 to 100 ppm for most adult marine organisms and from 0.1 to 1 ppm for the more sensitive larval and juvenile lifestages. Sublethal effects may occur from soluble aromatic concentrations ranging from 0.1 to 100 ppb (NRC, 1985).

Comparison of sensitivities of different species or lifestages can be misleading if there are differences in types of chemical analysis and exposure methods used in a bioassay. Most test methods have not included fully characterized or monitored hydrocarbon concentrations. In addition, comparisons between static and flow-through bioassays cannot be made because hydrocarbons evaporate rapidly from solutions; therefore, static exposures are less toxic than flow-through exposures. While flow-through tests are superior to static tests, most of the toxicity testing to date has been done with 96-hour tests, which are easier to conduct and are more cost-effective. In addition, different species or even lifestages of the same species may respond to hydrocarbon exposure at different rates; and, in many cases, the standard 96-hour test is inadequate. For example, salmon fry are unlikely to be affected by further exposure beyond the first 24 hours. In some tests using coon-stripe shrimp, some animals died each day in a test lasting 28 days. Blue mussels also may survive up to 21 days in a test but die within 28 days (Rice et al., 1984).

In spite of the numerous variables that may affect toxicity tests, some general patterns of sensitivity to hydrocarbons are evident. In short-term exposures, the sensitivity of marine organisms generally increases from lower invertebrates (echinoderms, mollusks, annelids) to higher invertebrates (crustaceans, hemocordates) to fish. Some correlations can also be made between the sensitivity of marine organisms to hydrocarbons and their habitat (Table IV-8). Pelagic fish and invertebrates tend to be most sensitive, while benthic and subtidal species are moderately sensitive. The intertidal fish and invertebrates are generally the least sensitive. Marine organisms in the intertidal environment that are exposed to a greater range of naturally occurring environmental factors (temperature, salinity, oxygen) may be physiologically and morphologically better prepared to accommodate an additional stress factor such as petroleum hydrocarbons. Those organisms occupying the more uniform benthic and pelagic environments are less capable of accommodating additional stress from the input of petroleum hydrocarbons (Table IV-8).

Table IV-8

Ranges of Sensitivities for Different Habitat Groups
Exposed to Cook Inlet Water-Soluble Fractions
(96-hour LC50 in parts per million aromatic hydrocarbons)

Organism	Habitat		
	Pelagic	Benthic	Intertidal
Fish	1-3	4-J5	J12
Crab and Shrimp	1-5	3-5	8-J10
Mollusk	--	4-J8	8

Source: Rice et al., 1979.

The ecological significance of these responses is important at the population and community levels. A species may be proven sensitive to oil in the laboratory; but in the natural environment, an entire population may recover rapidly due to such factors as effective reproduction and dispersal strategies and immigration. Conversely, although an individual organism may show high tolerance to oil contamination in the laboratory, recovery of that population under natural conditions may never occur or be delayed due to such factors as competition for food and space or dependence on a specific food resource. See Section IV.B for more specific discussions of toxicity as it relates to biological resources found in the proposed Sale 109 area.

3. Constraints and Technology: This section discusses those environmental features that are considered hazards to petroleum exploitation in the Sale 109 area and the strategies and technologies used to mitigate their effects. The environmental features identified as potential hazards include sea ice, waves and currents--especially during storm surges, unstable surface sediments, erosion, and superstructure icing. These features are part of the physical environment described in Section III.A of this EIS. The following discussion summarizes and incorporates by reference the description of constraints and technologies contained in the Diapir Field Lease Offering (Sale 87) FEIS (USDOI, MMS, 1984a); the summary includes additional material, as cited.

a. Sea Ice: Sea ice is the principal environmental factor affecting the offshore development of petroleum resources in the sale area. The large lateral forces that can be exerted by moving ice floes and sheets, ridges, floebergs, and ice islands are a major concern in the design and operation of offshore facilities associated with petroleum exploration and development and production. The force that moving sea ice exerts on a structure is limited by the strength of the ice and the magnitude of the driving forces. Sea ice is a heterogeneous substance with many small- and large-scale variations. These variations are likely to cause stress concentrations and local failures well before the calculated loads are reached. Other concerns associated with sea ice include rideup, pileup, override, and seafloor gouging.

The strategies used to mitigate the effects of sea ice are discussed in relation to the technologies and activities associated with exploration, development and production, and transportation of oil. These strategies are based on the experiences and proposals associated with petroleum exploitation in the Beaufort Sea.

(1) Exploration: The drilling units that have been used to drill exploration wells in the Alaskan and Canadian Beaufort Sea include (1) artificial islands, (2) caisson-retained islands, (3) ice islands, (4) bottom-founded mobile drilling units such as the Single-Steel Drilling Caisson (SSDC) and the Concrete-Island Drilling System (CIDS), and (5) floating units such as the ice-strengthened drillships and the Conical Drilling Unit (CDU). Because of differences between (1) the stable and dynamic features of the continental shelf that are part of the winter landfast-ice zone and (2) the characteristics and resources of the coastal areas of the Beaufort and Chukchi Seas, artificial islands and ice islands may not be used in the Sale 109 area. However, they are discussed because some aspects of these islands can be applied to other bottom-founded drilling units.

Artificial islands and other bottom-founded units are designed and constructed to resist the lateral forces that are associated with ice movement. These manmade islands are constructed from silt, sand, and gravel that is dredged from offshore deposits or mined from onshore deposits. The total weight of the unit provides the stability required to resist the lateral forces of moving ice. The failure mode of greatest concern is the massive sliding of the island on a horizontal-shear plane through the fill material or the seafloor. To prevent such failures, islands are designed to withstand the maximum force--the design load--associated with an event that is not expected to happen during the intended life of the structure. The islands are actually designed to withstand forces larger than the design load; this provides a safety factor to account for the uncertainties in sea-ice descriptions and ice-load predictions.

The sloping sides of the island cause advancing (1) ice sheets to fail in the flexure, or bending, mode (the strength of sea ice is less in flexure than in compression) and (2) deep-draft ice masses to ground (the grounded masses help to stabilize the nearby ice and initiate subsequent failure). Failure of the ice on the side results in ice pileups or rubble that become grounded. As the pileups grow seaward, the rubble helps to protect the island from future rideups or overrides. Manmade ice-rubble piles have been built around caisson-retained islands and bottom-founded mobile units to help protect the units from the ice forces.

Caisson-retained islands also could be used to drill exploration and delineation wells on a year-round basis. These structures consist of prefabricated concrete or steel caissons that are floated into position and lowered onto the seafloor or onto a subsea berm composed of fill material. Concrete and steel arctic-offshore-drilling units are designed so that damage or failure of any structural element does not result in a catastrophic collapse of the unit.

Ice has been used to construct bottom-founded drilling units and may be used to build future units. Construction of the foundation begins when the first-year ice is thick enough and stable enough to support the construction equipment. Two techniques have been developed to form an ice foundation thick enough to be grounded on the seafloor and strong enough to support a drilling rig and the associated auxiliary equipment.

Flooding was the first technique used to construct an ice island in the Alaskan Beaufort Sea. The island was built at a site located in the eastern part of Harrison Bay in waters about 3 meters deep during the winter of 1976/1977. Drilling from the Harrison Bay ice island began in mid-February and ended during the last part of April.

A more recently developed technique for building ice islands involves spraying seawater into subfreezing air, where the drops form into ice crystals before falling to the surface (OGJ, 1985). Spray ice is added to the surface until the island rests on the seafloor and the grounded mass is large enough to resist predicted loads associated with moving sea ice. Two experimental spray-ice islands were constructed in the Beaufort Sea prior to 1986. One island was constructed in the Mackenzie Delta area of the Canadian Beaufort. The other island was constructed in waters that are about 9 meters deep and located about 19 kilometers northwest of Prudhoe Bay. These islands were built to test the construction techniques and the ability to withstand various loads and ice stresses; no drilling occurred from either of these islands. The technique of using spray ice also was used to construct a grounded, horseshoe-shaped berm around the CIDS during its first operating season in the Beaufort Sea, and to construct an island that was used to drill an exploration well in Harrison Bay. The island was constructed in waters that are about 8 meters deep and located about 5 kilometers northeast of Cape Halkett. The well was drilled between March 12 and April 19, 1986.

Bottom-founded mobile units are capable of resisting sea-ice forces. The first unit of this type--the SSDC--began operating in the fall of 1982 in 31-meter-deep water in the Canadian Beaufort Sea. Two other units were constructed and began operating in 1984; the Mobile Arctic Caisson (MAC) was built for use in the Canadian Beaufort Sea and the CIDS for use in the Alaskan Beaufort Sea.

Ice-strengthened drillships have been used to drill exploratory wells in waters deeper than 20 meters in the Canadian Beaufort Sea since 1976. On the average, drilling and testing a single well from a drillship has taken nearly two drilling seasons. With the assistance of icebreakers or icebreaking supply boats, the drillships are able to operate from about mid-July to mid-October or the first part of November. The drillships are designed to operate in water depths from 15 to 303 meters. One of the Canadian ice-strengthened drillships was used to drill three exploration wells in the Alaskan Beaufort Sea during the 1985 and 1986 summer/fall drilling season. Two of the wells were drilled at a site 19 kilometers north of Flaxman Island in waters 32 meters deep, and one exploration well was drilled at a site about 32 kilometers northwest of Barter Island. The drillship was supported by an Ice-Class 3 icebreaking supply vessel and two ice-class supply vessels (Alaska Report, 1985).

Sea-ice forecasting has developed as a strategy to maximize drilling time and reduce the risks presented by moving sea ice. Ice observations are used to produce maps showing the various ice types, ages, concentrations, and directions of movement. The ice information is combined with weather forecasts and historical ice-movement, wind, and current data to predict sea-ice motion. These forecasts allow time for the well to be shut in safely and the drillship to disconnect from the well and the mooring system if weather and sea-ice conditions become severe enough to threaten the operation.

Icebreakers and icebreaking supply boats perform ice-management tasks to reduce the threat that sea ice poses to the drillship (Browne, Carter, and Kimmerly, 1984). These ice-management duties include breaking up ice around the drillship and breaking, towing, or pushing large floes so that their drift trajectories miss the drillship. In heavy ice, the support vessels maneuver around the drillship to keep the ice sufficiently broken so that it produces only minimal lateral forces on the drillship. Sea-ice forecasts also allow for the efficient deployment of the icebreaking vessels.

To protect the equipment installed at the wellhead on the seafloor from collisions with the keels of drifting ice masses, the MMS requires placement of subsea blowout-preventor (BOP) stacks that are used in areas subject to ice gouging in excavations (glory holes) deep enough so that the top of the stack is below the deepest probable gouge depth (USDOI, MMS, 1982a, Alaska OCS Orders). The BOP is designed to close the top of the well, control the release of fluids, permit the pumping of fluids into the hole, and allow movement of the drill pipe.

The BOP is used to safely shut in a well if ice conditions force the drillship to temporarily abandon drilling. If, near the end of the drilling season, ice conditions prevent the return of the drillship, the BOP also can be used to temporarily abandon the well during the winter and spring. The well could then be re-entered and drilling resumed the next season.

The CDU is the other type of floating unit that has been used in the Canadian Beaufort Sea. This unit is designed to operate in waters 24 to 180 meters deep. In the presence of sea ice, drilling can be maintained until first-year ice attains a thickness of about 1.2 meters and the velocities of the winds and the currents reach about 16 meters per second and about 30 centimeters per second, respectively (Park, 1984). Operations with the CDU began in August 1983 at a site in the Canadian Beaufort Sea about 160 kilometers northwest of Tuktoyaktuk (Tuk), Northwest Territories. With greater ice-strengthening and icebreaker support, the CDU or a similar type of vessel would be able to operate in the sea-ice environment of the Chukchi Sea for longer periods of time than would ice-strengthened drillships.

In addition to the operational units, designs have been proposed for a number of (1) bottom-founded mobile units (with a large surface area at the waterline) for water depths from 4 to 40 meters, (2) bottom-founded mobile units with a monopod/monocone configuration for water depths from 6 to 50 meters, and (3) floating units (Han-Padron, 1985). These units would be constructed and outfitted outside Alaska and towed to the Sale 109 area. In addition, the units would carry enough supplies to drill two or three wells without major resupply.

(2) Development and Production: If economically recoverable petroleum resources are discovered, structures designed for the recovery of oil will be placed in the sale area. The experiences gained from exploration units will contribute to the design and construction of these production platforms. Production platforms will be larger than exploration units because space must be provided for (1) drilling a number of production and service wells; (2) locating facilities to separate the oil, gas, and water that is produced from the wells; and (3) locating the equipment and wells that may be needed to inject gas and water. Production platforms may be larger versions of the units used for exploratory drilling.

Structures contemplated for year-round use in the stamukhi and pack-ice zones would have to resist the forces exerted by thick first-year and multiyear ice floes and sheets, ridges, floebergs, and ice islands. Installation of an offshore structure that could survive the impact of a large ice island may not be likely. However, if the probability of an event is very low and an oil spill could be avoided, a production platform could be designed and installed in the pack-ice zone.

Concepts also are being developed for arctic-production platforms that are monolithic, multisided concrete or steel structures or large monopod/monocone-type structures. A variety of steels is available for construction use in low-temperature environments; and concrete has been used to construct many different types of structures that resist seawater, ice, and freeze-thaw cycles.

(3) Transportation: Oil may be transported from the production sites to refineries by pipeline, tankers, or a combination of the two systems. A considerable amount of experience has been derived from these systems in many other offshore areas. As with other techniques, some of this experience will be used to design, construct, and operate petroleum-transportation systems in the Sale 109 area. Because experience with arctic-petroleum-transportation systems is very limited, a number of new problems must be solved.

(a) Offshore Pipelines: The threat that sea ice poses to a marine-pipeline system in the sale area is indicated by the presence of ice gouges. The area of most intense gouging is the stamukhi zone; the frequency of ice gouging decreases shoreward and seaward of this zone. Burial of the pipeline beneath gouge depth will afford protection from moving ice.

Offshore pipelines can be laid during the open-water period by a variety of existing pipelaying techniques. These methods include laying pipe from a conventional lay or reel barge or with bottom or surface tows. Most present-day techniques for laying marine pipe were developed in an ice-free environment. Short pipelines and shallow-water sections of longer pipelines will probably be installed by the bottom-pull method. Longer pipelines will probably be installed by a vessel that can lay pipe at a rate of about 2 kilometers per day.

Pipeline-burial depth will depend on the deepest gouge that is expected to be cut into the seafloor during the operational life of the pipeline. As with many other sea-ice phenomena, it is difficult to predict maximum-gouge events that will occur within some time interval for specific segments of the sea-floor. However, several methods are being developed to predict depths and rates of ice gouging. One of these methods uses ice-gouge data obtained from a repetitive sonar mapping of the seafloor; this is the principal quantitative method used today. Another method uses ice-ridge-drift rates and keel-depth distribution.

Pipeline trenches may be excavated by cutter-suction dredges or mechanical plows (Han-Padron, 1985). However, because existing cutter-suction dredges are limited to dredging depths of 30 meters and have forward speeds that are too slow for the short open-water season, specially designed new equipment will be required. Trenches may have to be cut in the bedrock in those areas where the layer of unconsolidated sediments is not thick enough to bury the pipeline below ice-gouge depth. A buried pipeline could be routed around areas of known intensive gouging or into the paleovalleys.

Design studies indicate that trenches as deep as 1 to 2 meters can be cut by a single pass of a large mechanical plow, but cutting trenches deeper than 2 meters will probably require multiple passes (Brown and Palmer, 1985). Since 1975, 13 large plows have been constructed to cut trenches in other parts of the world. The trenching depths of these plows range from 0.6 to 2 meters. The trenching rate and number of passes will depend, in part, on the size of the plow, the power of the pulling system, and the geotechnical characteristics of the seafloor. In the Beaufort Sea, Brown and Palmer (1985) estimate that trenching to a depth of 1 meter can be done at an average of 4.8 kilometers per day.

Those segments of offshore pipelines that cross the shoreline must also be protected from sea-ice hazards such as gouging, pileups, or rideups. Three of the methods that might be used are burial of the pipeline (1) beneath the offshore sediments and onshore soils, (2) in a causeway, or (3) in a frozen berm.

(b) Marine-Transportation Systems: A marine-transportation system could also be developed to transport Chukchi Sea oil. This system would include icebreaking tankers, offshore-storage and -loading terminals, and icebreaking support vessels.

Tankers: The most economic-size crude-oil tanker for a particular trade route depends on a number of factors that include time in port, cruising speed in open waters and in various concentrations and thicknesses of ice, the amount of oil loaded into the tanker, physical restrictions along the trade route, and terminal limitations (Han-Padron, 1985). It is assumed that the icebreaking tankers could transport the crude oil from the Sale 109 area to an ice-free transshipment terminal on the Alaska Peninsula. Conventional tankers will then be used to carry the oil to refineries outside Alaska.

Although limited, there is some arctic operational experience with icebreaking tankers. In 1969, the S.S. Manhattan, equipped with an icebreaking bow, made successful westbound and eastbound transits of the Northwest Passage in a route from the east coast of the U.S. to Barrow, Alaska, and return. The "Lunni" class of icebreaking tankers (16,000 deadweight tonnage [DWT]), currently in service in Finland, was designed to operate in 1-meter-thick level ice and through 10-meter-thick ridges. Two icebreaking tankers, the Lunni Class Sotku and the 6,900-DWT Kiisla, were used in a series of full-scale ice-resistance and -maneuvering tests in the Baltic Sea in 1984 to demonstrate the accuracy of model tests and to provide data on icebreaking-hull forms that may be expanded to larger ships for the arctic (Sucharski and Gordin, 1985).

To demonstrate the feasibility of arctic-oil transportation by tanker, 100,000 barrels of crude oil were shipped from the Bent Horn Field on Cameron Island in the Canadian Arctic Islands to Montreal during the summer of 1985 (Arctic News Record, 1985; OGJ, 1985). The MV Arctic, a converted Ice-Class 2 icebreaking bulk carrier, was used to transport the oil from Cameron Island 118 kilometers south to Rea Point on Melville Island where the ice conditions are less severe. At Rea Point, the Bent Horn oil was transferred to the icebreaking tanker MV Imperial Bedford for the remainder of the 5,285-kilometer journey through the Northwest Passage, Baffin Bay, Davis Strait, Labrador Sea, and St. Lawrence River to Montreal.

More recently, the VLCC Gulf Beaufort transported 300,000 barrels of oil from the Canadian Beaufort Sea past Point Barrow in early September 1986; the oil was from an extended flow test at the Amauligak discovery well northwest of Tuktoyaktuk. The Gulf Beaufort has a hull that is reinforced with a double skin to operate safely in the sea ice.

Based on the average sea-ice conditions in the Beaufort and Chukchi Seas, it is assumed that the tankers' power and structural specifications will be equivalent to Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR) Ice-Class 8. The maximum tanker size considered is 250,000 DWT; a tanker of this size would have a draft of about 24 meters, an overall length of 390 meters, and a beam of 55 meters (Han-Padron, 1985). (An Ice-Class 8 vessel would have sufficient hull strength and propulsion power to maintain a steady speed of 3 knots in 2.4 meters [8 feet] of level ice).

Offshore-Storage and -Loading Facilities: The structures used for storage and loading in the Sale 109 area would be gravity- or pile-founded units that would have to resist the same ice forces as the production platforms. Although a single structure that combines the storage and loading functions may be used, separation of the crude-oil-storage and mooring/loading facility may consist of a large concrete/steel caisson-type structure that is divided into compartments for oil storage, seawater or sediment ballast, and operating equipment. The mooring/loading facility would incorporate some means of mooring the tankers and a loading crane or arm to support the hoses that carry oil to the tankers.

Open-water mooring and loading systems are common in other offshore areas; but in the arctic, winter loading may have to be accomplished in moving ice fields. The mooring and loading systems would allow the tanker to point toward the oncoming ice and have a quick-disconnect capability. A number of concepts have been developed for arctic-offshore-loading terminals, including the Artificial Production and Loading Atoll (APLA) and the Arctic Single-Point Mooring (ASPM).

Production platforms may also serve as offshore-loading terminals. The use of the production platform for offshore loading must provide (1) for a loading system that will permit the moored tankers to weathervane, (2) sufficient fendering to prevent a catastrophic collision between an approaching tanker and the platform, and (3) a means of clearing ice rubble in shallow water (Han-Padron, 1985).

Icebreaking Support Vessels: Icebreakers and work/supply boats with ice-breaking capabilities would be required to support tanker operations. From time to time, these vessels may be needed to assist tankers transiting the northern part of the Bering and Chukchi Seas. Icebreaking vessels should also be available to assist the tankers during mooring and for ice-management duties during loading. Icebreaking support vessels would probably need to be Ice-Class 8 or greater.

b. Other Constraints:

(1) Waves, Currents, and Storm Surges--Flooding and Erosion: Waves in the Sale 109 area have the potential to cause flooding of low-lying structures and could induce erosion of shorelines and unprotected structures built from sand and gravel. Currents can cause erosion of material from natural and artificial islands, coastal areas, and around the foundations of bottom-founded structures. A storm surge is an extreme meteorological and oceanographic event of increased wind velocities, wave heights, and wave- and wind-induced current velocities. The presence of sea ice in open-water areas at the time of a storm surge increases the severity of the hazard. However, the presence of more than one-tenth ice coverage reduces the buildup of waves and surge and thus limits potentially damaging surges to late summer and fall (LaBelle et al., 1983).

There is a considerable amount of coastal and offshore engineering experience from other areas that can be adapted to the arctic environment. Excluding storms, available information indicates that waves and currents should not be a major problem affecting offshore operations. In the absence of long-term measurements, it is possible to statistically hindcast the characteristics of wind-driven waves, currents, and storm surges at potential operating sites. The hindcast results are used as input for statistical extrapolation procedures to determine wave heights and periods, storm-surge heights, and current velocities that could interact with structures of a given site during the operational life. Through careful analyses of regional and site-specific environmental data, protective measures can be taken to reduce the effects of moving water.

(2) Unstable Sediments: The ability of the seafloor sediments to support the weight of the heavy, bottom-founded structures and to resist sliding when sea-ice interacts with the structure is an important consideration in the Sale 109 area. The geotechnical properties of the sediments that support the structures must be determined to understand how the sediments will react under static or cyclic vertical and lateral loads. There is considerable engineering experience associated with offshore foundations that can be used in the arctic.

Sediment instability and mass movement are related to relatively high seafloor gradients, low sediment strength in fine-grained sediment that retains high amounts of water, sediment loading from waves during the passage of storms, and ground motion during earthquakes. Mass movement includes slides, slumps, flows, and subsidence. On the continental shelf inshore of the 50-meter isobath, the slope of the seafloor is generally very low. Ground motions associated with earthquakes are also expected to be generally low. Thus, mass movement in waters less than 50 meters is generally not a hazard that would significantly affect offshore operations. Hazards associated with mass movement are most likely to be found in the deeper parts of the sale area, particularly in the vicinity of the shelf break.

Pipelines are susceptible to sediment creep, slides, flowage, and subsidence. Methods used to minimize potential damage to pipelines include (1) routing a pipeline so that it follows the contour of a mudslide lobe, (2) crossing a flow in the general direction of the flow movement, and (3) laying pipelines in mudslide areas that show signs of less disturbance. Recent engineering adaptations to mudslide problems include using flexible joints, which allow some movement, and safety couples, which activate immediate shutoff of the line flow if the line is moved.

Unstable sediments also include those sediments that are transported along the seafloor in response to bottom currents and form ridges and migrating sediment-wave fields (Lewbel, 1984). These features may be hazardous to navigation and offshore construction. Sediment movement also could uncover buried pipelines. Frequent surveys may be necessary to detect current-produced sediment features that could be a hazard to offshore activities. When necessary, accumulations of sediment that threaten an offshore activity can be removed through dredging.

(3) Superstructure Icing: Icing caused by sea spray is the most frequent and most important form of icing at sea (LaBelle et al.,

1983). Ice buildup on a vessel's superstructure has both operational and safety implications. Buildup of ice may affect operations of equipment on deck and may pose a danger to personnel. Massive ice buildup may significantly affect the vessel's freeboard and center of gravity, with a corresponding reduction in vessel stability. These effects are of particular concern with regard to small vessels, such as work boats or other support vessels that may be used in offshore operations. Drilling units and production platforms, with their considerable size and freeboard, are less sensitive to superstructure icing than smaller vessels. In the northern Bering Sea/Norton Sound area, superstructure ice was considered to be a hazard only to (1) floating drilling units--low severity--and (2) work boats and service vessels--moderate severity.

Sea-spray icing constitutes the most serious and largest number of icing cases (LaBelle et al., 1983). Sea spray is formed (1) by the vessel or structure as it meets waves--the most important with regard to superstructure icing--and (2) when the wind blows droplets off the wave crests--this phenomenon depends on the forms and steepness of the waves and begins to occur at windspeeds of 8 to 10 meters per second. The conditions necessary to cause significant accumulations of superstructure icing are: (1) air temperature less than the freezing point of seawater (-1.7 to -1.9°C, depending on the salinity of water down to about -30°C); (2) windspeed of 10 meters per second or more; and (3) seawater temperature colder than 8°C.

In a study of possible months when superstructure icing might occur in the Chukchi Sea, Kozo (1985) evaluated combinations of the maximum, mean, and minimum parameter for ice-edge extent, air temperature, and sea-surface temperature; and wind velocities of about 14 and 26 meters per second. On the basis of specific assumptions regarding ice-edge extent, air and sea-surface temperatures, and wind conditions, the study predicts that icing might occur from June through November and that September and October are the months when superstructure icing is most likely to occur.

Summary: The environmental hazards that affect petroleum exploration in the Sale 109 area are related to sea ice, storm surges, factors that affect the geotechnical characteristics of the seafloor sediments, and superstructure icing. Sea ice is the major hazard; however, the potential severity of any hazard varies with each activity, and measures can be taken to lessen their effects. These measures include (1) scheduling activities to minimize exposure to a hazard, (2) conducting surveys to locate potentially hazardous areas and locating facilities away from known hazards, and (3) designing facilities to withstand a range of environmental forces. The use of these strategies necessitates being able to (1) identify the hazards, (2) locate or predict where and when they will occur, and (3) estimate their effects.

Caisson-type structures and bottom-founded mobile drilling units have been constructed that can withstand, on a year-round basis, the physical forces of the Chukchi Sea environment in waters as deep as 30 meters and can function as platforms from which wells can be successfully drilled and completed. Floating drilling units such as ice-strengthened drillships and the CDU can also operate during the open-water season and, with the assistance of icebreakers, in the sea ice during the latter part of the breakup period and during part of the freezeup period. Drilling and completing wells in the sale area can be accomplished with proven techniques.

The interaction of sea ice with fixed and moving structures is an important subject for continuing research, additional field observations, and analytical studies. Additional environmental data, particularly for sea ice, also is needed to improve the reliability of predicting extreme events at specific sites.

Designs for exploration drilling units and production platforms capable of operating year-round seaward of the landfast ice are being developed. Systems designed to transport offshore arctic petroleum also are being planned; these systems incorporate pipelines, as discussed for the Sale 109 mean-case transportation scenario, and, alternatively, tanker systems that include icebreaking tankers and offshore storage and loading facilities, as discussed for the low case.

B. Alternative I - Proposal

1. Effect on Air Quality: Federal standards for ambient and incremental air quality were designed to protect human health from pollutants emitted in normal operations. Accidental emissions are considered "upsets" and the air-quality standards and DOI exemption levels technically do not apply to upsets. Thus, accidental emissions, but also low-level normal emissions, could potentially result in environmental degradation--for example, acid precipitation--without violating the primary criteria of Federal air-quality standards or exemption levels. In this analysis, the possibilities of other secondary effects--those which occur even if standards and exemption levels are not exceeded or do not apply--are also considered.

The effects on arctic air quality resulting from emissions during normal offshore operations and accidental emissions from offshore oil and gas leasing are discussed and described in detail in Section IV.J.6 of the Sale 100 FEIS (USDOI, MMS, 1985c). This information is incorporated by reference; a summary pertinent to proposed Sale 109, as augmented by additional material as cited, follows.

a. Federal Air-Quality Standards: The MMS measures estimated air-pollutant emissions against a DOI exemption level as a first-order estimate of whether significant degradation of air quality would be possible over nearby land. Land is emphasized because air-quality standards are set with the intent to protect long-term human health. The DOI exemption levels (Table IV-9) are calculated from equations that contain a distance multiplier, so that the distance of offshore operations from land can be taken into account. If the DOI exemption level is exceeded for Volatile Organic Compounds (VOC), emission-control technologies would need to be applied. For other listed pollutants, emission controls would only be required if concentrations at the shoreline could exceed ambient or incremental standards (see Table IV-10a) or the DOI significance levels (Table IV-10b). The DOI regulations would prohibit any offshore activities that would result in exceeding applicable standards.

If exemption levels are not exceeded, no significant degradation is assumed. If exemption levels are exceeded, degradation of shoreline air quality may be possible. Normally at this point of the analysis, MMS regulations would require that an air-quality model be run to estimate air-pollutant concentrations at the shoreline. Such a model is being adapted for the Alaska OCS Region but is not yet available. This EIS, therefore, uses an alternative approach to estimate effects on air quality. This EIS first estimates whether exemption levels could be exceeded under the assumed exploration and development scenario, with the additional, extreme assumption that the emission sources are located close to shore. Second, if exemption levels might be exceeded, this EIS estimates whether applicable emission-control technologies (Table IV-11) could be sufficient to reduce emissions below the exemption levels. Note that this latter evaluation is an indicator of the magnitude of the emissions problem; although the exemption levels for pollutants other than VOC can legally be exceeded, the control technology would not necessarily be applied. If this second estimate indicates that such reductions below exemption criteria are not possible, the potential effect on air quality is estimated by analogy to pollutant levels resulting from existing onshore oil development. This is an extreme assumption; actual modeling of offshore pollutant emissions and resulting concentrations of pollutants could very well indicate a lesser effect over land and emissions would likely occur further offshore than assumed here. This point is particularly true for the Sale 109 area because long-term monthly wind records for the Sale 109 area compiled by the NOAA and the Arctic Environmental Information and Data Center (AEIDC) show that offshore winds predominate along the U.S. Chukchi Sea coast 11 out of 12 months of the year (Brower, Diaz, and Prechtel, 1977), and most oil resource is thought to be away from shore.

After the proposed sale, site-specific information would be available. If industry plans for exploration or development indicated that emissions-exemption levels would be exceeded, industry would be required to model air quality and demonstrate that significant degradation of air quality would not occur before the approval of the planned activities could be given by the MMS and the EPA. This procedure would occur regardless of whether a similar conclusion was or was not reached in the sale EIS.

Exemption levels for two critical distances for Sale 109 are provided in Table IV-9.

Exploration: Under the proposal, the exploration scenario calls for four rigs drilling no more than a total of eight wells in any 1 year. About 84 percent of the oil resource is estimated to lie seaward of the Coastal Deferral Area, or at least 41 kilometers from shore. Although very unlikely, two rigs could simultaneously operate as close to shore as the State offshore boundary--5 kilometers offshore. During exploration, the extreme case would be two rigs drilling one well each on the same block or one rig drilling two wells on the same block within the Coastal Deferral Area. (Under the proposal, a maximum of two exploration/delineation wells per year are anticipated in the Coastal Deferral Area. The other six wells would be drilled at least 41 kilometers from shore.)

Two exploration/delineation wells on the same block located 5 kilometers from shore would exceed the exemption levels for nitrogen-oxide emissions. Although unlikely, cumulative peak emissions between 41 and 72 kilometers from shore from other exploration/delineation wells could exceed exemption criteria. The exemption levels increase with distance from shore, and exploration drilling beyond 72 kilometers from shore should not emit enough pollutants to exceed exemption levels. To drill on one block located 5 kilometers from shore without exceeding the exemption levels would require additional control measures for nitrogen oxides and a limitation of no more than one well per year. However, such controls would be unlikely to be necessary to keep nitrogen-oxide concentrations within permissible levels. Winds in the sale area are offshore during 11 out of 12 months, and the only nitrogen-oxide standard is an annual arithmetic mean; 1 month of onshore winds would be insufficient to elevate the annual average concentration of nitrogen oxide to the standard's 100 micrograms per cubic meter of shoreline air. A concentration increase of 1 microgram per cubic meter would require application of Best Available Control Technology (BACT). Because nitrogen-oxide emissions could exceed exemption levels--but resulting nitrogen-oxide concentrations would not approach the maximum levels for nitrogen oxide permitted by Federal standards--a MINOR effect on air quality, as related to air-quality standards, would result from exploration/delineation activities.

Table IV-9
Estimated Emissions and USDOI Exemption Levels For All Offshore Platforms In the Sale 109 Area
(metric tons per year)

	Pollutant[1]				
	CO	NO_x	TSP	SO_2	VOC
Peak Exploratory Drilling[2]	441	1,313	33	116	188
5 to 41 kilometers offshore[3]	110	328	8	29	47
>41 kilometers offshore[4]	331	985	25	87	141
Peak Development plus					
Development/Production Drilling[5]	721	3,398	159	253	112
5 to 41 kilometers offshore[6]	270	1,129	61	96	46
Mean-Production Years[7]	343	1,290	52	57	5,309
5 to 41 kilometers offshore[8]	56	210	9	9	866
Peak-Production Years[9]	547	2,059	83	90.9	8,471
5 to 41 kilometers offshore[10]	95	357	14	16	1,468
Exemption Levels					
At 5 kilometers	6,430	90.8	90.8	90.8	90.8
At 41 kilometers	26,702	769.4	769.4	769.4	769.4

Source: MMS, Alaska OCS Region.

1/ NO_x = Nitrogen Oxides
TSP= Total Suspended Particulates
SO_2= Sulfur Dioxide
CO = Carbon Monoxide
VOC= Volatile Organic Compounds (excluding nonreactive compounds such as methane and ethane)

2/ Eight wells per year, 45 days of drilling per well with emissions based on drillship estimates for Sale 87 exploratory wells (Entrix, Inc., 1985). Calculation assumes that natural gas flared in well tests.

3/ Two wells per year, possibly from the same drilling unit on a single block.

4/ Six wells per year.

5/ In 1998, for construction of 5 platforms and drilling of 71 wells.

6/ Two platforms, 25 wells, could be on a single block.

7/ 141 MMbbls/year.

8/ 23 MMbbls/year may be produced from a single block.

9/ 225 MMbbls/year.

10/ 39 MMbbls/year may be produced from a single block.

Table IV-10a
State of Alaska Ambient-Air-Quality Standards
Relevant to Sale 109
(measured in micrograms per cubic meter)

Criteria Pollutant 1/	Annual	Averaging Time 24 hr	8 hr	3 hr	1 hr	30 min
Total Suspended Particulates	60 2/	150	-- 3/	--	--	--
Class II 4/	19 2/	37	--	--	--	--
Carbon Monoxide	--	--	10,000	--	40,000	--
Ozone 5/	--	--	--	--	235	--
Nitrogen Dioxide	100 6/	--	--	--	--	--
Lead	1.5 7/	--	--	--	--	--
Sulfur Oxide 8/	80 6/	365	--	1,300	--	--
Class II 4/	20 6/	91	--	512	--	--
Reduced Sulfur Compounds 8/	--	--	--	--	--	50

Sources: State of Alaska, Dept. of Environmental Conservation, 1982, 80 18 AAC 50.010, 18 AAC 50.020; 40 CFR 52.21 (43 FR 26388).

1/ All averaging times not to be exceeded more than once each year.
2/ Annual geometric mean.
3/ No standard for exposure interval indicated.
4/ The standards for Class II areas refer to the EPA Prevention of Significant Deterioration Program. The standards express maximum allowable increments in air quality attributable to proposed emission sources above baseline (existing) air-quality conditions.
5/ The State's ozone standard compares with U.S. EPA standards for photochemical oxidant(s), which are measured as ozone.
6/ Annual arithmetic mean.
7/ Quarterly arithmetic mean instead of annual.
8/ Measured as sulfur dioxide.

Table IV-10b
USDOI Significance Levels
Relevant to Sale 109
(increments measured in micrograms per cubic meter)

Criteria Pollutant	Annual	Averaging Time			
		24 hr	8 hr	3 hr	1 hr
Total Suspended Particulates	1	5	-- 1/	--	--
Carbon Monoxide	--	--	500	--	2,000
Nitrogen Dioxide	1	--	--	--	--
Sulfur Oxide 2/	1	5	--	25	--

Source: Federal Register, 1980.

1/ No standard for exposure interval indicated.
2/ Measured as sulfur dioxide.

Table IV-11
Control Measures for Major Offshore Oil- and Gas-Emission Sources

Emission Source	Location[1/]	Major Pollutant	Control Measure	Possible Emission Reductions	Measure In Use	Other Controls
Diesel Engines	Drilling vessel Marine tanker	NO_x	Injection-timing retard	10-20%	Yes [2/]	Exhaust gas recirculation
			Intake air cooling	30%	Some engines	
		SO_x	Low-sulfur fuel	Variable		
Gas Turbines	Platform OS&T	NO_x	Water injection	70-80%	Yes [3/]	Fuel-injection retard SCR on exhaust gas
		ALL	Waste-heat recovery [4/]	26%	Yes [5/]	
Flares	Drilling vessel Platform OS&T	VOC	Vapor recovery	95%	No	
Valves, Flanges, Compressor Seals, Pumps	Platform OS&T	VOC	Inspection & maintenance	50-75%	No	Double mechanical seals on compressors and pumps; connect compressor pumps to vapor-recovery system
Storage Tanks	Platform	VOC	Use of floating roofs or vapor recovery on fixed roofs	75-95%	Yes [6/]	
Tanker Loading	Platform OS&T	VOC	Vapor recovery	95%	Yes [5/]	
Gas Processing	Platform OS&T	SO_x	Tail-gas treatment (e.g., Stretford) Sulfur-recovery unit (e.g., Claus)	95-99%	Yes [7/]	

Source: Form and Substance, Inc., 1983.

1/ OS&T = Offshore storage and treatment.
2/ Pacific OCS.
3/ Used on Exxon Platform Hondo, Texaco Platform Habitat. Some problems noted.
4/ Can eliminate need for external-combustion-process heaters.
5/ Exxon Platform Hondo.
6/ Onshore facilities.
7/ Exxon Platform Hondo, Chevron Platform Grace, Union Platform Gilda (if H_2S is encountered).

Development and Construction: The assumed development scenario calls for nine platforms with a total of 153 wells. Peak development would occur in 1998 with the construction of five platforms and 71 wells. Two of these platforms and 25 of the wells are anticipated to be located within 5 to 41 kilometers of shore. Construction of the two inshore platforms in the same year in the same field, particularly if on the same block, or construction of several of the farther-offshore platforms in the same year in the same field could exceed exemption levels for nitrogen-oxide emissions--even with emission controls. Analysis of potential air-quality effects could be required in industry-development plans if industry submitted overlapping plans for platform construction in the Sale 109 area. Concentrations of nitrogen oxides in the air at the shoreline would not approach the Federal ambient annual standard of 100 micrograms per cubic meter because of the predominant offshore winds during most of the year and implementation of BACT if development would increase nitrogen-oxide concentrations at the shoreline by 1 microgram per cubic meter. The potential for exceeding exemption levels for nitrogen-oxide emissions would result in a MINOR effect on air quality with regard to air-quality standards.

Production: Mean- and peak-production emissions inshore of 41 kilometers would exceed exemption levels for VOC and might exceed exemption levels for nitrogen oxides. Mean and peak emissions from beyond 41 kilometers may exceed VOC-exemption levels, depending on distance from shore, individual platform production, and how closely platforms are grouped. Further analysis of potential air-quality effects would be required prior to production. However, VOC emission-control technology must be applied to reduce VOC emissions below exemption levels if exemption levels are reached--a harsher standard than for other pollutants. Available pollution-control technology can reduce VOC emissions from production sources by about 50 to 95 percent, sufficient to reduce emissions below exemption levels. The MMS would require that this technology be used to reduce emissions to the exemption level. Because the nitrogen-oxide standard is only an annual standard, the predominance of offshore winds during most of the year would ensure that nitrogen-oxide emissions would not exceed permissible (annual) levels at the shoreline. If the exemption level for nitrogen oxide were exceeded, however, an air-quality-model analysis would still be required to demonstrate that the ambient standard for nitrogen oxide would not be exceeded. Note that emissions from onshore production from the much larger Prudhoe Bay Field on the North Slope--for which the State of Alaska requires the BACT for emissions (Sec. III.A.5)--have not exceeded Federal standards for ambient or incremental air quality. By analogy, production emissions resulting from Sale 109, if BACT were applied, would not be expected to have more than a MINOR effect on air quality.

Oil storage on platforms is not assumed in this analysis because oil would be piped to the TAP as it is produced.

b. Other Effects of Air Quality: The secondary effects of air pollution include the possibility of environmental damage to coastal tundra from air emissions from OCS and other sources, as discussed in Sections III.D.7 and IV.G.7 of the Diapir Field Lease Offering (Sale 87) FEIS (USDOI, MMS, 1984a) and in Olsen (1982). This information is incorporated by reference, and a summary pertinent to proposed Sale 109 follows.

A significant increase in ozone concentrations is not likely to result from Sale 109 development. Ozone is not emitted directly but rather forms slowly in air-pollutant plumes from interactions of other pollutants, allowing time for widespread dispersion. Ozone concentrations both upwind and downwind of the much larger Prudhoe Bay development on the North Slope are similar to each other and are both well below National standards (see Table III-3). Ozone formation is expected to result in a NEGLIGIBLE effect on air quality.

In terms of potential damage to vegetation, emissions of acid pollutants, particularly sulfur oxides, are the most threatening. Lichens are the most vulnerable vegetation, with photosynthesis being depressed at concentrations of sulfur dioxide as low as 12 micrograms per cubic meter and damage occurring at 60 micrograms per cubic meter. Background concentrations of sulfur dioxide at Prudhoe Bay peak at 13 micrograms per cubic meter, and concentrations downwind of Prudhoe Bay peak at 25 micrograms per cubic meter for short periods (3-hour maximum, Table III-3)--above the concentrations affecting lichen photosynthetic rates but below the concentrations at which damage occurs to the lichen. Concentrations over time periods greater than 3 hours, 24 hours, and annual periods are lower both upwind and downwind of Prudhoe Bay and would not be expected to depress photosynthetic rates. Similarly, emissions of sulfur dioxide from Sale 109 should result in, at most, a local and infrequent depression of photosynthesis of lichens or other sensitive vegetation for a few hours at a time for a few days a year--a MINOR effect.

The possibility of acidification of coastal tundra on the North Slope was considered in detail in Sections III.D.7 and IV.G.7 of the Sale 87 FEIS (USDOI, MMS, 1984a). This information is incorporated by reference, and a summary pertinent to proposed Sale 109 follows. The Sale 87 analysis concluded that exploration, development, and oil production of 3 billion barrels of crude would emit sufficient pollutants to acidify no more than 29 square kilometers of tundra, ignoring any dispersion, wind direction, and distance from shore. For the 2.68 billion barrels estimated for Sale 109, no more than a proportionate 26 square kilometers could be acidified.

Even qualitative consideration of the effects of dispersion of both pollutants and facilities, wind directions and persistence, and distance from shore requires the conclusion that pollutant fallout could not be limited to and concentrated in such a small area. This conclusion is particularly true for the Sale 109 area: winds would blow most of the pollutants farther offshore rather than onshore. (Onshore breezes predominate only during the month of July.) Therefore, acid precipitation resulting from Sale 109 is expected to be NEGLIGIBLE.

<u>Effects of Accidental Emissions</u>: 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 do not show a statistical trend of decreasing rate of occurrence such as has been demonstrated for platform oil spills of 1,000 barrels or greater. 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.

A gas blowout could release 20 metric tons per day of gaseous hydrocarbons, of which about 2 metric tons per day would be nonmethane hydrocarbons classified as VOC. Based on the assumption of the Poisson distribution (as for oil spills in Sec. IV.A.1.b), the probability of experiencing one or more blowouts in drilling the 193 wells projected for the proposal would be 47 to 56 percent. If a gas blowout occurred, it would be unlikely to persist more than 1 day, and it would very likely release less than 2 metric tons of VOC. Since 1974, 60 percent of the blowouts have lasted 1 day or less; only 10 percent have lasted more than 7 days.

A gas blowout would release up to 0.03 metric tons of hydrogen sulfide per day (Stephens, Braxton, and Stephens, 1977). Hydrogen sulfide and other gases from blowouts could be extremely hazardous to workers on or near the drilling rig, but not at farther distances or onshore because of rapid dispersion and oxidation of hydrogen sulfide to sulfur dioxide (forming up to 0.09 metric tons of sulfur dioxide/day). However, because most blowouts last 1 day or less and the total amount of sulfur dioxide from blowouts would be much lower than normal, sulfer-dioxide emissions over the life of the field are expected to have a NEGLIGIBLE effect onshore.

Oil spills are a second accidental source of gaseous emissions. The logarithmic-mean size of 1,000-barrel-or-greater OCS spills is 8,000 barrels for platform spills and 7,500 barrels for pipeline spills. Over the life of an oil slick, one-third to two-thirds of the slick mass will evaporate (Sec. IV.A.2.a). If a 10,000-barrel spill occurred in the proposed sale area, 3,350 to 6,670 barrels of oil, 450 to 900 metric tons of gaseous hydrocarbons, or 45 to 90 metric tons of VOC could be lost to the atmosphere, mostly within the first few days of the spill. The movement of the 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. The most likely number of seven spills of 1,000 barrels or greater that is projected for Sale 109 would release 320 to 630 metric tons of VOC. However, more than one such spill in any single year is not anticipated.

Smaller spills of less than 1,000 barrels occur more frequently than larger spills. The number of small spills projected for the proposal is 777, totaling 3,140 barrels over the life of the field (Sec. IV.A.1.b). Evaporation from these spills could release an additional 20 to 29 metric tons of VOC over the projected 29 years of oil exploration and production for the proposed action.

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 affects 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 emission--relative to quantities in other oil and gas industry emissions--of other pollutants (Table IV-12).

If an oil spill is ignited immediately after spillage, the burn can combust the 33 to 67 percent of crude oil or higher amounts of fuel oil that otherwise would evaporate. On the other hand, incomplete combustion injects about 10

Table IV-12
Emissions from Burning 20 Metric Tons of Natural Gas per Day During a Blowout (metric 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
Carbon Monoxide	0.009	0.04	0.07
Nitrogen Oxides	0.04	0.15	0.26

Source: Calculated from emission factors in Frazier, Maase, and Clark, 1977.

Table IV-13
Emissions from Burning Crude Oil
(metric tons)

	Size of Burn	
	10,000 barrels	100,000 barrels
Total Suspended Particulates 1/	130	1,300
Sulfur Dioxide 2/3/	86	860
Volatile Organic Compounds 2/	0.5	5
Carbon Monoxide 4/	89	890
Nitrogen Oxides 4/	3.8	38

Source: MMS, Alaska OCS Region.

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 et al. (1977).
3/ Assumes a sulfur content of 2.9 percent.
4/ Emissions calculated from factors in Evans et al. (1986, 1987).

percent of the burned oil as oily soot plus minor quantities of other pollutants into the air (Table IV-13). 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 (see Evans et al., 1987). Clouds of black smoke from a 360,000-barrel tanker fire 75 kilometers off the coast of South Africa deposited oily residue in a rain on animals and crops 50 to 80 kilometers 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 barrels of a spill were burned over a 2-hour period "apparently with no long-lasting adverse effect" (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).

Coating portions of the ecosystem in oily residue is the major, but not the only, potential air-quality risk. 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 micrograms per cubic meter to be a health hazard for bronchitis. National Ambient Air Quality Standards in the U.S. have a secondary 24-hour maximum limit of 150 micrograms per cubic meter of total suspended particulates, respectively, not to be exceeded more than once per year (Table IV-10a).

Over the 30 years of oil exploration and production in the sale area, several oil spills of 1,000 barrels or greater could be accidentally or deliberately set on fire. Pollution of air quality over land would require that such fires be accompanied by onshore breezes, which are atypical in the sale area in all months but July. The EPA considers that prudent health concerns can be met by deliberately burning spills only when winds would carry pollutants away from populated areas. In addition, large fires create their own breezes--toward the fire at ground level--that would further limit local contamination. The soot produced from burning oil spills tends to both clump and wash off vegetation in subsequent rains. Once deposited, it would not be easily resuspended in the air, limiting any health risks to a very short term. Accidental emissions would have a MINOR effect on onshore air quality.

SUMMARY: Exemption levels for nitrogen oxide and VOC could be exceeded during normal offshore operations--a MINOR effect on air quality, as related to standards. The quantities of pollutants that would be emitted by Sale 109 could cause short-term depression of lichen photosynthesis but are insufficient to pose risk of acidification of the tundra ecosystem. The predominantly offshore winds would also tend to keep these pollutants offshore. Accidental emissions from blowouts, spills, or in situ burning of spills are expected to have a MINOR effect on air quality.

CONCLUSION (Effect on Air Quality): The effect of proposed Sale 109 on air quality is expected to be MINOR in regard to standards. Other effects related to air quality also are expected to be MINOR.

CUMULATIVE EFFECTS: Over 98 percent of air-pollutant emissions from OCS operations in the Chukchi Sea would be from Sale 109 because little other activity in the Arctic coincides with this sale area and because of the high level of projected activity associated with Sale 109. Contributions from Sale 97 would be almost NEGLIGIBLE because almost all Sale 97 activity would occur in the Beaufort Sea, away from the Sale 109 area. Emission levels for possible inshore State sales are unknown, but the MMS estimates the oil and gas resources to be negligible in State waters; therefore, inshore State emissions would pose no significant risk to shoreline air quality. In addition, the State automatically requires BACT for emission sources rather than automatically allowing pollutant levels to reach their legal maximum.

MINOR effects on onshore air quality, as related to standards, could occur from cumulative production emissions. The cumulative oil-spill-risk analysis projects a most likely number of seven spills of 1,000 barrels or greater within the Chukchi Sea. Almost all of this cumulative risk is from the proposed action. Because of the predominance of offshore winds and limited duration of accidental emissions, such emissions are expected to have a MINOR effect on onshore air quality.

Conclusion: Pollutant emissions from cumulative projects are expected to cause a MINOR effect on air quality, as related to standards. Other effects related to air quality also are expected to be MINOR.

2. Effect on Water Quality: The agents most likely to affect water quality in the Sale 109 area are oil spills, deliberate discharges from platforms, and construction activities. These agents and their generic effects, which are described and discussed in Section IV.B.15 of the Sale 97 FEIS (USDOI, MMS, 1987a), are incorporated by reference.

a. Effects of Oil Spills: It is likely that accidental oil spills will occur: a most likely number of seven spills of at least 1,000 barrels is projected to occur as a result of proposed Sale 109; in addition to these large spills, more chronic spillage of smaller volumes is expected (see Sec. IV.A.1.b). During drilling of 43 exploration and delineation wells over 8 years, on the order of 67 such chronic spills could occur; but the total spilled would amount to only about 18 barrels. For production, an additional 710 small spills of less than 1,000 barrels each, totaling 3,120 barrels, are projected over the life of the field. Small spills of this magnitude are relatively common in western and northern Alaska. The total volume of additional spillage from spills of less than 1,000 barrels projected for Sale 109 is less than the median volume of several thousand barrels anticipated from one spill in the size category of 1,000 barrels or greater (Sec. IV.A.1.b).

The more volatile compounds in an oil slick, particularly aromatic volatiles, are usually the most toxic components of the slick. In situ, cold-water measurements have demonstrated that for individual compounds in a slick, significant decreases in concentrations take from hours to tens of days. However, because the bulk of these volatile compounds is lost in less than 3 days, 3-day trajectories are considered the appropriate length to approximate the initial, higher toxicity of spills in Alaskan waters. Over the first 10 days of a spill, only about 5 percent of a slick can be expected to dissolve (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980).

Highest rates of dissolution of aromatics from a slick, and consequently accumulation in underlying water, occur in the first few hours after a spill. At sea, water depth and shoreline do not restrict movement of the slick or water, and the slick and underlying water generally move at different angles to the wind. The rate of horizontal dispersion or mixing in the ocean is orders of magnitude greater than the rate of vertical dispersion. By the time dissolved oil worked down 10 meters in the water column, it would have spread horizontally and been diluted over a distance of perhaps 10,000 meters. The slick itself would become patchy, with the total area containing the widely separated patches of oil being orders of magnitude larger than the actual amount of surface area covered by oil (see Table IV-5). Thus, at sea, the water under the slick changes continuously; and aromatics do not continue to accumulate in the same water.

Water-column concentrations of hydrocarbons following spills are difficult to compare to existing State and Federal water-quality standards because of ambiguity in the standards. Applicable ambient-water-quality standards for marine waters of the State of Alaska are the lower of 0.015 ppm (micrograms per liter) total hydrocarbons and 0.010 ppm (10 micrograms per liter) aromatic hydrocarbons or 0.01 of applicable continuous-flow, 96-hour LC50 for critical lifestages of important local species (State of Alaska, ADEC, 1979). Federal standards are set at 0.01 of the applicable LC50: no absolute Federal concentration standard exists for hydrocarbons (USEPA, 1986). The State of Alaska criteria of a maximum of 0.015 ppm of total hydrocarbons in marine waters--about fifteenfold background concentrations--provide the readiest comparison and are used in this discussion of water quality (see Sec. IV.A.2.f. for further discussion of LC50's).

Major spills generally result in peak dissolved hydrocarbon concentrations that are only locally and marginally at toxic levels (see Sec. IV.A.2.f). The highest concentration observed following the Argo Merchant spill was 0.25 parts per million (ppm), despite the presence of 20 percent by volume of more-soluble cutting stock. Volatile liquid hydrocarbons in the Ixtoc spill decreased from 0.4 ppm near the blowout to 0.06 ppm at a 10-kilometer distance and to 0.004 ppm at a 19-kilometer distance from the blowout. Similarly relative and rapid decreases were also found for specific toxic compounds such as benzene and toluene. Concentrations of volatile liquid hydrocarbons--present mostly as oil-in-water emulsion--within 19 kilometers of the Ekofisk Bravo blowout in the North Sea ranged up to 0.35 ppm (Grahl-Nielsen, 1978). Lesser amounts of oil [probably less than 0.02 ppm] were detectable in some samples, at a 56-kilometer distance, but not at an 89-kilometer distance.

In more restricted waters during flat calm, a test spill during the Baffin Island Oil Spill Project (BIOS) resulted in maximum hydrocarbon concentrations in the water column of 1 to 3 ppm. These concentrations were reached within 2 hours of the spill and persisted through 24 hours. No oil was detected deeper than 3 meters, and the most oil and highest concentrations were in the top meter.

These concentrations of oil in the water column are relatively low because even if a slick were completely mixed into the same water mass through use of chemical dispersants, vertical--and especially horizontal--dispersion and consequent dilution would rapidly decrease hydrocarbon concentrations for all but the largest spills in several hours to a few days after spillage ceases.

The volume of water contaminated would increase in direct proportion to the decrease in concentration, however, because the oil is diluted, not decomposed.

Because of unavoidable chronic and accidental discharges of oil, measurable degradation of existing pristine water quality is likely to occur in the sale area. Plumes of dissolved hydrocarbons from a 100,000-barrel spill could be above ambient standards and detectable over the low background levels for perhaps 100 kilometers or possibly 500 kilometers, if under ice. However, a major spill of such size is not anticipated. Other smaller, but more likely spills could cause transient increases in dissolved-hydrocarbon concentrations underneath a slick--over a 1-to-33-square-kilometer area for a 10,000-barrel spill (see Fig. IV-5), and over a smaller area for a smaller spill.

Only a small portion of the oil from a spill would be deposited in the sediments in the immediate vicinity of the spill or along the pathway of the slick. The observed range in deposition of oil in bottom sediments following offshore spills is 0.1 to 8 percent of slick mass. Generally, the higher percentages of deposition occur in spills near shore, where surf, tidal cycles, and other inshore processes can mix oil into the bottom. Farther offshore, only about 0.1 percent of a crude would be incorporated into sediments within the first 10 days of a spill.

If the spilled oil were of a composition similar to that of Prudhoe Bay crude, about 68 percent of the spilled oil could persist on the water surface after the slick disappeared, dispersed into individual tar balls (see Table IV-5 and Fig. IV-7). Slow photo-oxidation and biological degradation would continue to slowly decrease the residual amount of oil. Through 1,000 days, about 15 percent of the tar balls would sink, with an additional 20 percent of slick mass persisting in the remaining tar balls (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980). Because of drift of the oil over distances of hundreds or thousands of kilometers during the slow process of sinking; individual, sunken tar balls would be extremely widely dispersed in the sediments. The "average" levels of local or regional contamination in sediments would be insignificant. Oil would either be locally present in the sediment as a tar ball or, more likely, absent. For a spill of 10,000 barrels, the 15 percent of the oil that sinks within 1,000 days would be equivalent to two small (10-gram) tar balls per hectare within the proposed sale area.

Decomposition and weathering processes for oil are much slower in the Alaskan OCS than in temperate OCS areas. Prudhoe Bay crude remained toxic to zooplankton in freshwater tundra ponds for 7 years after an experimental spill, demonstrating persistence of toxic-oil fractions or their weathering and decomposition products. In marine waters, advection and dispersion would reduce the effect of any similar release of toxic-oil fractions or their toxic-degradation products--including those from photo-oxidation--except possibly to isolated waters of embayments or shallow waters under thick ice, or from a fresh spill in a rapidly freezing lead.

Peard Bay would be the most susceptible exception, being both the only shallow water and the only isolated embayment within the sale area. A spill in Peard Bay during a period of rapid ice growth could leach water-soluble aromatics into the sinking brine waters. In an area such as Peard Bay, mixing of brine waters would be restricted by both topography and the high density of the brine. The brine and any dissolved oil could flow down the bottom of the Barrow Canyon farther offshore and form a thin, intermediate-density layer at about a 100-meter water depth. Stability of the stratified water mass would limit dispersion of the dissolved hydrocarbons and high concentrations (a few ppm) could be hypothesized to persist for several years. However, oil released under such conditions (rapid ice formation) would freeze into the ice in at most 5 to 10 days, stopping dissolution and limiting the effect of this freezeup scenario.

Regional, long-term degradation of water quality below standards because of hydrocarbon contamination is not anticipated. Several of the seven projected spills of 1,000 barrels or greater are likely to occur in winter. Such spills would be frozen into the ice and then would move with the ice for the remainder of the winter. Spills in first-year ice would melt out in late spring or early summer. Spills in multiyear ice would melt out later in summer or in subsequent summers. Spills released from the ice would be relatively unweathered and would have the characteristics of a fresh spill. Before the oil was released from the ice, the contaminated ice could drift for hundreds of kilometers. Spills in the sale area would tend to stay within the Chukchi Sea and also would have little tendency to strand onshore (Figs. IV-17 and IV-18). Relative to the life of the field, the persistence of individual oil slicks would still be short-term (less than a year); but the oil spill would drift hundreds of kilometers, intact and unweathered in the pack ice. This short-term, regional degradation of water quality would be a MODERATE effect.

b. Effects of Deliberate Discharges:

(1) Exploration: Exploratory vessels would discharge drilling fluids in bulk quantities, along with sanitary wastes from wastewater-discharge sources. Discharges of drilling muds and cuttings for exploration and delineation are projected from the development scenario in Section II.A and would occur over an 8-year period. Discharges during exploration and delineation would peak between 1991 and 1994 at 4,212 dry metric tons of muds per year and 10,160 dry metric tons of cuttings per year (Table II-1).

Drilling muds used offshore of Alaska are of low toxicity and are limited to this low level of toxicity in permits for their discharge granted by the EPA (Appendix I). During exploration, barium, mercury, and zinc concentrations would be more than 100-fold greater than background-sediment concentrations in permitted discharges (Table IV-14).

The EPA determined that exploratory discharges of such magnitude for proposed Sale 109 would not be likely to exceed applicable water-quality criteria outside of a 100-meter radius, or 0.03 square kilometers around each discharge site (Appendix I). With only four exploratory platforms present, water quality of no more than 0.03 square kilometers around each platform, for a total of 0.12 square kilometers, could be temporarily degraded during active discharge of drilling muds and cuttings. Therefore, the effect of exploration discharges on water quality is expected to be NEGLIGIBLE.

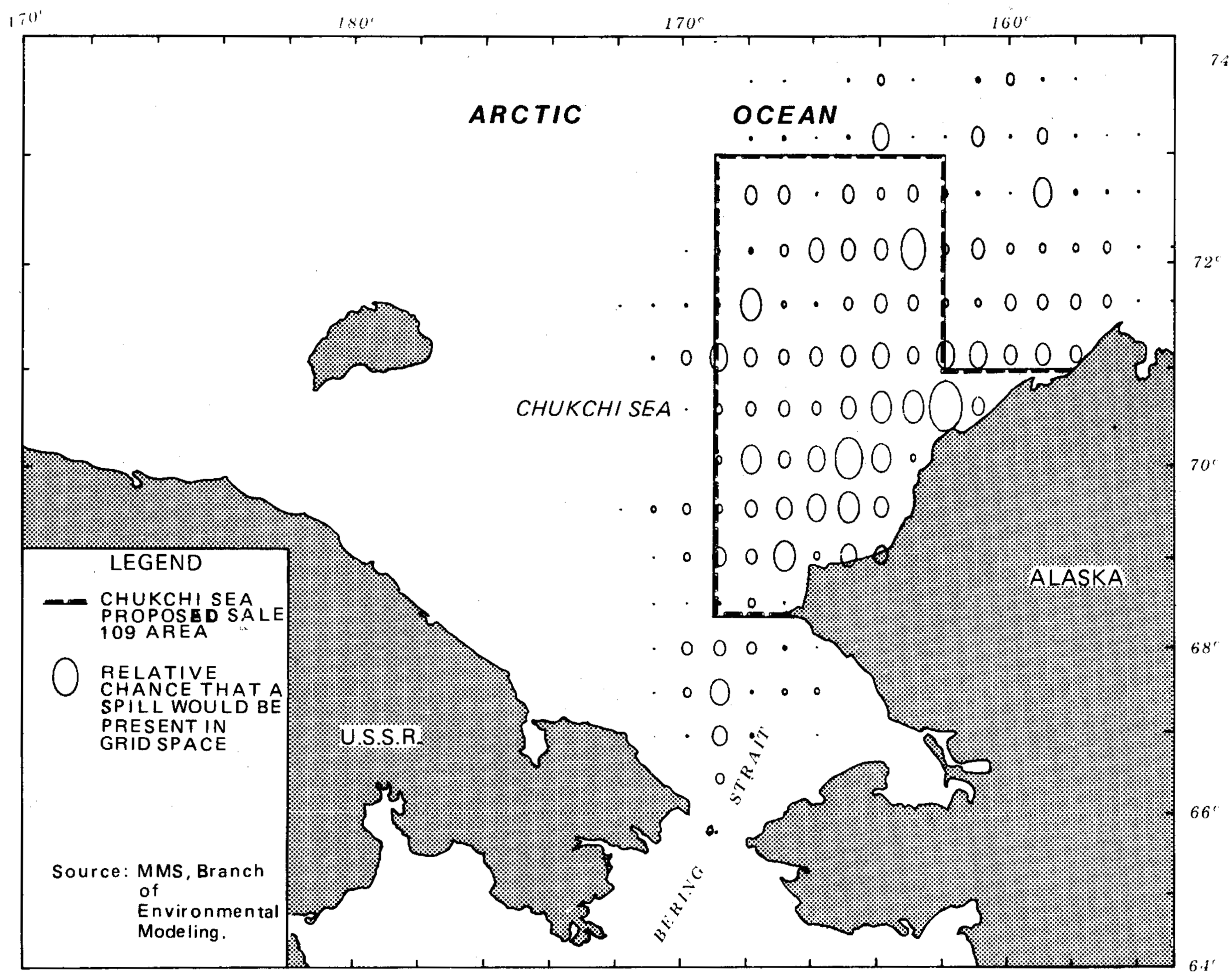


FIGURE IV–17. SPATIAL REPRESENTATION OF OIL CONTACTS AT SEA FOR SUMMER-SPILL TRAJECTORIES FROM ALL LAUNCH POINTS

NOTE: The larger the ellipse, the greater the conditional probability that if a spill occurred in summer, the resulting slick could be found in that grid space during the next 30 days. The latitudinal grid spacing represents about a 2.9-percent conditional probability of a spill being in that grid space.

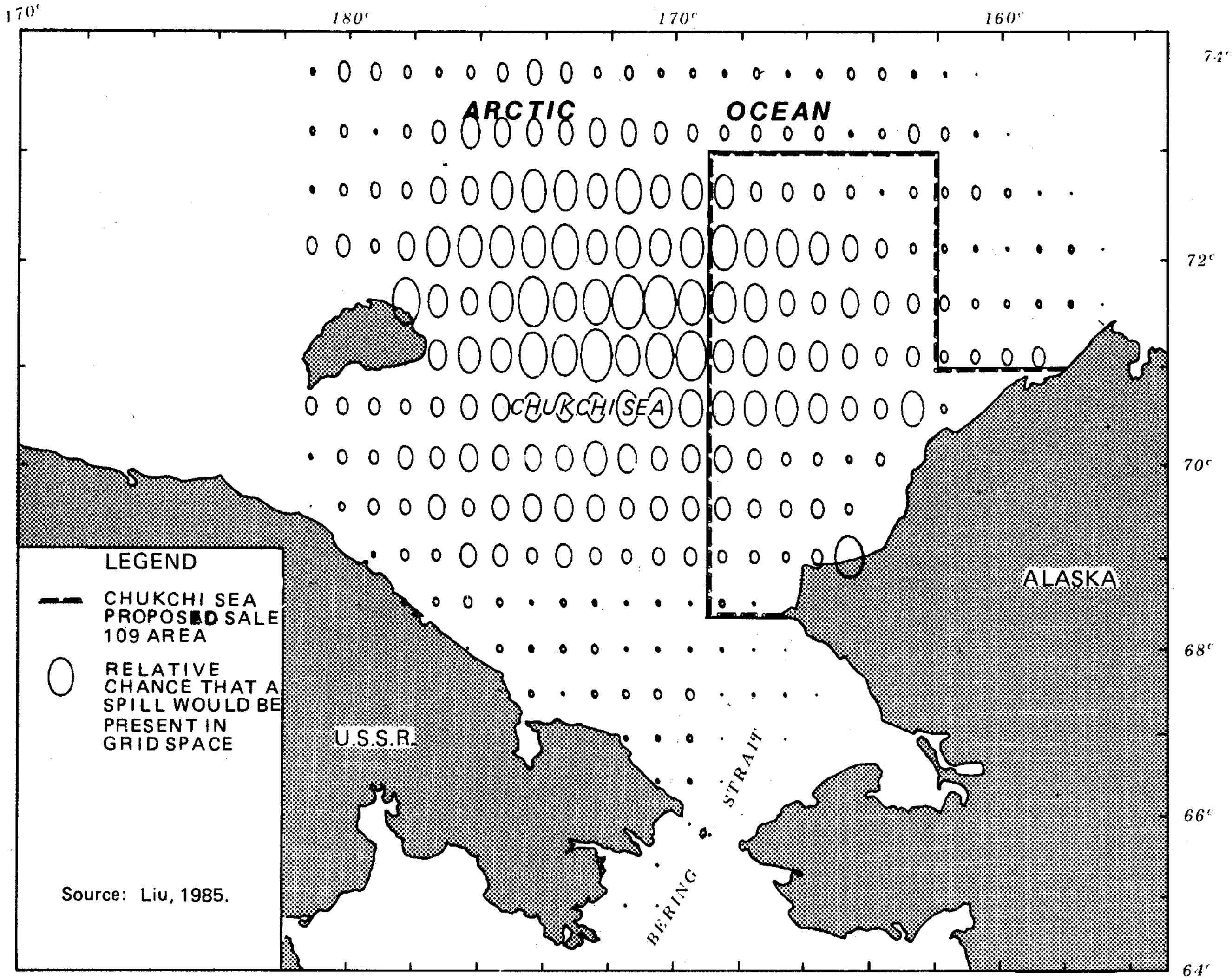


FIGURE IV–18. SPATIAL REPRESENTATION OF OIL CONTACTS AT SEA FOR WINTER-SPILL TRAJECTORIES FROM ALL LAUNCH POINTS

NOTE: The larger the ellipse the greater the conditional probability that if a spill occurred in winter, the resulting slick could be found at that grid location in winter. The latitudinal grid spacing represents about a 0.07-percent conditional probability of a spill being in that grid space.

Table IV-14
Maximum Expected Trace-Metal Concentrations of Discharged Drilling Muds and the Ratio of Expected Trace-Metal Concentrations in Drilling Mud to the Trace-Metal Concentrations in Sediments

Metal	Drilling-Mud Concentration (parts per million)	Enrichment Factor Over Bottom Sediments 1/
Arsenic	17.2	--
Barium	398,800	1,000-2,700
Cadmium	4.2	42 2/
Chromium	1,300	22-43
Copper	88	2.5-6.8
Lead	1,270	91
Mercury	3.7	220
Nickel	88	2.9-8.8
Vanadium	235	--
Zinc	3,420	28-140

Source: Table III-4 and Appendix I of this EIS.

1/ Over existing shelf concentrations in the Chukchi Sea Planning Area.
2/ Calculated as enrichment over extractable cadmium.

NOTE: -- Denotes no data.

(2) Deliberate Discharges During Production: Platforms on the OCS would discharge drilling fluids in bulk quantities, along with lower-level petroleum hydrocarbons and sanitary wastes from wastewater-discharge sources.

Discharges of drilling muds and cuttings during development are projected from the development scenario in Section II.A and would occur over a 3-year period. Peak discharges from the nine production platforms would occur in 1998--when 71 of 153 wells would be drilled with 6,461 to 31,524 dry metric tons of drilling muds and 98,548 dry metric tons of drill cuttings (Table II-1). The quantities projected to be discharged are likely to be small compared to the natural nearshore-sediment loads of the Chukchi Sea Planning area: inshore waters of the Chukchi Sea are naturally turbid (Sec. III.A.6).

Natural-sediment loading is not as well measured in the Chukchi Sea as in some other OCS areas; however, some of the estimates from other arctic OCS planning areas can be used to place the muds and cuttings discharges in perspective. The maximum annual discharge of up to 130,072 dry metric tons of muds and cuttings projected for the Sale 109 area is equivalent to about 0.2 percent of that contributed to Norton Basin by the Yukon River, and to about 2 percent of that contributed to the Alaskan Beaufort Sea by the Colville River.

High rates of erosion occur along the Chukchi Sea coast, particularly on the northern portions. Coastal erosion along the shoreline adjoining the sale area averages 0.3 meters per year (Lewbel, 1984). This is equivalent to about 400 metric tons per kilometer of shoreline; 380 kilometers of shoreline would contribute as much sediment as peak drilling discharges. Erosion may be considerably higher in some areas; for example, land around a single arctic lagoon--Simpson Lagoon--has been estimated as eroding at 300,000 metric tons per year, more than twice the total peak discharge estimated for all nine platforms in the Sale 109 scenario.

The biota--for example, feeding gray whales--also resuspends huge quantities of sediment. Elsewhere, in the Chirikov Basin in the northern Bering Sea, gray whales resuspend 120 million cubic meters of sediment each summer (Johnson and Nelson, 1984), or about a thousandfold more sediment annually than estimated for peak discharge of drilling muds and cuttings during developmental drilling of Sale 109 leases.

The total quantity of drilling muds discharged during development would be threefold greater than during exploration, and the total quantity of cuttings discharged would be fourfold greater than during exploration. With a total of only eight drilling rigs on the nine platforms, and assuming that maximum discharge rates are limited by the EPA to the same extent as they have been for Beaufort Sea exploration, instantaneous discharge rates would be on the same order of magnitude during development drilling as during exploration drilling but would occur on an episodic and more frequent basis over the 3 years of production drilling. Only 0.03 square kilometers would be affected by increased turbidity (or other regulated pollutants) per drilling rig (100-m radius around the discharge point), for a maximum of 0.24 square kilometers. The effects on water quality of increased turbidity or chemical contamination from developmental drilling discharges would be NEGLIGIBLE.

Formation waters are produced from wells along with the oil. These waters contain dissolved minerals and soluble fractions of the crude oil. Process equipment installed on the production platform separates the formation water from the oil and treats it for disposal. The salinity usually ranges from 1 to 250 parts per thousand. (Seawater has a salinity of 35 parts per thousand.) Oil and grease concentrations in such waters are limited by EPA to a maximum of 72 milligrams per liter (72 ppm) with a maximum monthly average of 48 milligrams per liter (48 ppm). The EPA-approved analytical procedures used to measure oil and grease exclude lower-molecular-weight hydrocarbons (less than C14), which pose most of the risk to the biota (NRC, 1985). The National Research Council has estimated that formation waters average 20 to 50 ppm of lower-molecular-weight hydrocarbons and 30 ppm higher-molecular-weight hydrocarbons. In Alaska, treatment facilities for State fields in Cook Inlet discharge 6.6 to 21 ppm total aromatic hydrocarbons into Cook Inlet (Federal Register, 1986). (Lower-molecular-weight and total aromatic categories overlap but are not identical.)

Over the life of a field, the volume of formation water produced is equal to 20 to 150 percent of the oil-output volume. As oil is pumped from a field, the ratio of water to oil being produced increases. For example, some of the older Cook Inlet/Kenai fields in Alaska are now producing up to 2.3 barrels of water for every barrel of oil produced, while the newer Kuparuk and Prudhoe Bay Fields are producing 0.1 to 0.2 barrels of water per barrel of oil. Toward the very end of the productive life of a field, 10 barrels of water may be produced for every barrel of oil. On the basis of these considerations, the production of formation waters over the life of Sale 109 fields can be estimated at 536 to 4,020 million barrels, with up to 510 million barrels of this amount produced in the last year of field production. Over the life of the field, the mass equivalent of 40,000 to 300,000 barrels of oil would be contained in produced waters.

Treated formation waters may be discharged into the open ocean, reinjected into the oil-producing formation to maintain pressure, or injected into underground areas offshore. Discharge of formation waters would require an EPA permit and would be regulated so that the criteria for water quality outside an established mixing zone are not exceeded. In recent years, reinjection and injection projects to maintain field pressure have become almost standard operating procedure. Of the eight active oil fields in Alaska six had water-injection projects as of October 1985. However, treatment facilities for State Cook Inlet fields still discharge formation waters into Cook Inlet (Federal Register, 1986). On the other hand, formation waters from the Endicott Reservoir--soon to be the first offshore producing field in the Beaufort Sea--will be reinjected into the oil formation as part of a waterflood project.

The major constraint to underground injection is finding a formation at shallow depth that (1) has a sufficiently high permeability to allow large volumes of water to be injected at low pressure and (2) can contain the water. Water cannot be injected into a formation that might otherwise be a future potable-water supply.

If formation waters were reinjected or injected into different formations, no discharges of formation waters would occur and no effect would occur. If formation waters were discharged, the effect on water quality would be MINOR.

Deliberate discharges--other than muds and cuttings and formation waters--generally are expected to have a NEGLIGIBLE effect on water quality (Jones and Stokes Associates, Inc., 1983).

c. Effects of Construction Activities:

(1) Dredging: Dredging would be used primarily for trenching and burial of subsea pipelines. Dredging might also be used occasionally to prepare foundations for the nine projected production platforms. Pipeline installation would involve greater volumes of dredged materials and greater areal disturbance.

If oil is found, 400 kilometers of offshore pipeline from nine platforms could be emplaced over a 3-year period in the Sale 109 area and in inshore waters (Sec. II.A). The pipeline would have to be placed in a dredged trench at a rate of between 1 and 2 kilometers per day during summer and possibly fall. Trenching would disturb 946 hectares (9.46 square kilometers) of ocean bottom in the Chukchi Sea. Dumping of dredged spoils would disturb an additional 1,892 hectares (1.892 square kilometers) in the Chukchi Sea, or somewhat less if the spoils were used to backfill the trench. Total volume of fill material would be 28 million cubic meters.

Experiences with actual dredging or dumping operations elsewhere offshore of Alaska and in other U.S. waters show a decrease in the concentration of suspended sediments with time (2-3 hours) and distance (1-3 km) downcurrent from the discharge. Similarly, in the dredging operations associated with artificial-island construction and harbor improvement in mostly sandy sediments of the Canadian Beaufort Sea, the turbidity plumes also tended to disappear within hours after operations ceased and generally extended a few hundred meters to a few kilometers (Pessah, 1982).

The size, duration, and amount of turbidity depends on the grain-size composition of the discharge, the rate and duration of the discharge, the turbulence in the water column, and the current regime. The sea bottom over the sale area within 80 kilometers of shore is mostly sand; farther from shore, the bottom is mostly mud (Lewbel, 1984). Turbidity typically would extend perhaps 3 kilometers from trenching and dumping operations.

Because dredging occurs at a rate of up to 2 kilometers per day, the extent of the turbidity plumes would not be more than about 6 square kilometers (2-km by 3-km plume) at any one time. Over the three summers of pipeline dredging, perhaps an equal area would be separately affected by turbidity from dumping on a daily basis.

Dumping of dredged spoils is not expected to introduce or mobilize any chemical contaminates. Chukchi Sea Planning Area sediments are pristine, without evidence of industrial contamination (Sec. III.A.6).

Prior to any discharge, site-specific discharges of dredge or fill material into U.S. waters will be evaluated in followup environmental documents as required. This EIS--a lease-sale environmental evaluation--does not contain sufficient specification regarding locations of disposal or fill sites to meet the required permit evaluations of the U.S. Army Corps of Engineers. However, based on the analysis in this EIS, nonsite-specific effects on water quality from dredging (and dumping) would be local and short-term. Effects on water quality from turbidity during dredging are expected to be NEGLIGIBLE.

(2) Other Construction: No true causeways are anticipated as a result of the proposed action, although a short gravel berm--a fraction of a kilometer in length--may be used to protect the pipeline where it crosses the shore. The only aspect of water quality expected to be affected by construction of a short pipeline crossing is turbidity. The construction introduces particulate matter into the marine environment by disturbing the bottom sediments and by the intermittent dumping of large volumes of material. Most of the discharged material descends rapidly to the seafloor. The remaining approximately 5 to 10 percent is composed of fine-grained silt and clay particles that would enter the suspended-transport system (Northern Technical Services, 1981). Movement by waves and currents would then be the same as for naturally suspended-sediment particles. The increase in the concentration of sediment particles in the water column is expected to affect a few square kilometers during construction. Dispersion and settling would reduce the concentration of particulate matter downstream from any discharge- and sediment-disturbance sites.

Dumping from barges or trucks, or offloading and dumping with dragline buckets, intermittently introduces a large volume of sediment into the water column during the very short period of time it takes to offload or dump. This action also creates a density current that is generated with a larger initial mass but is shorter-lived when compared to density currents associated with continuous discharge. Dumping of barged fill would result in local high turbidity on the order of 10,000 to 20,000 ppm over an areal extent similar to that around dredging sites about 1 to 3 kilometers downcurrent. During construction, current shifts could result in the plume extending in any direction from the construction site at the shoreline; a total area of 2 to 4 square kilometers could be affected by increased turbidity for some part of this time. The effect on water quality from turbidity is expected to be NEGLIGIBLE.

When abandoned, shore-attached berms for pipeline crossings would be more likely to promote local sedimentation rather than erosion, but abandonment would have a NEGLIGIBLE effect on water quality.

SUMMARY: Oil spills of 1,000 barrels or greater would temporarily and locally increase water-column-hydrocarbon concentrations. A spill of 100,000 barrels or more could temporarily degrade water quality over a distance of several hundred kilometers for a MODERATE effect on water quality, but a spill of such magnitude is extremely unlikely. The seven spills of 1,000 barrels or greater anticipated over the production life of the field could result in detectable frequent, but short-term, oil contamination of pack ice over long distances, for a MODERATE effect on water quality.

Construction activities would at most increase turbidity over a few square kilometers in the immediate vicinity of the construction, and only while the activity persisted--a NEGLIGIBLE effect on water quality.

Deliberate discharges are regulated by the EPA such that any effects on water quality must be extremely local; water-quality criteria cannot be exceeded at greater than a 100-meter distance from the discharge point. Discharge of formation waters--rather than their reinjection into the seafloor--would result in long-term pollution in the vicinity of the oil field, a MINOR effect on water quality.

CONCLUSION (Effect on Water Quality): The effect of proposed Sale 109 on water quality is expected to be MODERATE.

CUMULATIVE EFFECTS: The agents most likely to affect water quality in the Sale 109 area are oil spills, deliberate discharges from platforms, and construction activities of the oil industry.

Cumulative Effects of Oil Spills: Only spills of 1,000 barrels or greater that occur in the U.S. Beaufort Sea plus spills of any size within the Sale 109 area or in inshore waters would affect water quality.

The oil-spill-trajectory analysis for the Beaufort Sea indicates that trajectories in the most westerly portion of the Beaufort Sea Planning Area generally move westward or northwestward, avoiding most of the Sale 109 area. Spills for U.S. OCS leases in the Bering Sea would not reach the Sale 109 area.

On this basis, about seven spills of 1,000 barrels or greater and about 777 smaller spills could occur in or reach the Sale 109 area over the life of the field. The smaller spills would total about 3,140 barrels. Spills greater than 100,000 barrels are not anticipated. The relatively high persistence of spills of 1,000 barrels or greater in the sale area in winter would result in short-term, frequent, but dispersed and localized oil contamination of the water--for a MODERATE effect on water quality.

Cumulative Effects of Deliberate Discharges: Muds and cuttings discharges would result in only extremely local pollution. Additional muds and cuttings from possible State sales would be discharged in State waters. Discharges from both State and Sale 109 leases would be regulated by the EPA during both exploration and development. Discharges of muds and cuttings would continue for at most only the few years as production wells are drilled or as necessary during any workover. Cumulative effects would still be NEGLIGIBLE.

Cumulative Effects of Construction Activities: Causeways locally affect turbidity through enhanced sedimentation of suspended loads and through redirection of the flow of water masses carrying the suspended loads. The redirection of flow also changes local temperature and salinity regimes. However, major causeways are unlikely along the Chukchi Sea coast because of higher wave heights and much more rapid deepening of water near the shore than occurs in the Beaufort Sea. Even in the Beaufort Sea, causeways do not extend into Federal waters; and their effect on the water quality of the OCS is negligible. In the cumulative case, any effect on water quality from causeway construction in State waters would be NEGLIGIBLE.

The only dredging activity expected to significantly affect water quality in the Sale 109 area is pipeline trenching for Federal leases. Pipelines from development in State waters would be short and in waters that are already naturally turbid over much of the summer. Almost all dredging to trench and/or bury pipelines would be associated with proposed Sale 109. On any single day, only a few square kilometers of water would have increased turbidity as a result of dredging, and the turbidity at any location would rapidly disappear as the dredge moved onward. Thus, the effect of dredging in the cumulative case would be NEGLIGIBLE.

A gravel island would require a mined-gravel volume of 645,000 cubic meters if in 15 meters of water. Gravel would be carried by barge to the construction site during summer. About 20 barge loads a day, each of 1,200 cubic meters of gravel, would be required over a 25- to 30-day period to construct the island. A total area of 7 square kilometers could be affected by increased turbidity for some part of this time.

Any gravel islands constructed on inshore State leases would require relatively little dumping of material compared to the above dredging as long as causeways were not included. Turbidity effects in the vicinity of the construction activity would be short-term and local. Cumulative effects on water quality would be NEGLIGIBLE.

During its useful life, an artificial island would be protected from erosion by sandbagging. If exploration from the artificial island were unsuccessful, the sandbags would be removed and the island itself would be either abandoned or removed. The choice would depend upon several considerations including applicable stipulations, island value as wildlife habitat, whether the island is a hazard to navigation, etc.

Removal of the gravel would result in a temporary increase in turbidity similar to that discussed above for dredging. If the island were abandoned, storms, ice override, and ice gouging would erode the island over a period of several years. During this time, however, ocean currents would winnow finer sediments from the island into a plume detectable for about 1 to 3 kilometers downcurrent. The area affected would be similar to that of the construction area. Turbidity levels would be much lower than during construction, but increased turbidity could persist over several years. Cumulative effects of gravel-island abandonment on water quality would therefore be MINOR (long-term but local).

Abandonment rather than removal of an artificial island could result in local but persistent turbidity plumes as the island eroded. The effect of island abandonment on water quality would be MINOR. (Causeways, abandoned or otherwise, would not similarly erode, but would more likely enhance deposition of waterborne materials and thus decrease turbidity.)

In summary, seven spills of 1,000 barrels or greater are assumed to occur and contact the Sale 109 area. Such spills would contaminate pack ice for all of winter over long distances, which would be a MODERATE effect. Other agents--smaller spills, dredging, causeways, construction or removal projects--and deliberate discharges would locally degrade water quality but would have no more than a MINOR effect on water quality. The overall cumulative effect on water quality would be MODERATE.

Conclusion: The overall cumulative effect on water quality is expected to remain MODERATE, the same as for the proposal.

3. <u>Effect on Lower-Trophic-Level Organisms</u>: This discussion incorporates by reference the section on effects on lower-trophic-level organisms contained in the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c), with augmentation by additional information as cited. Exploration and development of oil resources in the proposed Sale 109 area could have various potential effects on lower-trophic-level organisms. These effects include responses to oil spills; seismic disturbance; drilling discharges; and construction activities. A discussion of each of these potential effects follows.

Marine plants and invertebrates of greatest concern, due to their abundance or trophic relationships, are (1) benthic epifauna and infauna that serve as prey for numerous higher-order consumers such as marine mammals, fishes, birds, and other invertebrates; (2) kelp beds (only two have been reported); (3) planktonic and epontic communities, especially their linkage to other consumers; and (4) particularly the dense planktonic community occurring off of Cape Lisburne that indirectly supports the huge colonies of birds nesting nearby.

Aside from the kelp-bed communities, which are vulnerable because of their extremely restricted distribution, marine plants and invertebrates assume importance as primary producers (transforming energy from the sun into organic carbon) and as sources of food for other organisms. In the Chukchi Sea, a number of marine mammals (including gray whales and walruses) as well as birds and fishes depend on invertebrates as their primary food sources. These invertebrates are, in turn, dependent on primary producers. Since both marine plants and invertebrates can occur in different habitats, consideration is given to effects on pelagic, benthic, and epontic communities.

a. <u>Effects of Oil Spills</u>: Oil has been observed to cause both lethal and sublethal effects on marine plants and invertebrates. Although lethal effects may be initially more obvious or compelling, sublethal effects of oil may also be important and generally develop at much lower concentrations than lethal effects (Steele, 1977; Rossi and Anderson, 1978). These effects include reduction in growth and/or fecundity, increased physiological stress, and behavioral changes. These sublethal effects may increase the probability of death, or may lead to reductions in future population size.

Concentrations of oil used in lab experiments are usually higher than those observed following natural and experimental spills (see Sec. IV.B.2); however, concentrations of less than 1 part per million (ppm) have produced a variety of negative effects in marine organisms ranging from phytoplankton to fish (NRC, 1985, Table 5-18).

Effects of oil on marine plants and invertebrates are briefly summarized here:

(1) <u>Marine Plants</u>: Both lethal and sublethal effects of oil have been observed in marine plants (phytoplankton, macroscopic algae, and sea grasses). Effects vary with the species of plant, type and concentration of oil, and timing and duration of exposure. Sublethal effects include alterations in chlorophyll <u>a</u> content, photosynthesis, growth, and reproduction. When exposed to low concentrations of oil, many phytoplankton and macroscopic algae show stimulation of photosynthesis and growth; at higher concentrations, these functions are inhibited. The mechanism whereby low concentrations of oil stimulate algal photosynthesis is unknown (Hsiao et al.,

1978). Experiments using samples of natural arctic-marine phytoplankton taken from the Beaufort Sea and Eskimo Lakes area showed that photosynthetic production varied with the type of oil the samples were exposed to, phytoplankton density, species composition, and environmental conditions. A mixture of oil plus the dispersant, Corexit, proved to be more toxic than the oil by itself. Two arctic macrophytes (Laminaria saccharina, a brown alga, and Phyllophora truncata, a red alga) showed inhibition (15-20%) of photosynthesis after exposures to whole crude-oil concentrations as low as 4 ppm. High concentrations of oil also led to inhibition of photosynthesis (Hsiao, Kittle, and Foy, 1978).

Reproduction of both phytoplankton and macrophytes may be affected by exposure to oil. For unicellular phytoplankton, growth equals reproduction, so reductions in chlorophyll a content, photosynthesis, and growth following exposure to oil may all result in a reduced reproductive rate.

In addition to direct effects caused by petroleum hydrocarbons, marine plants may show indirect effects, such as alterations in population sizes of particular species through changes in competition or predation (Foster, Neushul, and Zingmark, 1971; North, 1973; Teal and Howarth, 1984; Howarth, 1985).

In the Sale 109 area, the marine plants of greatest concern are (1) the phytoplankton and epontic algae, and the relationship between these primary producers and consumers; and (2) the kelps and other macroscopic algae that form beds in the nearshore Chukchi Sea. Since effects on phytoplankton and zooplankton are interrelated, the likely effects of oil on the plankton are discussed later in this section in Effect of Oil on Pelagic Communities.

Effects of oil on several of the brown algal species that predominate in the Skull Cliff kelp bed (Phyllaria dermatodea and Desmarestia vividis) have not been examined directly. Tests with the kelp, Laminaria saccharina, from Liverpool Bay and the Eskimo Lakes in the Canadian Beaufort Sea, indicated that primary production was significantly inhibited by all types and concentrations of oil tested. Exposures to whole crude-oil concentrations as low as 43 ppm caused about 25-percent inhibition of photosynthesis, while concentrations of 4,000 ppm caused a 45- to 60-percent decline in photosynthesis (Hsiao, Kittle, and Foy, 1978). Shiels, Goering, and Hood (1973) found that 7 ppm of Prudhoe Bay crude oil inhibited the photosynthesis of L. saccharina as well as two green algae, Cladophora stimpsonii and Ulva fenestrata.

An oil spill that contacted areas with kelp beds in the Chukchi Sea would be expected to have a relatively short-term effect on kelp and the other macroscopic algae present, particularly since these plants are all subtidal and thus are not likely to be coated by oil. Photosynthesis might be reduced; and this effect could be translated, if it persisted long enough, into reduced growth and/or reproduction. If these plants are similar to Laminaria solidungula from the Beaufort Sea, which shows maximum growth in late winter or early spring, a reduction in photosynthetic rate during the open-water season might later become manifested in reduced growth or reproduction the next year. The most likely effect of an oil spill on kelp and other macroscopic algae in the Chukchi Sea is expected to be MINOR. However, there is very little chance that oil would contact the kelp beds. The probability of an oil spill of 1,000 barrels or greater occurring and contacting land near the kelp beds (Fig. IV-1, Land Segments 22 and 23) in the open-water season within 10 days or from a winter spill all through the winter is less than 0.5 percent (Appendix A, Tables A-16 and A-18). If a large (for example 100,000-barrel) or continuous spill occurred in the immediate vicinity of a kelp bed, MODERATE effects are possible because the populations are restricted and reproduction and/or recruitment could be affected. However, this is quite unlikely, since the probability of a spill of 100,000 barrels or greater occurring and contacting Land Segments 22 and 23 is less than 0.5 percent (Fig. IV-1 and Appendix A, Tables A-20 and A-22).

Thus, the effect of spilled oil on phytoplankton and macroscopic algae in the Sale 109 area is expected to be MINOR, although MODERATE effects could accrue to macroscopic algae in the kelp beds if a large or continuous spill occurred in the near vicinity.

(2) Invertebrates: Oil spills have often resulted in extensive mortality of marine invertebrates, which has been particularly observable in the intertidal (Teal and Howarth, 1984). Sublethal effects, as observed in both the laboratory and the field, include effects on physiology, growth, development, and behavior (see Johnson, 1977; Cowles, 1983; Cowles and Remillard, 1983; NRC, 1985). Effects may be linked, e.g., reduced feeding may lead to reduced reproductive effort, etc.; and alterations in behavior may increase the probability of death. Of great concern is the potential for disruption of chemically mediated behaviors, which are common among invertebrates and which appear to be disturbed by very low concentrations of hydrocarbons (as low as 1 part per billion) (Jacobson and Boylan, 1973; Takahashi and Kittredge, 1973; Johnson, 1977). If such disruption occurred, feeding, mating, and habitat-selection activities could be affected. Both reproduction and recruitment of benthic invertebrates and zooplankton may be affected by exposure to sublethal concentrations of petroleum hydrocarbons (Berdugo, Harris, and O'Hara, 1977; Johnson, 1977; Cowles and Remillard, 1983; Teal and Howarth, 1984). Invertebrate larval forms are generally more sensitive to toxic agents than are adults (Johnson, 1977; Lewbel, 1983), with eggs often somewhat less sensitive than larvae (Lewbel, 1983).

In the Sale 109 area, the invertebrates of greatest concern include (1) zooplankton in the Cape Lisburne area that are an important trophic link between phytoplankton and higher-order consumers and (2) benthic epifauna and infauna that serve as prey for numerous higher-order consumers. Since effects on phytoplankton and zooplankton are interrelated, the likely effects of an oil spill on the plankton are discussed later in this section, in Effect of Oil on Pelagic Communities.

Among the important invertebrates are crustacean members of the plankton or the epibenthos (prey of whales, fishes, and other animals; see Fig. III-15). Crustaceans and other invertebrates that are benthic as adults, but that occur in the plankton while they are larvae, are susceptible to the surface slicks of spilled oil, dissolved fractions of oil that move through the water column, and oil that becomes entrained in sediments. Lab studies have indicated that oil concentrations ranging from 1 to 4 ppm can cause significant mortality to both adult and larval crab and shrimp after 96 hours of exposure (Starr, Kuwada, and Trasky, 1981).

Sensitivities may vary among species; Rice, Karinen, and Korn (1978) found that although subtidal species were generally more sensitive to oil than intertidal species, among the subtidal species, mysids were considered tolerant. In the Chukchi Sea, where mysids are an important component of nearshore benthic communities, such a difference in sensitivity or tolerance could affect local species composition following a spill, leading in turn to some changes in fish, bird, or invertebrate diets.

Amphipods are another important crustacean group in both nearshore and lagoonal environments as well as in whale and fish diets. Amphipods, in particular ampeliscid amphipods, seem sensitive to oil; and some species have suffered great mortality following spills (Teal and Howarth, 1984; Howarth, 1985). If oil contaminated sediments, recruitment of larvae or emigration of amphipods and other epibenthic invertebrates could be affected for some time, depending upon the degree of contamination and the sensitivity of the species involved. Effects are more likely to occur in nearshore areas, where water depths are shallow.

Under the proposal, the probability of one or more oil spills of 1,000 barrels or greater occurring and contacting land in the open-water season within 10 days is less than 0.5 percent (Appendix A, Table A-15). For particular land segments bordering Peard Bay and Kasegaluk Lagoon (Fig. IV-1, Land Segments 20, 21, and 23, and Appendix A, Tables A-16 and A-18) the probability is less than 0.5 percent for open-water spills (to contact within 10 days) or less than or equal to 8 percent for winter spills (over the entire season). A spill of 100,000 barrels or greater would affect a larger area of the ocean's surface than a smaller spill (e.g., after 10 days, a 100,000-barrel spill would cover 8.7 km^2 as opposed to 1.8 km^2 for a 10,000-barrel spill; for conditions and other details, see Table IV-7). Therefore, effects on phytoplankton and zooplankton would be greater in extent but are still expected to be MINOR, since regional populations would be unaffected. Marine plants and invertebrates in shallow nearshore environments could also be affected if oil came into contact with them or affected their environments. The probability of a 100,000-barrel-or-greater spill occurring and contacting land in the open-water season within 10 days is less than 0.5 percent (Appendix A, Table A-19). For the specific land segments bordering Peard Bay and Kasegaluk Lagoon, the probability is less than 0.5 percent for open-water spills to contact land within 10 days or for spills to contact land over the entire winter season (Appendix A, Table A-20). Thus, the probability that spilled oil would reach nearshore areas is low, and extremely low during the open-water season when benthic invertebrates would be more vulnerable.

There is a much higher probability of oil contacting the Peard Bay Target, an area that includes both nearshore and offshore environs and where gray whales have been observed feeding. There is a 56-percent probability that a spill of 1,000 barrels or greater would occur and contact this target within 10 days during the open-water season. The same probability (56%) exists for a 1,000-barrel-or-greater spill to contact this target over the entire winter (Appendix A, Tables A-15 and A-17). For a spill of 100,000 barrels or greater, there is a 3-percent probability that it would occur and contact this target within 10 days in the open-water season (Appendix A, Table A-19). There is a corresponding 3-percent probability that such a spill could occur and contact this target over the entire winter season. The probability of oil contacting sediments where amphipods live is much lower. Very little concentrated oil would be expected to reach sediments in offshore areas. Concentrations greater than a few parts per billion are unlikely.

Given the generally broad distributions of most invertebrate species in the Chukchi Sea and the relatively small area likely to be contacted by spilled oil (see Table IV-7), the effect of oil on invertebrates in the Sale 109 area is expected to be MINOR.

(3) Marine Communities: The effects of oil on pelagic, epontic, and benthic marine communities are detailed in the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c); and effects on benthic and pelagic communities are discussed in Clark (1982), Teal and Howarth (1984), Howarth (1985), and NRC (1985). Examination of communities following oil spills and laboratory and mesocosm experiments have indicated that major shifts in species composition can take place. These shifts appear to take place when the predominant species are more sensitive to oil than other species in the community. Changes in species composition or predominance may qualitatively change food-web dynamics and could also lead to a decreasing efficiency of energy transfer to higher trophic levels if the number of linkages in the food web is increased. Indirect effects can also occur when the interactions between or among species are altered.

(a) Pelagic Communities: Because of the fluid, mobile environment of planktonic communities, the broad distributions of the species components, and the believed ease of recolonization, persistent effects of oil are considered unlikely for these communities unless chronic discharges occur. If a spill occurred nearshore, or in more open-ocean areas, then plankton abundance and dynamics within the plankton could be affected. The effects of an oil spill depend on (1) whether species composition within either the zooplankton or phytoplankton changes due to differing relative sensitivities to oil and (2) whether zooplankton or phytoplankton are relatively more sensitive.

Plankton in the Cape Lisburne area have a low probability of being contacted by oil in the open-water season, when their concentrations are presumably highest and when they indirectly support the dense colonies of nesting seabirds found in that region. The probability of an oil spill of 1,000 barrels or greater occurring during the open-water season and contacting the nearshore and offshore waters near Cape Lisburne (Appendix A, Tables A-15 and A-17, Seabird Concentration Area I) within 3 days, while it is still unweathered and hence toxic, is less than 1 percent. The corresponding probability for contact within 10 days, which represents the normal persistence of a discrete slick, is 3 percent. The probability that a spill of 100,000 barrels or greater would occur and contact this area within 10 days in the open-water season is less than 0.5 percent (Appendix A, Table A-19). Thus, the likely effect of the proposal on these plankton is MINOR. Since seven oil spills of 1,000 barrels or greater are projected to occur under the proposal, plankton are very likely to be affected at some time and in rather localized areas. A 10,000-barrel spill (an example of a 1,000-barrel-or-greater spill) after 10 days could form a slick measuring 1.8 square kilometers (see Table IV-7). As mentioned earlier, a spill of 100,000 barrels would be expected to cover 8.7 square kilometers. Therefore, effects on phytoplankton and zooplankton would be greater in extent. Plankton contacted by oil are likely to die or to have reproduction and/or recruitment affected. Regional populations of planktonic species are unlikely to be affected by a spill, given the broad distributions of most planktonic species and the apparently great input of plankton from the Bering Sea. Therefore, the effect of oil spills on planktonic communities in the Sale 109 area is most likely to be localized and MINOR.

(b) Epontic Communities: Epontic (under-ice) communities are transient in the Chukchi Sea, and effects of accidental oil spills are expected to be very localized. Oil spilled onto the surface of the ice would reduce the light reaching epontic algae, probably resulting in lowered productivity. If oil were spilled under the ice and trapped directly beneath it, those epontic organisms that were not highly mobile would probably be smothered and killed. The oil would probably become encapsulated within the ice with increasing time. The areal extent of these effects would be small. Assuming a 10,000-barrel spill as a likely representative of a 1,000-barrel-or-greater spill, and assuming homogenous spreading to a thickness of 0.8 centimeters on the undersurface of the ice, an area covering 198.9 square kilometers would be affected. Likewise, 1,988.9 square kilometers would be affected by a 100,000-barrel spill. If oil on, in, or under the ice should be released during ice breakup, then effects could spread. Since the ice algae are thought by some to serve as an important source of food in early spring, when food is presumably in short supply for larval or overwintering zooplankton, effects on the epontic community could extend to the open-water community. If a spill of 1,000 barrels occurred, only a small portion of the regional community would be affected; and expected effects would be MINOR. Even though a larger extent would be affected by a 100,000-barrel spill, regional populations are not expected to be significantly affected; and effects again would be MINOR.

(c) Benthic Communities: Changes in species composition have been observed following a number of spills due to massive kills of species present, followed by colonization or proliferation of species that are more resistant and/or opportunistic. Shifts in composition in benthic communities are likely to be persistent, especially if fine sediments become contaminated with oil. Most macroscopic benthic organisms are longer-lived than species in planktonic and epontic communities, and shifts in species composition may be very long-lasting if the newly predominant species inhibit recruitment or recolonization of previously predominant species. Many epibenthic invertebrate species that predominate in the nearshore Chukchi Sea are believed to be good colonists, since the zone where shorefast ice occurs is probably repopulated on an annual basis. However, the nearshore areas are unlikely to be contacted by spilled oil (the probability of a spill of 1,000 barrels or greater occurring and contacting land during the open-water season within 10 days is less than 0.5%; Appendix A, Table A-15).

Benthic organisms in more offshore areas are not very likely to be contacted by oil, since oil is relatively buoyant; and even though it can become mixed into the water column, the rate of horizontal mixing is much faster (1,000-fold) than the rate of vertical mixing. Thus, even though seven spills of 1,000 barrels or greater are projected to occur over the production life of the field, the probability of appreciable quantities of oil contacting sediments in offshore areas is very small. Concentrations of oil greater than a few parts per billion are unlikely. Thus, the effect of spilled oil on benthic communities in the Sale 109 area is most likely to be MINOR.

(d) Trophic Interactions: Although trophic considerations have been discussed within the framework of pelagic, epontic, and benthic communities, it is important to remember and consider that all of these communities are linked. To some extent, the linkages were explored in the preceding sections, but some elaboration and summarizing is pertinent.

Certain aspects of the Chukchi Sea environment and communities make its constituents vulnerable to effects deriving from oil-related activities. For one, the environment is highly seasonal. Timing and synchronization of events can be exceedingly important. Pulses of primary production, whether resulting from epontic or open-water activity, may be critical to the success of zooplankton and to the reproductive activities of these and other consumers. Epontic production may be more important as an early pulse of energy available to larval or overwintering forms than for the magnitude of its production. Activities that significantly reduce primary production or alter timing in such a way that utilization of resources is affected could have significance beyond the expected magnitude of effect. In the Chukchi Sea, effects on plankton could be translated to the benthos rather directly if the planktonic larval forms of benthic organisms suffer (e.g., die, starve, show delayed growth, etc). Recruitment to the benthos could readily be affected; however, since effects on the plankton are expected to be localized, effects on the benthos are also expected to be limited in extent. In some areas like the Cape Lisburne region, dense planktonic communities support pelagic consumers that are fed on by huge numbers of nesting seabirds. If a large spill occurred in this region and affected the density of arctic cod or other important zooplankton consumers, then some seabirds could be affected for that season. Since the seasonal and internal dynamics within the plankton are not well understood, it is difficult to hypothesize very concretely about the effects of a large spill. Annual variability in ice cover probably has a greater effect on the pelagic communities and the success of nesting seabirds than an oil spill would.

Food webs in a large part of the Sale 109 area appear to be dependent on detrital carbon becoming available to benthic organisms, which in turn support a diverse array of higher-order consumers (including gray whales, walruses, and bearded seals). Since detrital carbon may originate--at least to some extent--from more southerly regions, effects on plankton might not be translated to the benthos except in several situations. One situation, mentioned earlier, would occur if the planktonic larval stages of benthic organisms were affected. The second situation would occur if primary production itself were affected; then the standing crop of both phytoplankton and zooplankton would become reduced, and this could affect the amount of carbon sinking to the benthos. However, effects like this are expected to be very localized and are not anticipated to affect regional populations of benthic organisms. If it is true that populations of walruses, which feed extensively on benthic bivalves (clams) in the Chukchi Sea, are now reaching the carrying capacity of the environment and are competing for food, then a decrease in the abundance of bivalves in an area could lead to decreased health of the walruses, a shift in the diet to alternative prey, and/or a shift in feeding location. Given the difficulty of delineating cause-and-effect relationships in offshore-arctic waters, it is unlikely that we could ascribe such a scenario to changes in primary production resulting from an oil spill.

In general, activities associated with the proposal are not expected to have significant, broad effects on trophic interactions. The interaction most vulnerable to such effects is the Cape Lisburne pelagic community/seabird relationship; however, it is very unlikely that this area will be contacted by oil during a critical time (see discussion of Pelagic Communities).

b. Effects of Seismic Disturbance: The sources of acoustical energy used in seismic exploration have included explosives of different sorts (high explosives, low explosives, and blasting agents); airguns, which capitalize on compressed-air releases to generate sounds; and waterguns, which use the release of water pressure to create a seismic pulse. Although use of explosives is not prohibited, common practice has been to use airguns and waterguns.

Most algae known from the Chukchi Sea do not contain critical gas chambers. The only alga reported from the Chukchi Sea that has air-containing chambers is Fucus spp. (Broad et al., 1978), a plant that grows in the intertidal and shallow subtidal. The distribution of this species makes it highly unlikely for seismic exploration associated with the proposal to affect individuals. Thus, effects of seismic exploration on marine plants are quite likely to be NEGLIGIBLE. In general, even high explosives (e.g., dynamite) have relatively little effect on marine invertebrates, presumably due to lack of air-containing chambers, such as the swim bladder of fish (Falk and Lawrence, 1973). Airguns, which are much more innocuous for fish than explosives, were shown to have no effect on caged oysters placed close to the airgun (Gaidry, unpubl., as cited by Falk and Lawrence, 1973). To our knowledge, effects of waterguns on marine organisms have not been assessed; but their effects are expected to be less than those of airguns since the energy released is orders of magnitude less. The extent of seismic testing expected under the proposal is detailed in Table II-1. Due to the prevalent use of airguns and waterguns in Alaskan OCS waters, seismic exploration should have NEGLIGIBLE effects on invertebrates and marine plants in the Sale 109 area.

c. Effects of Drilling Discharges: The types of material discharged deliberately during the exploration, development, and production of oil include drilling muds, cuttings, and formation waters. The effects of drilling fluid discharges on phytoplankton, zooplankton, and benthic communities have been discussed in Appendix I. Other discussions of effects on these communities are found in Appendix L of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and in Sec. IV.B.1.a(3) and Appendix F of the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c), and these discussions are herein summarized and incorporated by reference.

In the exploratory phases of the proposal, a total of 22,408 dry metric tons of drilling muds and 54,340 dry metric tons of drill cuttings are expected to be released (Table II-1). These discharges would occur over an 8-year period from 1989 to 1996. During this period, from two to eight exploration and delineation wells would be drilled each year, with the maximum number (8) being drilled during years 5 through 8 following the sale. Thus, a maximum of 4,169 metric tons of drilling muds and 10,110 metric tons of drill cuttings would be released in a given year.

During the development phase, 153 wells are expected to be drilled from nine platforms over a 3-year period, with a maximum total release of 68,005 dry metric tons of drilling muds and 212,363 dry metric tons of drill cuttings. Details of the extent and timing of water-quality effects are presented in Section IV.B.2.

For phytoplankton and zooplankton, the effect of discharged drilling muds and cuttings is expected to be MINOR, primarily because of the low levels of toxicity demonstrated and the small area (2.7 km^2 during development) that should be affected. Benthic communities are generally expected to incur a MINOR effect; however, effects will probably be longer-lasting (but localized) due to the deposition of drilling muds and cuttings.

Kelp-bed communities are considered particularly vulnerable to effects from drilling discharges in the Chukchi Sea because these communities are uncommon and apparently have very limited spatial distributions. Only two kelp-bed communities have been reported in the Chukchi Sea, one near Skull Cliff, about 20 kilometers northeast of Peard Bay, and another about 25 kilometers southwest of Wainwright. Both the large seaweeds that predominate in the community and the invertebrate residents (particularly the filter feeders) could be affected by sedimentation and the chemical composition of the drilling fluids. Sedimentation effects are more likely to be significant for organisms in the kelp communities than is the chemical nature of the released drilling fluids. Sedimentation could reduce larval and spore settlement and survival, as well as feeding efficiency of filter-feeding invertebrates. Turbidity in the water column is likely to reduce productivity. Effects of discharges of drilling fluids on these organisms could be MODERATE, but will depend on where operations are sited. If activities are sited sufficiently far from the kelp beds, probably more than 1,000 meters away, effects are more likely to be NEGLIGIBLE.

Formation waters are produced from wells along with oil (Sec. IV.B.2). Toxic effects on marine plankton and the 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 536 to 4,020 million barrels, with up to 510 million barrels of this quantity produced during the final year of field production (see Sec. IV.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.

The effects of formation-water discharges associated with the proposal are likely to produce only small effects. Factors which suggest this are (1) the low toxicity of formation waters (LC50 values of 1,850-408,000 ppm [Menzie, 1982]); (2) the rapid dilution of these discharges within 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. The latter could produce long-term effects on benthic organisms.

Dilutions greater than the toxicity values reported would probably be achieved within several hundred meters of a platform. Assuming a 1,000-meter radius for all effects in both water column and sediments around each of nine production platforms, a total of 27 square kilometers could be affected.

Assuming no reinjection, the effects of formation waters on planktonic and benthic organisms would very likely occur through the development and production phases. These effects, as well as those from drilling discharges, are expected to be MINOR. MODERATE effects from drilling discharges could accrue to kelp beds if activities associated with Sale 109 are sited close enough for siltation and turbidity effects to occur. Although only two kelp beds have been reported from the Chukchi Sea (see Sec. III.B.1.c.(1), and earlier discussion of effects of drilling fluids), the lack of systematic surveys for such beds means that other kelp beds could also occur along the coast. The bathymetry of the Chukchi coast and the general occurrence of kelp beds in fairly shallow water (less than 20 m), suggests that drilling discharges from OCS activities are unlikely to affect kelp beds.

d. Effects of Construction Activities: Construction activities, as well as release of drilling muds and cuttings, could alter habitats of benthic or epibenthic animals and plants. Activities relating to siting and construction of platforms and pipelines are expected to be very localized. Nine platforms are expected to be built in conjunction with Sale 109 oil activities. Platforms add a three-dimensional structure to the environment that may provide habitat for refuging fishes or for invertebrates and plants requiring hard substrate for settlement. In general, one would expect organisms relying on soft-sediment areas altered or preempted by platforms and pipelines to be negatively affected, whereas organisms utilizing hard substrate may be favored by the construction of platforms. Because of the number of platforms (nine) projected to be built in the Sale 109 area, the small area expected to be affected, and the apparently broad distributions of most adult and larval marine organisms in the Chukchi Sea, regional populations are not expected to be affected. However, the localized effects are expected to be long-term for those benthic organisms that are affected.

During exploration, two bottom-founded drilling units and two drillships are expected to serve multiple times as bases for drilling operations. The bottom-founded units will rest either directly on the seafloor or on manmade berms. Because only an extremely small area would be affected, these units are most likely to have a MINOR effect on marine plants and invertebrates.

During development, it is possible, although quite uncertain, that a channel would be dredged in Peard Bay. Since such action could greatly alter the physical environment, abundances and distributions of invertebrate species could be greatly affected. If dredging occurred, a long-term, MODERATE effect is likely; and if the distribution of species in the bay were highly restricted, a MAJOR effect is also possible. Dredging activities in nearshore waters are regulated by the U.S. Army Corps of Engineers, which could require extensive environmental studies before action were allowed.

During development under the mean-case scenario, oil is assumed to be transported offshore and onshore by pipelines. Buried pipelines from the nine production platforms would converge offshore and come onshore at Point

Belcher. The section of pipeline coming onshore might be buried, or raised and supported by trusses. In laying an estimated 400 kilometers of offshore pipeline, trenching and dumping of fill material would affect an estimated total of 2,838 hectares. Dredging can affect marine organisms by physically altering the benthic environment, increasing sediments suspended in the water column and thereby decreasing water quality, displacing sediments and thereby smothering some benthic organisms, altering water currents by modifying benthic topography, and killing some organisms directly through mechanical actions (Starr, Kuwada, and Trasky, 1981; Lewbel, 1983).

Since pipelines would be in place for years, effects of pipeline installation are expected to be localized but may be long-term for those benthic organisms affected. The kelp-bed communities are considered to be quite vulnerable to effects from construction activities because these communities are uncommon and have very spatially restricted distributions. As discussed in Effects of Drilling Discharges on kelp beds, the bathymetry of the Chukchi Sea coast and the general occurrence of kelp beds in shallow water (less than 20 m deep) suggest that construction activities associated with OCS exploration and development (except the laying of pipeline) are unlikely to affect kelp beds. If construction activities were sited sufficiently far from these communities, effects could be NEGLIGIBLE or MINOR. If a pipeline or platform were sited within the community, a MAJOR effect could ensue; however, this effect is not very likely given the apparent rarity of these communities. In general, the most likely effect of the proposal on marine plants and invertebrates is expected to be MINOR, since only a small portion of the benthos would be affected, and regional populations are not expected to be significantly affected.

In summary, effects of construction activities would vary depending on the species involved. Some sessile marine organisms would be killed or displaced by these activities, but effects are expected to be extremely localized. Those species that require hard substrate for settlement and growth may increase in abundance because platforms increase the available substrate. Construction activities should benefit these species. Invertebrate populations in Peard Bay could suffer a MODERATE effect if dredging occurred there, or a MAJOR effect if the distribution of species is highly restricted. Kelp-bed communities are vulnerable and could incur MAJOR effects if construction activities were located in their midst. In general, effects on marine plants and invertebrates in the Sale 109 area are expected to be MINOR, with regional populations of these organisms not significantly affected.

SUMMARY: Marine plants and invertebrates of greatest concern because of their abundance or trophic relationships are (1) benthic epifauna and infauna that serve as prey for numerous higher-order consumers such as marine mammals, fishes, birds and other invertebrates; (2) kelp beds; (3) planktonic and epontic communities, especially their linkage to other consumers, and (4) in particular, the dense planktonic community occurring off of Cape Lisburne that indirectly supports the huge colonies of seabirds nesting nearby.

Oil spills are more likely to cause widespread negative effects on marine plants and invertebrates than are other activities associated with exploration, development, and production of oil resources. In general, oil spills are most likely to have MINOR effects on marine plants and invertebrates, since the distributions of most of these organisms are quite broad and re-

colonization of affected areas is quite likely unless sediments become too contaminated. At greater risk to effects are benthic and epibenthic organisms living in nearshore shallow environments, where contact with oil could occur more easily. However, the oil-spill-risk analysis indicates that nearshore areas are very unlikely to be affected by spilled oil. A very large spill that contaminated nearshore sediments could affect populations of benthic invertebrates, perhaps for years. Oil-spill effects on the planktonic and epontic communities are expected to be MINOR due to the limited area likely to be affected. Effects on these communities are not expected to be noticeably translated to higher-trophic levels, although if a large spill occurred in the Cape Lisburne area during the open-water season, some seabirds could be affected for that year.

Effects from other activities (seismic exploration, drilling discharges, and construction activities) would be very localized. The effect of seismic exploration would be NEGLIGIBLE; and the effects of the other activities generally are expected to be MINOR.

Construction activities (e.g., dredging) in Peard Bay could lead to a MODERATE effect on benthic invertebrates since localized, long-term changes would occur; and a MAJOR effect is possible if species are restricted in their distribution to Peard Bay.

Kelp-bed communities in the Chukchi Sea are more vulnerable to effects from oil-related activities, since they are very restricted spatially. Because productivity and successful recruitment could be affected if a large or continuous oil spill occurred nearby, effects could be MODERATE. However, MINOR effects from oil spills on this community are most likely. The location of wells (as related to drilling discharges) and construction activities could also lead to more significant (larger) effects on kelp beds if these activities were located close to, or in the midst of, beds. Drilling discharges that occurred too close (probably within 1,000 m) to kelp beds could lead to MODERATE effects, while construction that occurred within a bed could have a MAJOR effect. Drilling discharges and construction activities associated with Sale 109 are more likely to have a MINOR effect on kelp beds, since the known kelp beds are located near the periphery of the sale area.

<u>CONCLUSION (Effect on Lower-Trophic-Level Organisms)</u>: The effect of proposed Sale 109 on lower-trophic-level organisms is most likely to be MINOR.

<u>CUMULATIVE EFFECTS</u>: In the cumulative case, activities from the western part of Federal Sale 97 and Canadian tankering are considered in addition to the proposal. Potential effects from planned State-oil-lease sales in the Chukchi Sea also are discussed. Effects from the eastern part of the Sale 97 area and the Bering Sea are not anticipated.

<u>Cumulative Effects of Oil Spills</u>: In the cumulative case, the most likely number of oil spills expected to occur in the Chukchi Sea is seven 1,000-barrel-or-greater spills and zero 100,000-barrel-or-greater spills. Most of the oil-spill risk in the cumulative case comes from the proposal. The effects expected to result from oil spills should not change appreciably from the proposal. There is only a slight increase (from 3 to 6%) in the probability that a spill of 1,000 barrels or greater will occur and contact the Cape Lisburne offshore area (Seabird Concentration Area I) during the open-water

season. Therefore, the most likely cumulative effects of oil spills on marine plants and invertebrates would be the same as for the proposal--MINOR.

The State of Alaska had several oil-lease sales scheduled for the Chukchi Sea region and environs--two in offshore and lagoonal environments of the northeastern Chukchi Sea (Sales 58 and 60), one onshore in the same area (Sale 53), and a fourth in Kotzebue Sound (Sale 45). These sales have been deferred from the current State 5-year lease schedule, but may be reinstated. Were these sales to be reinstated, they would increase the probability that marine plants and invertebrates in nearshore and lagoonal environments will be affected by oil. In particular, kelp beds and organisms associated with soft sediments in the shallow nearshore environment would be more vulnerable. Although the effect of an oil spill is most likely to be MINOR for marine plants, a MODERATE effect could accrue to kelp beds if a large or continuous spill occurred nearby, because the populations are apparently very restricted and reproduction and/or recruitment could be affected. Although the possibility of a MODERATE effect on kelp beds is possible under the proposal, it is much more likely to occur in the cumulative case because of activities related to State leases in nearshore waters.

If soft-sediment areas in the nearshore were contacted by oil, they could remain contaminated for years (Gundlach et al., 1981; also see Fig. IV-13). Benthic invertebrates found in such areas could be affected, perhaps for a number of years; but because the effects are expected to be rather localized, and the populations of invertebrates are thought to be very widespread, effects are not expected to exceed MINOR.

In general, the effect of oil spills under the cumulative case is most likely to be MINOR for marine plants and invertebrates. However, MODERATE effects on kelp beds are more likely, since possible State oil-lease sales would occur in more nearshore waters and increase the likelihood that kelp beds and other organisms in nearshore waters would be affected.

<u>Cumulative Effects of Seismic Disturbance</u>: The amount of seismic exploration conducted in the nearshore waters of the northeastern Chukchi Sea will increase in the cumulative case if State lease sales are reinstated on the State's 5-year lease schedule. Since seismic exploration is not known to have lethal effects on marine plants and invertebrates found in the Chukchi Sea, any additional testing under the cumulative case is not expected to change the level of effect determined for the proposal. Therefore, the cumulative effect of seismic exploration on marine plants and invertebrates is expected to remain NEGLIGIBLE, as for the proposal.

<u>Cumulative Effects of Drilling Discharges</u>: Under the cumulative case, the increase in drilling discharges will depend on the extent and location of drilling activities on offshore tracts leased by the State. The EPA regulates discharges through NPDES permits and frequently restricts the amount or concentration of discharges in shallow waters. Since discharged material generally becomes diluted rapidly from finite points of discharge and has low toxicity to marine plants and invertebrates (see USDOI, MMS, 1987a [Sale 97 FEIS, Appendix L]), effects are expected to be very localized and MINOR. Kelp-bed communities are more vulnerable because of their rarity and apparently very restricted distribution. If drilling discharges were released very close to kelp beds, MODERATE effects could occur because reproduction and/or

recruitment could be affected. Since kelp beds occur in fairly shallow water (the one near Skull Cliff is in water about 13 m deep), effects from drilling discharges are more likely to occur from State leases. Thus, if offshore sales in the Chukchi Sea are reinstated on the State's 5-year lease schedule, kelp-bed communities are more likely to incur MODERATE effects under the cumulative case than under the proposal. In general, effects on other marine plants and invertebrates are expected to remain MINOR under the cumulative case.

Cumulative Effects of Construction Activities: Construction activities related to possible State leasing of nearshore tracts comprise the only addition to the cumulative case beyond the proposal. Offshore-construction and siting activities that are part of the Red Dog Mine Project will occur in the southeastern Chukchi Sea, in the vicinity of Kivalina, and are not expected to affect marine plants and invertebrates in the northeastern Chukchi Sea.

Although no detailed plans are currently available, construction on the State-offered leases could involve causeways, pipelines, gravel islands, and foundations for mobile drilling units. Effects from these activities or structures are generally not expected to be different from those of the proposal--MINOR. If construction activities occurred in Peard Bay, benthic invertebrates could incur a MODERATE effect since localized, long-term changes would occur; and a MAJOR effect is possible if species are restricted in their distribution to Peard Bay.

The kelp-bed communities in the northeastern Chukchi Sea are vulnerable to effects from construction activities because they are uncommon and apparently have very spatially restricted distributions. If construction occurred within these communities, a MAJOR effect could result. A MAJOR effect on the kelp-bed communities from construction activities is more likely to accrue under the cumulative case than under the proposal. In general, cumulative construction activities are expected to have a MINOR effect on most marine invertebrates and plants in the northeastern Chukchi Sea.

Conclusion: Under the cumulative case, effects on lower-trophic-level organisms in the Sale 109 area are most likely to be MINOR.

4. Effect on Fishes: This discussion incorporates by reference the discussion of the effects on fishes contained in the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and the Norton Basin Sale 100 FEIS (USDOI, MMS, 1985c), with augmentation by additional information, as cited. Fishes in the nearshore zone would be the most vulnerable to petroleum-related effects because this zone contains the highest densities of fishes in the proposed Sale 109 area, at least during the open-water season. (See Sec. III.B.2 for details.) In the summer, anadromous fishes move into the nearshore estuarine area to feed; in the fall, some return to the rivers to overwinter and spawn, and others move to the open ocean to mature. A few marine species also use the brackish water area for feeding and with some exceptions, they return to the deeper, more offshore regions during and following freezeup to overwinter and spawn. The larval and juvenile development stages of fish are more sensitive to oil-development activities than adults and are often concentrated in the estuarine areas.

Activities, agents, or events associated with oil development under the proposal that could result in effects on fishes in and near the sale area include oil spills, drilling discharges, seismic exploration, and construction activities.

a. Effects of Oil Spills: The interaction of oil with fish could produce a variety of lethal and sublethal responses (refer to Malins, 1977; Hamilton, Starr, and Trasky, 1979; Neff and Anderson, 1981; Rice, 1981; and Starr, Kuwada, and Trasky, 1981, for a more detailed discussion of these responses). Such responses include actual mortality if lethal concentrations are encountered, or damage to fish (i.e., gills, brain, liver, lateral line, eyes, etc.) that could later lead to death. Sublethal effects include an assortment of physiological and behavioral responses that could alter the ability of the fish to resist disease, find food, or avoid predation. Once fish that have been exposed to sublethal amounts of oil return to clean water, a majority of the hydrocarbons are released from their systems.

Chronic sublethal effects may occur if fish are exposed to low-level concentrations over a long period of time. Such effects may involve declines in growth rates and reproductive rates, which could affect populations of fish over the long term. These sublethal effects--the most poorly understood--would be difficult, if not impossible, to relate to fluctuations in recruitment. Other effects could involve a loss or decline in fish-prey organisms or tainting of subsistence species.

Lethal and sublethal amounts of hydrocarbons vary depending on the type of oil, the method used to determine the concentration, and the species and development stage of the fish. Most acute-toxicity values (96-hour lethal concentration for 50% of the test organisms [96-hr LC50]) for fish are generally on the order of 1 to 12 parts per million (ppm). However, the concentrations observed under past crude-oil spills and those calculated by modeling are lower than the determined acute values for fish. Concentrations observed at 0.5 to 1 meter beneath a slick from the Tsesis spill (Kineman, Elmgren, and Hansson, 1980) ranged from 50 to 60 parts per billion (ppb). Modeled concentrations were less than 1 ppm after 12 hours at a distance of 2 kilometers from a blowout discharging oil at 100 barrels per hour, with a wind of 6 meters per second and a rate of incorporation into the water of 6.8 grams per square meter per hour.

The most likely number of oil spills that could occur for the proposed sale is seven spills of 1,000 barrels or greater. These spills are estimated to occur over the 30-year life of the field from spill points widely distributed throughout the proposed Sale 109 area.

The brackish-water zone is characterized as important fish habitat, especially for the anadromous species that use this zone during the open-water season. The probability that one or more spills of 1,000 barrels or greater would occur during the summer and contact a portion of the entire nearshore area within 10 days is less than 0.5 percent. However, there is a 56-percent chance that the Peard Bay area would be contacted by a spill of this size in 10 days during the summer. This high probability occurs because of the convergence of the pipelines just offshore of Point Belcher, southwest of Peard Bay. There is a less-than-0.5-percent probability that at least one oil spill would occur and contact Kasegaluk Lagoon within 10 days in the summer

(2% or lower for 30 days). During the entire winter, there is a greater probability (66%) of 1,000-barrel-or-greater spills occurring and reaching any nearshore area, with the highest chance of contact on the eastern side of Wrangel Island. During the winter, the chance of contact around Peard Bay remains 56 percent. There is a 1- to 8-percent probability of oil spills occurring and contacting individual land segments along Kasegaluk Lagoon during the entire winter. Low probabilities of oil contact prevail during summer and winter for important fish habitats such as river deltas or lagoons (Appendix A, Tables A-15 through A-18).

Dispersants can be used to decrease oil-spill contact with nearshore and other sensitive areas. Their use can result in a temporarily higher hydrocarbon content in the water column and the benthic fauna than an untreated oil spill but a lower hydrocarbon effect on the subtidal and beach sediments (Boehm et al., 1985). The short-term effects may be increased because organisms are exposed to a burst of higher hydrocarbon concentrations. The chemically dispersed oil generally shows higher toxicity values than untreated oil--not because the oil, per se, is made more toxic by the dispersants, but because the oil is made more available. The Baffin Island Oil Spill (BIOS) experiments indicated that even if dispersants increased short-term toxicity, long-term effects were decreased because dispersants caused oil to be dispersed more readily out of the area. Nondispersed oil leached continually from contaminated sediments (Manen, 1987, oral comm.).

(1) Anadromous Fishes: The initial growth of young pink salmon occurs in the estuary prior to the beginning of their 2-year migratory route in the open ocean. If the growth of young salmon is delayed, they may not be able to take advantage of the seasonal abundance of larger prey items. These larval and juvenile lifestages are more vulnerable to hydrocarbons than eggs or adults. When pink salmon fry were exposed to sublethal doses of hydrocarbons, their growth rate decreased as the hydrocarbon concentration increased (Rice et al., 1975, as cited by Patten, 1977); exposure can lead to higher mortality as the smaller-than-average-size juveniles head out to sea.

Avoidance reactions to hydrocarbons have been observed in some fish species but not in others and in different lifestages within species (Maynard and Weber, 1981; McCain and Malins, 1982). Young coho salmon have a 96-hour LC50 value of 3.67 ppm of total aromatic hydrocarbons (Moles, Rice, and Korn, 1979). In avoidance tests, coho smolts avoided 1.9 ppm of total aromatic hydrocarbons. Presmolts, however, were not prone to displacement and did not avoid the aromatic hydrocarbons until the concentration was 2.8 to 3.7 ppm (Maynard and Weber, 1981). Adult coho salmon were exposed to various amounts of hydrocarbons in an estuarine environment as they headed upstream to spawn; the adults avoided aromatic hydrocarbons above 3.2 ppm (Weber et al., 1981).

Estuaries and lagoons (i.e., Kasegaluk Lagoon) may decrease in productivity if contacted by an oil spill in a relatively unweathered (i.e., within 3 days) state during conditions--such as high turbidity or surf--that would promote sinking or mixing of oil into the bottom sediments. The probability of a 1,000-barrel-or-greater spill occurring and contacting such areas under these conditions is less than 0.5 percent. The residual effects of oil could inhibit colonization of important epibenthic food organisms (mysids and amphipods) in the contaminated area and thus cause anadromous fish to feed less or swim longer distances to feed.

This increased use of energy could reduce the amount of food reserves the fish would have for overwintering or spawning. The decreased availability of food could subsequently decrease survival and reproductive capacities and lead to declines in local populations.

Pink and chum salmon are most vulnerable to oil spills for several weeks in June and July, when smolts reside in estuarine habitats prior to moving to the ocean. An oil spill could cause a high percentage of mortality to a river's production of salmon fry, thereby significantly reducing returns of adult pink salmon 2 years later and adult chum salmon 4 to 5 years later. It might take several generations for these small stocks to recover from an oil spill because of their life-history patterns. Adult salmon would be likely to return to spawn, even if they were delayed by an oil spill in their migratory route (Weber et al., 1981; Craig, 1984). An oil spill is most likely to have a MINOR effect on salmon, since some individuals in the affected area could die or be displaced. However, an oil spill that occurred during June or July and reached the brackish-water areas within 10 days (less than 0.5% probability of happening) could have a MODERATE effect on the local salmon populations by affecting the more sensitive and vulnerable smolts.

Rainbow smelt are vulnerable to oil spills in late winter, when the adults form under-ice aggregations off the mouths of spawning rivers. Since rainbow smelt do not migrate far from their spawning streams and many spawn only once, the local population could be affected for a period of time by the loss of a group of adults. This would be a MODERATE effect. Larvae are unlikely to be affected by a spill since the large river discharge at breakup would retard or prevent significant amounts of oil from moving upstream to the spawning grounds. The effect of oil spills on rainbow smelt could be MODERATE. Although there is a 66-percent probability that a 1,000-barrel-or-greater oil spill would occur and contact the nearshore zone during the winter, the probability of such a spill occurring and contacting land segments encompassing the major river mouths is much less (the maximum probability is 8% for the Icy Cape Land Segment; other land segments of interest near the Kuk, Utukok, Kokolik, and Kukpowruk Rivers have probabilities of less than 0.5% to 1%). Therefore, the most likely effect of an oil spill on rainbow smelt would be MINOR.

Other anadromous fishes such as arctic char, ciscoes, and whitefishes appeared uncommon during 1983 investigations in the Sale 109 area (Fechhelm et al., 1984; Kinney, 1985). It is not known whether the 1983 data showing that anadromous fishes are uncommon are representative of abundance in other years.

Of concern because of recent results from genetic studies are arctic char. Information that arctic char in Beaufort Sea drainages show distinct genetic dissimilarity suggests that separate stocks occur in each drainage (Everett and Wilmot, 1987). Thus, an oil spill affecting the majority of a year-class, spawning run, or migration in or out of a particular river could significantly affect that population. If arctic char behave similarly in the Beaufort and Chukchi Seas, then the total population in a drainage is not expected to be decimated by an oil spill for several reasons. Young fish from zero up to 4 years of age remain in freshwater (between ages 2 and 5, char start moving to sea in the summer). In some populations, male char do not migrate to salt-water even though females in the same population are anadromous (Glova and

McCart, 1974; Morrow, 1980). Also, the movements of large and small char in the Beaufort Sea vary somewhat with time (see Cannon and Hachmeister, 1987). In general, the variation in timing of movements of these different age-classes reduces the probability that both these groups will suffer large effects from an oil spill.

In addition, at least a few adult arctic char in the Beaufort Sea are known to have overwintered in other than their natal streams (Everett and Wilmot, 1987). Kristofferson (1987) suggests that the evidence for interdrainage exchange is the exception rather than the rule. Thus, depending on the extent to which this occurs, effects on spawning adults from one drainage could be ameliorated.

An oil spill contacting the nearshore environment in midsummer, when arctic char are thought to be widely dispersed, is expected to have a MINOR effect on arctic char. However, contact with char while they are in close association with the delta of their home drainage may result in a MODERATE effect, since individuals are aggregated and one or more age-classes could be affected, with a resultant effect that could last for more than one generation.

Other anadromous species, such as ciscoes and whitefishes, are not known to be tied to specific drainages in the Chukchi region. If their biology is similar to individuals in the Beaufort Sea, they are likely to be widely dispersed in the nearshore environment during the open-water season and would be most likely to incur a MINOR effect if contacted by a spill.

The paucity of information regarding stock sizes, fidelity to streams, and movements of anadromous fishes in the Sale 109 region means that analysis is based primarily on generalization from Beaufort Sea populations. If these fishes are much rarer in the nearshore Chukchi Sea--as preliminary data suggest--stocks may be more vulnerable, particularly when and if aggregated in nearshore zones. Since eggs and larvae (and juveniles of some) of these species are in freshwater habitats, an oil spill contacting aggregated assemblages in the nearshore is not expected to cause a greater than MODERATE effect on the populations. A MINOR effect would be most likely if, as in Beaufort Sea populations, movements of individuals into and out of freshwater are spread out in time.

(2) Marine Fishes: Marine fishes are susceptible to hydrocarbon exposure in both nearshore and offshore habitats during different lifestages. Eggs deposited in the intertidal zone (i.e., herring and capelin) and exposed to hydrocarbons have shown decreased hatching success and increased larval abnormalities after the *Tsesis* spill off Sweden (Nellbring et al., 1980) and in the laboratory (Patten, 1977; Smith and Cameron, 1979). Pelagic eggs and larvae (i.e., arctic cod) are often near the ocean surface, thereby increasing the likelihood of contact with lethal or sublethal concentrations of hydrocarbons. The sublethal quantities may inhibit growth and/or eventually result in death. The sensitivity to hydrocarbons of 39 adult marine fishes and invertebrates found around Alaska was evaluated by Rice et al. (1979), and similarities were found based upon habitat. Pelagic fish and shrimp were the most sensitive (96-hr LC50 = 1-3 ppm); benthic animals were moderately sensitive (96-hr LC50 = 3-8 ppm); and intertidal species were the most tolerant (96-hr LC50 = 8-12 ppm) to Cook Inlet crude oil.

Arctic cod are found throughout the Sale 109 area in both nearshore and offshore habitats and are the most common fish in Kasegaluk Lagoon. They are most vulnerable when the oil is released from the ice at breakup, when the adults and eggs are near the underside of the ice; however, no concentrations of adult arctic cod or eggs have been found during the winter. Large schools have been seen in estuarine areas during the open-water season, but the probability of a 1,000-barrel-or-greater spill occurring and contacting these areas during the first 10 days of the spill during the summer is less than 0.5 percent.

Marine species such as arctic and saffron cod, flatfishes, sculpins, and capelin are abundant, widespread, and live and reproduce over a broad area. One area used by several fish species is Kasegaluk Lagoon. This lagoon and other barrier-island, estuarine areas provide productive habitats for growth and maintenance of various development stages of fishes. Arctic cod and capelin populations are more vulnerable to oil spills because they may form concentrations in the nearshore area during the open-water season and may spawn only once. The most likely effect of an oil spill on marine fish species would be MINOR, since some individuals could die or be displaced. However, capelin could suffer MODERATE effects if spawning adults or eggs and developing larvae on sandy beaches were contacted by oil. Since the probability of oil spills occurring and contacting the nearshore area in an unweathered state during the open-water season is less than 0.5 percent, a MODERATE effect is possible but unlikely.

The above analyses of effects of offshore oil spills on fish resources are based on spills of 1,000 barrels or greater, with seven spills most likely to occur. Although there is a 24-percent probability that one or more 100,000-barrel-or-greater spills would occur, the probability of such a spill occurring and contacting land within 10 days in the open-water season is less than 0.5 percent, and over the winter 4 percent. The effects of a large spill would be basically the same as for the smaller spills described earlier; but the oil would cover more area, potentially contacting more fish and important fish habitat resulting in increased mortality in the local populations. Therefore, a MODERATE effect is more likely to occur. However, given the low probability of a large spill contacting the nearshore zone, the most likely effect of such a spill on fishes is expected to be MINOR.

In summary, the broad distribution of fishes, the low concentrations of hydrocarbons in the water column associated with oil slicks, and the low probabilities that offshore spills would contact important coastal or nearshore habitats in the open-water season is most likely to result in a MINOR effect on the fish resources of the Alaskan Chukchi Sea as a result of potential offshore oil spills associated with proposed Sale 109. MODERATE effects are possible for some anadromous fishes (salmon, rainbow smelt, and arctic char) and capelin if spawning-year individuals, aggregated multi-age assemblages, or a year-class of young were affected by a spill in nearshore waters.

Onshore-Oil-Spill Effects: The construction of a pipeline from near Point Belcher on the Chukchi Sea coast to connect with the TAP (adjacent to the Sagavanirktok River) opens up an extensive section of the interior to potential oil spills. Of greatest significance to fishes would be the occurrence of a spill that contaminated freshwater habitats. If a spill contacted a river, the oil might contaminate the river from the spill point down to the Beaufort Sea. Fish in freshwater may be more sensitive to spilled oil than fish in marine waters (Anderson and Anderson, 1976, as cited by USDOI, BLM, 1983). Eggs and larvae--generally the lifestages most sensitive to oil--could be affected while in bottom sediments (e.g., gravel) or in the water. Juveniles or adults in the rivers also could be affected. Since most anadromous fishes in the Beaufort Sea/North Slope region spend the majority of each year in freshwater (e.g., arctic and least ciscoes, arctic char, and broad and humpback whitefishes), an oil spill that affected the quality of the habitat, sensitive lifestages, or concentrations of these fishes, could significantly affect fish populations of the resident species. Overwintering habitat is hypothesized to be the main factor limiting many anadromous fish populations in the Beaufort Sea (Craig, 1987); and within a river, entire stocks of species may reside in a few overwintering areas. If this habitat--or nest-site areas--were affected, then one or more year-classes of fishes could be affected. The time of occurrence of a spill also could be important. Most rivers freeze solid except for a few deeper holes or springs, and a spill that occurred and contacted a river in the winter probably would become encapsulated in ice before contaminating much of the river. However, this oil would be released in a generally unweathered state during spring breakup and then could contaminate the river while still fairly toxic. If fish that had just finished overwintering were contacted by oil while still in the river, they could be especially vulnerable because of their poorer condition. Griffiths and Schmidt (1986) have observed dead fish in overwintering areas, and most fish are thought not to feed during the winter. A spill occurring in winter could be more severe since all age-classes are in the river at that time. A spill that occurred in summer and contaminated a river is more likely to affect eggs and larvae of anadromous species, since the juveniles and adults of many of these species spend the majority of the open-water season in nearshore, marine environments.

The projected onshore pipeline would be 640 kilometers long and would cross approximately 10 major rivers or their tributaries (Table IV-1; see also Graphic No. 3). Of greatest concern would be possible contamination of the Colville River, since the Colville contains the most extensive fish overwintering habitat of all the rivers feeding into the Alaskan Beaufort Sea. As depicted in Graphic No. 3, the path of the pipeline could cross four major tributaries of the Colville. Based on their experience with the TAP, the BLM has determined that the NPR-A pipeline length/year is the best predictor for pipeline spillage. The BLM also has estimated that 40 percent of the length of a pipeline across the NPR-A would traverse wetlands (USDOI, BLM, 1983). Under the proposal, 188 spills could be associated with the pipeline over the life of the field (Table II-1). To compute the probability of a spill contacting a major river tributary, the MMS assumed first that each kilometer of pipeline was equally likely to be a spill site, that a spill within a 1-kilometer width of a river crossing could contaminate that river, and that the probability of onshore spills (like offshore spills) followed a Poisson distribution. Sixty-seven spills of 24 barrels or greater are predicted to occur. Given the length of the pipeline (640 km), the number of major river crossings (10), and the number of spills (67), the probability of at least one spill of 24 barrels or greater occurring and contacting a major river tributary is 65 percent. In the largest size-class of these spills (those spills over 239 barrels, with an average size of 1,500 barrels), 22 spills are predicted. The probability of at least one spill greater than 239 barrels occurring and contacting a major river tributary is 29 percent. The probability of at least one large winter spill occurring and contacting a river is approximately 22 percent. These percentages only assume contact with the estimated 1-kilometer segment encompassing that river and do not take into account contamination from wetlands outside that zone. Thus, it is fairly likely that fish in freshwater would be affected by an onshore pipeline spill. The effect of a large spill contacting fish in rivers is likely to be MODERATE, since concentrations of various species of multiple ages as well as important overwintering and rearing habitats could be affected. MAJOR effects are possible if the Colville River were affected, since the Colville contains the most extensive overwintering habitat of the rivers entering the Alaskan Beaufort Sea and effects on fishes there could be felt throughout much of the central Beaufort Sea.

A large onshore oil spill occurring and contacting a major river is likely to have a MODERATE effect on fishes, and a MAJOR effect is possible if the Colville River is contaminated.

b. Effects of Drilling Discharges: The toxicity of drilling muds to Alaskan fish species has been reviewed by Jones and Stokes Associates, Inc. (1983). For the eight Alaskan fish species tested with a total of 24 drilling muds, 95 percent of the 96-hour LC50 values exceeded 10,000 ppm. The lowest 96-hour LC50 value was 3,000 ppm observed for pink salmon fry (Dames and Moore, 1978). Data obtained in studies of species common in the Chukchi Sea reveal that 96-hour LC50 values for fourhorn sculpin exceeded 40,000 ppm, and values for arctic cod exceeded 161,000 ppm (Tornberg et al., 1980).

The heavy fraction of the drilling muds and cuttings that accumulate on the bottom near the discharge site may contain high amounts of barium and chromium. In laboratory studies, demersal fishes showed no significant accumulations of these metals over a long period of time (Tillery and Thomas, 1980; Payne et al., 1982; Neff et al., 1985).

A limited number of studies have been performed on the toxicity of formation waters (Menzie, 1982). Ten species of freshwater fishes obtained 96-hour LC50 values of 43,000 to 112,000 ppm for exposures to brine wastes. Other studies with two species of shrimp, barnacles, and one marine-fish species (crested blenny) resulted in 96-hour LC50 values between 8,000 and 408,000 ppm.

The total amount of drilling muds and cuttings expected to be discharged in the exploration and delineation phase is 22,408 dry metric tons of drilling muds and 54,340 dry metric tons of cuttings. During development of production wells, the maximum amount of drilling muds and cuttings discharged would be 68,005 and 212,363 dry metric tons, respectively. A discharge-concentration model for drilling muds and cuttings in Beaufort Sea conditions predicted a decrease in the concentrations of suspended solids by three to four orders of magnitude within 100 meters. Solids deposition was predicted to be almost 100 percent within 100 meters. Dilution factors of the dissolved portions of these discharges were predicted to be between about 70 and 500 within 100 meters. Modeling of formation-water discharges has not been reported; however, rates probably would be similar to those associated with the dissolved portion of the drilling-fluid discharge (Jones and Stokes Associates, Inc., 1983). The area in which concentrations would exceed acute-lethal-toxicity values consequently would be limited. Considering the low densities and mobile behavior of marine-fish species, the likelihood of exposures to even sublethal concentrations is small. Therefore, discharges of drilling fluids and formation waters would produce MINOR effects on the fish resources of the Sale 109 area.

c. Effects of Seismic Disturbance: Exploration plans often include seismic surveys to map out prospective petroleum areas or ocean-floor characteristics. High explosives, when used in such surveys, can be lethal to fish and can result in rupture of the swim bladder, abdominal cavity, blood vessels, and internal organs, and tearing of muscle tissue (Falk and Lawrence, 1973). Airguns, however, are prevalently used, assumed to be the main seismic source for the Sale 109 area, and relatively harmless to fishes (Weaver and Wienhold, 1972; Falk and Lawrence, 1973). Airguns can harm the small percentage of fish eggs that are within 0.5 meters from the source (Kostyuchenko, 1973). Waterguns, which will be used for high-resolution surveys, produce much less energy than airguns and are not known to have any effect on fishes. Within the Sale 109 area, the total trackline distance of high-resolution seismic-reflection surveys would be 7,979 kilometers for both site-specific and block surveys that would be conducted 1 year prior to drilling at the exploration- and delineation-well sites. Prior to production, 8,783 trackline kilometers of deep, three-dimensional, multichannel seismic-reflection surveys would be done for platforms; and 1,609 kilometers of high-resolution seismic-reflection surveys would be done for the laying of the offshore pipeline. The surveys would be done primarily in August and September. Therefore, seismic exploration is expected to produce MINOR effects on the fish resources of the Sale 109 area.

d. Effects of Construction Activities: Implementation of the proposal could result in the construction of manmade berms for bottom-founded drilling units and 400 kilometers of subsea pipelines. It is assumed that bottom-founded drilling units would accommodate 67 percent of the exploration and delineation wells. The amount of construction needed for berms for these units can vary depending on water depth; some units must be placed within 22 meters of the ocean surface. It is assumed that the main pipeline would come onshore at Point Belcher. Sand and gravel movement for the offshore-pipeline trenching and burial construction would be on the order of 28 million cubic meters. The total area disturbed by the offshore-pipeline construction would be 2,838 hectares. Within Peard Bay, a channel 5 meters deep may be needed to accommodate support vehicles for the shorebase. Since the channel is already 6 meters deep for most of its length, dredging probably will not be necessary.

Dredging effects on the fish resources of this region are addressed in a generic discussion in the Proposed Arctic Sand and Gravel Lease Sale FEIS (USDOI, MMS, 1982c), and are incorporated by reference. Dredging operations associated with these construction projects generally would result in short-term, localized effects on fish by introducing sediments into the water column and by entraining adult fish or larvae in the suction head of the dredge. Dredging could produce lethal effects through entrainment; increased sediments could produce sublethal responses by inhibiting respiration or feeding activities through increased turbidity. Fish densities are extremely low in the offshore marine zone where these activities would take place. Further, coastal waters in this region frequently are naturally turbid.

Adult fishes will generally move away from construction and dredging activities with no effect on the populations, and they will probably return after construction. Larvae of anadromous and marine fishes that occur in the area of dredging could be entrained in large numbers. However, the effect of these deaths may not be measurable because of natural fluctuations in recruitment. Therefore, the dredging- and construction-induced effects on fish populations in the Sale 109 area are expected to be MINOR.

SUMMARY: The fish resources of the Sale 109 area would very likely be affected by oil spills, drilling discharges, seismic disturbance, and construction activities associated with the proposal; however, the magnitude and duration of these effects would vary for each of the causal agents.

Oil spills would produce a variety of lethal and sublethal responses in the fishes that occur in the Sale 109 area. Offshore oil spills are expected to have a MINOR effect on fishes, given the relatively broad distribution of fish, the low concentrations of oil associated with slicks, and the low probabilities of offshore spills contacting important fish habitats. However, MODERATE effects are possible for some anadromous fishes (salmon, rainbow smelt, and arctic char) and capelin if spawning-year individuals, aggregated multi-age assemblages, or a year-class of young were affected by a spill in nearshore waters. A large spill from the projected onshore pipeline is likely to have a MODERATE effect on fishes by affecting overwintering and rearing habitat, sensitive lifestages, and/or concentrations of fishes. A MAJOR effect on fishes is possible if the Colville River is contaminated.

Drilling discharges could affect fish in a limited area around the discharge point. Considering the low densities and the mobile behavior of fish, the low toxicities of drilling discharges, and the rapid dilution and dispersion of drilling fluids and cuttings, these effects on fishes in the Sale 109 area are expected to be MINOR.

Seismic disturbance is assumed to be caused by airguns, which are prevalently used for exploration. Considering that a small percentage of fish eggs could be harmed in the immediate vicinity of the energy release, the effects of seismic disturbance on the fish resources of the Sale 109 area are expected to be MINOR.

Offshore-construction activities in the Sale 109 area would cause suspended sediments and entrainment of some adult, juvenile, and larval fishes. Considering the low densities of fish and their high tolerance to suspended sediments, the effects of offshore-construction activities on the fish resources of the Sale 109 area expected to be MINOR.

CONCLUSION (Effect on Fishes): The effect of proposed Sale 109 on fishes is likely to be MODERATE.

CUMULATIVE EFFECTS: Proposed and existing development (see Table IV-2) would result in cumulative activities that could affect the fish resources of the region. These activities include both onshore and offshore State and Federal oil and gas leasing in the Beaufort and Chukchi Sea region, onshore mining, and tankering of oil produced in Canada through the Sale 109 area.

Onshore oil and gas development that could affect fish resources of the region include leasing operations of the National Petroleum Reserve-Alaska (NPR-A), the Arctic Slope Regional Corporation, and the State of Alaska. Effects on fish resources from these leasing activities could result from construction activities (roads, pipelines, well pads), oil spills entering lakes or river systems, withdrawal of water from critical fish-overwintering sites, and introduction of drilling discharges into lakes or river systems. These potential effects have been detailed in the NPR-A FEIS (USDOI, BLM, 1983). Effects may be mitigated to a certain extent by measures proposed by regulatory agencies (Bureau of Land Management, Fish and Wildlife Service, U.S. Army Corps of Engineers, State of Alaska, and North Slope Borough). Under the Sale 109 proposal, oil spills from onshore pipelines that contacted fish in major freshwater rivers were thought likely to produce a MODERATE effect on fishes. Since activities projected for the NPR-A also involve an onshore pipeline with similar probabilities of an oil spill occurring and contacting a major river, a MODERATE effect on fishes is even more likely under the cumulative case. A combination of the pipelines for Sale 109 and for the NPR-A increases the probability to approximately 50 percent that a large spill (greater than 239 barrels, mean size 1,500 barrels) would occur and contact a major river. The probability of fishes in the Colville River being affected also increases; thus, a MAJOR effect is more likely than under the proposal--although less likely than a MODERATE effect would be.

In the cumulative case, there is only a slight increase in the probability that oil spills from proposed and existing Federal leases and tankering of Canadian oil would occur and contact the nearshore area. The probability of an oil spill occurring and contacting Peard Bay within 10 days during the open-water season or during the entire winter is 59 percent, versus 56 percent for the proposal. The probability that an oil spill would occur and contact individual land segments along Kasegaluk Lagoon is the same as for the proposal--less than 0.5 percent for the summer within 10 days, and 1 to 8 percent for the entire winter. The most likely number of 1,000-barrel-or-greater spills within the Chukchi Sea is seven. The probability of one or more oil spills of 100,000 barrels or greater occurring and contacting Peard Bay within 10 days during the open- water season or during the entire winter is 4 percent for the cumulative case, versus 3 percent for the proposal.

The probability of oil reaching the nearshore area during conditions that would promote sinking and mixing into the sediments is remote. The probabilities that one or more offshore oil spills would occur and contact important fish habitats, such as lagoons and estuaries, would not change significantly from the proposal to the cumulative case (effects are most likely to be MINOR). MODERATE effects are possible for some anadromous fishes (salmon, rainbow smelt, and arctic char) and capelin if spawning-year individuals, aggregated multi-aged assemblages, or a year-class of young were affected by a spill in nearshore waters. A large spill from the projected onshore pipeline is likely to have a MODERATE effect on fishes by affecting overwintering and rearing habitat, sensitive lifestages, and/or concentrations of fishes in freshwater. Therefore, oil-spill effects on fish resources of the Sale 109 area from proposed and existing Federal OCS leases and Canadian tankering are likely to be MODERATE.

Existing and proposed State of Alaska leasing would have a greater likelihood of causing effects on fish resources in nearshore waters than would Federal offshore activities because of the proximity of State leases to nearshore areas, where the highest densities of fish are located. This is especially true for State Sales 53 and 58 located along Kasegaluk Lagoon and State Sale 60 from south of Barrow to Icy Cape (these sales have been deferred from the current State 5-year lease schedule, but may be reinstated.) Oil spills from offshore State leases would occur in nearshore waters and, therefore, would have a greater likelihood of being incorporated in nearshore sediments in an unweathered state. Further, the chance of a spill occurring and contacting a major estuary or lagoon is greater. Therefore, the likelihood of MODERATE effects on fish from oil spills occurring on State leases is greater than for the proposal if a spill occurred.

Drilling discharges from State and Federal offshore leases would not add significantly to the potential effects on fish. Formation-water discharges generally are prohibited in waters less than 10 meters deep (which covers a large portion of the State waters), drilling discharges are prohibited under ice except under certain circumstances, and oil-based drilling discharges are prohibited. Therefore, drilling discharges associated with cumulative activities would have the same MINOR effects on the fish resources of the Sale 109 area as the proposal.

Seismic-disturbance effects on fish from these cumulative activities would remain MINOR (as for the proposal) because of the prevalent use of airguns for this activity and their relatively harmless effect on fishes.

Dredging in State waters would increase the number of sites where effects on fish could occur. Dredging that occurred in these nearshore waters would have a higher probability of entraining fish because of the higher densities of fish and larvae; however, the mobile nature of most adult fish species in this region would preclude all but relatively small numbers from being entrained. An exception, the fourhorn sculpin, would be more susceptible due to its low mobility and demersal behavior; however, this species is numerous and broadly distributed, so dredging effects of cumulative activities on the fish resources of the Sale 109 area would be MINOR.

Possible coal mining from Cape Lisburne to Wainwright could affect the nearshore waters by directly increased turbidity in these waters or by an increased sediment load in the nearby streams. Anadromous fishes may encounter the increased turbidity in the freshwater streams, which could affect the egg and larval stages. Onshore mining would have a MINOR effect on the fish resources of the Sale 109 area.

The main effect of Canadian oil tankering on the fish resources of the Sale 109 area would be possible oil spills. However, the addition of Canadian tankering does not increase the expected number of either 1,000-barrel-or-greater or 100,000-barrel-or-greater spills. Although the probability of spills increases, it is not enough to increase the expected number of spills by one in either case (see Table IV-4).

In summary, cumulative effects on the fish resources of the Sale 109 area would occur from both onshore and offshore proposed and existing State, Federal, and North Slope Borough leasing projects. Causal agents for onshore effects include construction activities, oil spills, water withdrawal, and water pollution. Effects on fishes from offshore spills are most likely to be

MINOR, while onshore-pipeline spills are likely to have a MODERATE effect on fishes. A MAJOR effect is possible if a large spill from an onshore pipeline contaminated the Colville River and affected important overwintering and rearing habitat, sensitive lifestages, and/or concentrations of fishes. Overwintering fishes might be particularly sensitive. The probability of oil spills occurring increases in the cumulative case (see Table IV-4, and the preceding discussion), although the likely level of effect would remain the same as for the proposal--MODERATE. The likelihood of MODERATE effects increases in the cumulative case, as does the probability that MAJOR effects on fishes would occur from onshore-pipeline spills.

Drilling discharges in the cumulative case would increase some but are regulated more in the shallow-water area, so a large amount is not expected in the nearshore area. Therefore, the effect of discharges on fishes in the Sale 109 area would remain MINOR. Seismic disturbance may increase, but the prevalent use of airguns would result in a MINOR effect on the fish resources. Construction activities would increase in the cumulative case; however, the effect on the fish resources of the Sale 109 area would remain MINOR.

Conclusion: Cumulative effects on fishes are likely to be MODERATE, the same as for the proposal.

5. Effect on Marine and Coastal Birds: Several million migratory birds occur on coastal, marine, and tundra habitats within or adjacent to the proposed Sale 109 area. Among the most abundant species that may be affected by the proposal are common and thick-billed murres, black-legged kittiwakes, arctic terns, glaucous gulls, Ross' gulls, common eiders, Pacific brant, oldsquaw, northern pintails, red phalaropes, semipalmated and pectoral sandpiper, and dunlins. Important habitat areas include Kasegaluk Lagoon; Peard Bay; the Wainwright/Kuk River area; Capes Lisburne, Lewis, and Thompson; Ledyard Bay; and Point Hope Lagoon (Sec. III.B.3 and Graphic No. 1).

The primary adverse effects on marine and coastal birds from OCS activities in the proposed Sale 109 area could come from oil pollution of the marine environment, manmade disturbance of bird populations, and alteration of habitats. The effects of oil pollution on birds are well documented. For a detailed discussion of the nature of these effects, refer to Alaska OCS Region Technical Paper No. 3 (Hansen, 1981), which is incorporated by reference.

a. Effects of Oil Spills: Direct oil contact alone usually is fatal or, in addition to indirect effects, causes substantial bird mortality. 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. Oil contamination of eggs by oil-fouled feathers of parent birds also significantly reduces egg hatching.

Indirect effects of oil pollution include reduction, contamination, and displacement of food sources, as well as contamination of shoreline habitats. A sudden, local, oil-spill-related adverse effect on major food sources that occurred during a migration-stopover period, or during the nesting period, could lower reproduction and survival of the bird populations that depend on the affected food source. Long-term, low-level contamination of food sources and habitats could also lead to chronic toxicity in birds through the accumulation of hydrocarbon residues that may adversely affect their physiology, reproduction, and behavior.

The effects on birds of an oil spill in the Sale 109 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 factors. Spills that occurred during the winter would have no immediate effect on birds. If any oil remained in the ice after winter-cleanup efforts, it could directly affect birds during the following spring-breakup period or indirectly affect them through changes or reductions in food-source availability.

Site-Specific Oil-Spill Effects: Unless otherwise specified, oil-spill-contact probabilities referred to in this section assume the occurrence of development, to the extent estimated in Section II.A, and associated spill rates (Sec. IV.A.1). Most attention is devoted to spills equal to or greater than 1,000 barrels that have trajectory periods of up to 10 and 30 days for spills occurring during the summer season (June 16-October 31), and a trajectory period over the entire winter for spills occurring during the winter season (November 1-June 15).

Combined probabilities of oil spills occurring during the summer and winter seasons and contacting important marine- and coastal-bird habitats are shown in Figure IV-19. Oil-spill risks from the proposal to marine and coastal birds using Cape Lisburne, Ledyard Bay, and Icy Cape are greater than the oil-spill risks to other important bird populations and habitats. However, the highest spill-contact probability is only 9 percent for the Cape Lisburne Seabird-Concentration Area during the entire winter season; spill-contact risk to any bird-concentration area during the summer season is 6 percent or less--even with 30-day trajectories. Oil-spill-contact probabilities for bird populations and habitats south of Cape Lisburne are zero for the proposal. Potential oil spills occurring during the winter season pose more than twice the risk of contact with the Cape Lisburne Seabird-Concentration Area than do spills occurring during the summer season (Fig. IV-19). Oil-spill-contact risks to all coastal-bird concentrations are less than 10 percent for both the summer and winter seasons. Winter spills occurring offshore of the lagoons are not likely to contaminate Kasegaluk Lagoon, Peard Bay, or other important lagoon and river-mouth bird habitats during that season because shorefast ice and the barrier islands would prevent the oil slick from actually entering the lagoons. During most of the winter season, oil-spill risks to these habitats represent spill contact to the shorefast-ice zone adjacent to the lagoons and barrier islands. During both the winter and summer seasons, oil spills are likely to move farther offshore to the west and are not likely to contact large concentrations of birds.

Under the proposal, seven oil spills of 1,000 barrels or greater are estimated to occur over the 30-year life of the field. Assuming that oil spills have an equal chance of occurring during any time of the year, two to three spills are likely to occur during May through November, when marine and coastal birds are present and generally common or abundant within the Sale 109 area. If one of the above-projected spills occurred specifically near Kasegaluk Lagoon or Icy Cape, several hundred to a few thousand eiders or oldsquaw in the Icy Cape area could be directly killed. If the spill entered the lagoon and inundated the shallow lagoon waters and salt marshes, greater numbers of birds--

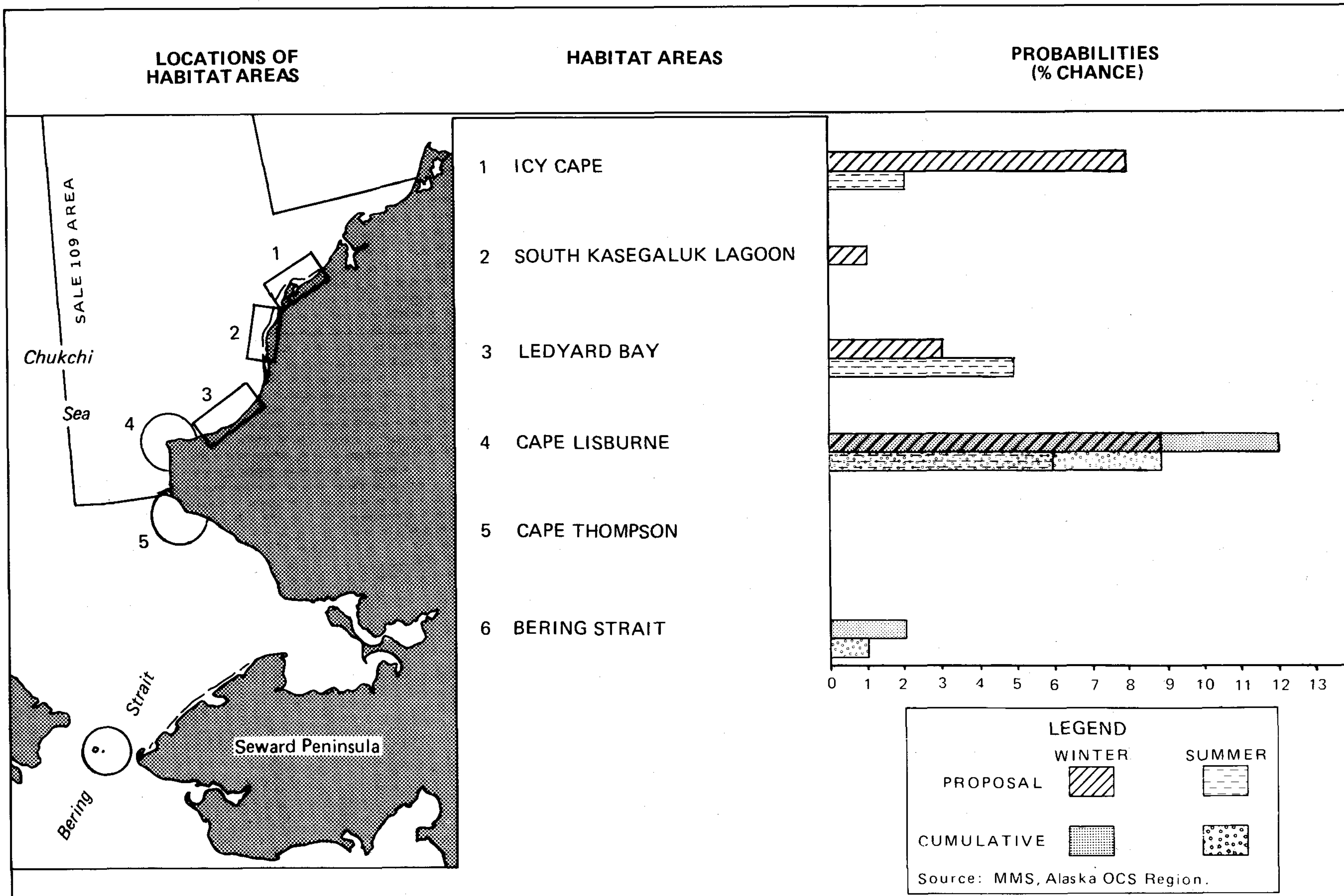


FIGURE IV–19. COMBINED PROBABILITIES OF OIL–SPILL CONTACT TO MARINE AND COASTAL BIRD HABITATS

NOTE: PROBABILITIES OF ONE OR MORE SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE AND COASTAL BIRD HABITATS DURING THE OPEN–WATER SEASON WITHIN 10 DAYS (FOR HABITAT AREAS 4, 5, AND 6) AND 30 DAYS (FOR HABITAT AREAS 1, 2, AND 3) IN COMPARISON TO THE ENTIRE WINTER SEASON OVER THE LIFE OF THE FIELD

HABITAT AREAS 1 TO 6 CORRESPOND TO THE FOLLOWING LAND SEGMENTS IN THE OIL–SPILL–RISK ANALYSIS (APPENDIX A and FIG. IV–1):

HABITAT AREA 1 = LAND SEGMENT 21
HABITAT AREA 2 = LAND SEGMENT 20
HABITAT AREA 3 = LAND SEGMENTS 16 AND 17
HABITAT AREA 4 = SEABIRD CONCENTRATION AREA I
HABITAT AREA 5 = SEABIRD CONCENTRATION AREA II
HABITAT AREA 6 = BERING STRAIT AREA

including shorebirds--could be killed or indirectly affected through the contamination and loss of invertebrate food sources. However, with a 2-percent chance of spill contact within 30 days, such an event is very unlikely (Fig. IV-19). On-site oil-spill-contingency efforts could be most effective in protecting salt-marsh habitats within the barrier islands by diverting oil slicks away from the salt marshes and thus reducing some of the oil-spill effects. However, a fairly large number of birds (a few hundred to a few thousand) could still be directly affected. If a spill of 100,000 barrels or greater occurred during the summer near the Cape Lisburne seabird colony and spread as discontinuous patches of oil over about 500 square kilometers in 10 days, several hundred to a few thousand murres could be directly killed (numbers based on mean densities of murres not in flight on the water from summer survey data [NOAA, NODC, 1975-1978]). If a spill occurred during the spring within a lead near this colony when several thousand murres and other colonial birds were rafting on the open water, greater numbers of birds could be lost.

In general, oil spills that may occur as a result of the proposed action could kill several hundred to several thousand birds over the 30-year life of the field. The numbers of birds lost to each species populations--such as oldsquaw and common eider--are likely to be replaced through recruitment within 1 or 2 years or within one generation. Thus, the effect of the proposal on these bird populations would be MINOR.

The loss of several thousand murres in the Cape Lisburne colony (150,000-250,000 murres [Roseneau et al., 1982]) due to one or two oil spills, including a 100,000-barrel-or-greater spill, contacting this habitat area could require one generation to replace lost breeding birds because of the low reproductive rate of murres. However, the present murre population of this colony is quite high; within a few years, surplus sexually mature and immature murres could replace many of the breeding birds lost to an oil spill. The chance of spill contact and mortality of large numbers of murres is less than 10 percent for the proposal (Fig. IV-19); thus, oil-spill effects on murres are likely to be MINOR.

Because they spend little time in the water, few kittiwakes are likely to be lost as the direct result of an oil spill. However, this species may be more sensitive to local changes in prey species because of such an oil spill. For example, an oil slick may affect the local distribution of sand lance near the Cape Lisburne colony, which could reduce the productivity of the kittiwake population for that year or season and thus cause a MINOR effect. During the open-water season, flocks of Ross' gulls along the pack-ice front north and west of Point Barrow are at some risk to oil-spill contact. However, because this species is a nondiver and not likely to come in contact with the oil, and because oil-spill effects on its pelagic food sources are likely to be local and temporary near spill sites, effects of the proposal on Ross' gulls are likely to be MINOR. Direct oil-spill effects on any species of marine and coastal birds found in the Sale 109 area are likely to be MINOR. Regional populations of species known to be highly vulnerable to oil spills, such as murres and other alcids, could possibly suffer MODERATE effects (loss of perhaps 10,000 or more birds), but this is very unlikely because of the low probability of spill contact to bird concentration areas.

Indirect effects of oil spills through loss of available food sources are very likely to be local (near the spill site) and of short-term duration--one season or less (MINOR effects). Oil contamination of sensitive habitats such as salt marshes could have long-term, local effects; but the chance of spill contact with salt marshes is nearly nil. Habitats affected are likely to represent a small portion of any bird population's food source. Combined oil-spill effects of Sale 109 on marine and coastal birds from direct contact with oil and indirect seasonal loss of food sources are likely to be MINOR, with bird populations recovering from spill mortalities and seasonal loss of food sources within less than one generation.

Onshore-Oil-Spill Effects: In the event of an onshore-pipeline spill, some tundra vegetation and freshwater ponds in the pipeline corridor would become contaminated. An estimated 188 small oil spills (averaging from 6 to 1,500 barrels [see Table II-1]) could be associated with the proposal. If a pipeline spill occurred, it is likely that control and cleanup operations (ground vehicles, air traffic, and personnel) at the spill site would frighten waterfowl and shorebirds away from the spill site and reduce the possibility of birds feeding on the oiled vegetation or contaminated prey organisms. Thus, onshore oil spills associated with the proposal are not likely to directly affect large numbers of marine and coastal birds, although a small number of birds (probably less than 100) may still become oiled if the spills contaminated some tundra ponds--representing a MINOR effect.

Onshore oil spills on wet tundra would kill the moss layers and above-ground parts of vascular plants, or they would kill all macroflora at the spill sites (McKendrick and Mitchell, 1978). Thus, pipeline oil spills can destroy or alter the local feeding habitat of some waterfowl along the pipeline corridor. Damage to oil-sensitive mosses may persist for several years if the spill sites are not rehabilitated (e.g., by applying phosphorus fertilizers to spill sites [McKendrick and Mitchell, 1978]). For the most part, onshore oil spills would be very local and would contaminate tundra and perhaps a few tundra ponds in the immediate vicinity of the pipeline; these spills are not expected to significantly contaminate or alter bird wetland or tundra habitats on the North Slope. However, local contamination at spill sites may persist for several years but probably represents no measurable effect on the availability of wetland and tundra habitats to marine and coastal birds, due to the abundance of uncontaminated habitats.

b. Effects of Noise and Disturbance: Human activities associated with oil exploration and development, especially air traffic near nesting waterfowl and seabirds, could reduce productivity of some species and may cause temporary displacement of birds from important nesting, feeding, and staging areas. The effects of aircraft--especially helicopter noise over nesting colonial birds--have been documented: low-flying aircraft passing near bird colonies often frighten most or all adult birds off their nests and leave the eggs and the young vulnerable to exposure, predation, and accidental displacement from the nest during hurried departures by the adult birds (Jones and Peterson, 1979). Evidence indicates that repeated disturbance could significantly reduce hatching and fledgling success, and perhaps could cause adult abandonment of eggs and young (Scott, 1976). Effects studies in the arctic indicate that arctic terns, black brant, and common eiders all show less nesting success in disturbed areas (Gollup, Goldsberry, and Davis, 1972). Bird responses to human disturbances are highly variable and 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.

Within the Chukchi Sea area, potential disturbance of bird-nesting colonies at Capes Lisburne and Lewis is a major concern. Eiders and terns nesting on barrier islands offshore of Kasegaluk Lagoon may be disturbed by aircraft and boat traffic; and some disturbance of molting and staging eiders, oldsquaw, and shorebirds on Peard Bay and Kasegaluk Lagoon is likely to occur. However, effects studies by Ward and Sharp (1973) and Gollup, Goldsberry, and Davis (1972) indicate that long-term displacement or abandonment of important molting and feeding areas by oldsquaw due to occasional aircraft disturbance is unlikely. On the other hand, Johnson (1982) reported that oldsquaw may temporarily change their local distribution in response to disturbance sources. Disturbance of nesting birds along the northern part of the Sale 109 area is likely to occur locally but would not involve disturbance of very large groups of nesting birds, such as may be the case at Cape Lisburne. The nesting activities of most species of waterfowl and shorebirds are widely dispersed over the coastal tundra; thus, disturbance of local tundra-nesting birds would probably have little effect on North Slope waterfowl and shorebird populations as a whole.

Site-Specific-Noise and -Disturbance Effects: Primary sources of noise and disturbance of marine and coastal birds would come from a maximum level of helicopter traffic of 124 to 810 round trips per month to the four exploration and nine production platforms, respectively, in the Sale 109 area. Air support would be centered out of Barrow and Wainwright, with four to five helicopters servicing all of the drilling platforms (see Table II-1). If production takes place, an airstrip would be built at Point Belcher. During exploration, goods would be lightered to shore near Point Belcher. Two to four drilling units would be used in the summer during exploration, and nine concrete-steel bottom-founded structures would be used during development and production. Production platforms would be supported by one to two icebreaking supply boats per platform, and one to three helicopter flights per day per platform. The pipeline landfall and terminal facility would be located at Point Belcher. The greatest disturbance is likely to be caused by aircraft flying near bird-feeding and -molting concentrations at Kasegaluk Lagoon and Peard Bay (Graphic No. 1). Aircraft flying from Barrow, Wainwright, and Point Belcher along the coast of the sale area during the summer-fall periods are more likely to disturb several thousand birds than aircraft flying directly from these airstrips to offshore platforms. On occasion, offshore flights may briefly disturb foraging flocks of seabirds numbering in the hundreds to a few thousand, with little or no lasting effects. However, aircraft--especially helicopters--that may fly at low altitudes along the coast could greatly disturb larger flocks of several thousand molting and feeding waterfowl, particularly in August and September. Such disturbance may disrupt migratory birds as they are acquiring the energy necessary for successful migration. If disturbance occurred frequently, waterfowl- and shorebird-migration mortality would increase for that year.

Low-altitude overflights of the Capes Lisburne and Lewis seabird colonies during the nesting season (June-August) could cause the direct loss of eggs and nestlings and might significantly reduce productivity of these seabird populations if disturbance incidents were frequent. However, because air support is likely to be based out of Barrow and Wainwright and is not likely to pass near Capes Lisburne and Lewis on flight paths crossing directly over open water to the platforms, disturbance of these colonies would not occur. The overall effect on marine and coastal birds from aircraft disturbance associated with the proposal is likely to be MINOR.

During exploration, the movement and noise from four drilling units, six support icebreakers, and one to eight barges crossing open water could disturb seabirds foraging offshore very near drilling sites. However, the low-frequency sounds emitted from drilling operations have not been shown to continually displace seabird-foraging activities from active oil-development areas along the California coast or in Cook Inlet and are not expected to displace birds in the sale area. During development and production, work-boat (1-2) and supply-boat (3) traffic to and from Point Belcher (1-2 trips/day/platform) could very briefly disturb flocks of less than 100 to several thousand birds when the boats pass nearby. As the vessels pass near the birds, short-term diving or flight responses probably would represent NEGLIGIBLE effects. Unless industry uses small boats or hovercraft capable of moving through very shallow water, and boat operators deliberately pass through the coastal lagoons or very near them, vessel-traffic disturbance of rafting and foraging birds is likely to be very brief (a few minutes) and probably have NEGLIGIBLE effects. It is very unlikely that industry operations would have any reason for moving boats through the shallow lagoons under the proposed marine-support and -transportation scenario. However, if industry-boat traffic does pass through Kasegaluk Lagoon and Peard Bay, disturbance effects on birds would be similar to those caused by low-flying aircraft. The overall effects on marine and coastal birds of noise and disturbance from aircraft, boat traffic, and drilling activities associated with the proposal are likely to be MINOR.

c. Effects of Construction Activities:

Offshore Construction: Under the proposal, two to four exploration drilling units would be used at one time. Dredging may be required to prepare the seafloor for the nine bottom-founded production platforms, and for trenching and burial of 400 kilometers of offshore trunk pipeline coming ashore at Point Belcher. Perhaps several hundred birds could be temporarily displaced (for one season) near platform and pipeline sites. Displacement could occur because of noise disturbance and temporary disruption or removal of food sources from dredging at the platform or pipeline sites (Arctic Sand and Gravel FEIS [USDOI, MMS, 1982c]). Disturbance of birds from dredging and platform installation would be short-term (one summer season or less), and disruption of food sources would be very local, within a few kilometers of the pipeline route, and temporary (one season). Therefore, specific effects on marine and coastal birds from construction associated with the proposal are likely to be MINOR.

Onshore Construction: Other factors that may directly affect birds include shoreline alteration associated with the shorebase (25-30 hectares), the 640-kilometer onshore pipeline and support road (Sale 109 pipeline corridor), ten helicopter pads along the pipeline corridor, and gravel mining (500,000 cubic meters).

During the exploration phase of the proposal, these effects are likely to be NEGLIGIBLE because no permanent facilities would be built. Of primary concern during the development phase, however, would be the permanent loss of 25 to 30 hectares of habitat from siting the shorebase at Point Belcher and approximately 64 square kilometers of habitat in the pipeline corridor, including the ten helicopter pads and support road connecting Point Belcher with the existing infrastructure at Prudhoe Bay. Road construction along the pipeline corridor would reduce nesting and feeding habitats along the road through gravel burial of tundra and changes in water drainage. Water impoundments created by road construction can affect the availability of insect prey for some shorebirds near these facilities (Conners, 1983). The pipeline would probably be located along the 600-foot contour line across the NPR-A between the Colville River and the lake district, and would cross the Colville near Umiat and connect with the TAP at Pump Station No. 2. Sixty-four square kilometers of low- to medium-density tundra habitat of various waterfowl and shorebirds (1-15 ducks/square mile) would be destroyed or altered along the pipeline corridor. Because this habitat loss would be a very small percentage of the available tundra habitat, effects on birds from onshore development associated with the proposal are likely to be MINOR.

<u>SUMMARY</u>: The direct effects of seven offshore oil spills and many small onshore-pipeline spills on marine and coastal birds may include the loss of several hundred to several thousand sea ducks and murres and small numbers of other birds over the 30-year life of the field. However, the chance of oil spills contacting coastal concentrations of tens of thousands of birds is very low--less than 10 percent--under the proposal (Fig. IV-19). The loss of several thousand oldsquaw, common eiders, and murres would represent MINOR effects because recruitment would replace lost individuals within 1 or 2 years or within one generation or less. Indirect oil-spill effects through loss of available food sources are very likely to be local near the spill site and last for one season or less (MINOR effects). Oil contamination of sensitive habitats such as salt marshes and tundra ponds from onshore spills may have long-term effects lasting several years, but the chance that any one or more of the seven projected spills would contact marine salt marshes is nearly nil and the local contamination of tundra ponds and wetlands near the spill sites is not expected to have any measurable effect on the availability of these habitats and food sources to marine and coastal birds due to the abundance of uncontaminated habitats.

The 124 to 810 helicopter trips per month to and from platforms, particularly low-altitude flights along the coast of the Sale 109 area, could be the greatest cause of disturbance to birds. Aircraft disturbance of large flocks of molting and feeding waterfowl (such as oldsquaw, eiders, and Pacific brant) and shorebirds in the Kasegaluk Lagoon and Peard Bay habitats could temporarily displace these migratory birds as they are acquiring the energy necessary for successful migration and may result in higher migration mortality and lower winter survival of affected birds. However, the frequency of aircraft-caused disturbance of birds in the sale area alone (1-3 helicopter round trips/day/platform or 124-810 round trips/month) is not likely to have more than MINOR effects, because most aircraft would fly directly to the nine platforms and not disturb coastal concentrations. Aircraft disturbance of large, nesting seabird colonies at Capes Lisburne and Lewis (over 150,000 birds, mostly murres and kittiwakes) is not likely to occur because aircraft traffic centered out of Barrow and Wainwright would fly directly to the offshore platforms and not pass near these or any other large colonies (10,000 or more birds). Most boat-traffic disturbance (4 drilling units, 6 icebreakers for exploration, and 3 supply boats and 1-2 work boats for development) of birds is likely to be very brief, and have an inconsequential effect on the well-being of birds involved (NEGLIGIBLE effects). Overall effects on marine and coastal birds of noise and disturbance from air and boat traffic associated with the proposal are likely to be MINOR.

Offshore installation of nine production platforms, trenching and burial of 400 kilometers of offshore pipeline; and onshore construction--including a 25- to 30-hectare shorebase at Point Belcher, a 640-kilometer onshore pipeline corridor with a support road and ten gravel helicopter pads--is likely to temporarily disturb and displace some birds from local habitat areas that would be altered or destroyed by these activities. Offshore dredging, pipelaying, and platform construction would have local short-term, or MINOR, effects on birds. Construction of the onshore pipeline corridor to the TAP would alter approximately 64 square kilometers of bird tundra habitat along the pipeline route and represent a MINOR habitat loss (a very small percentage of habitat available) to bird populations.

The overall effects of oil spills, noise disturbance, and habitat alteration due to construction activities on the marine and coastal birds of the Sale 109 area are likely to be MINOR.

<u>CONCLUSION (Effect on Marine and Coastal Birds)</u>: The effect of proposed Sale 109 on marine and coastal birds is expected to be MINOR.

<u>CUMULATIVE EFFECTS</u>: In this section, the additive effects of other ongoing and planned projects, as well as the proposal, are discussed to present an analysis of the potential cumulative effects on marine and coastal birds. Although the probability of any or all of the planned and ongoing offshore and onshore projects listed in Table IV-2 reaching developmental stages generally is unknown, this analysis assumes that all projects discussed in this section do reach developmental stages. These projects could affect birds through oil spills, noise and disturbance, and habitat destruction or alteration from construction activities. The State of Alaska lease sales discussed below have been deferred from the current State 5-year lease schedule; however, these sales may be reinstated and are therefore evaluated.

<u>Cumulative Effects of Oil Spills</u>: Cumulative oil-spill-contact risks to marine and coastal bird habitats are shown in Figure IV-19. Under the cumulative case, increases in spill-contact risk would occur only in the Cape Lisburne Seabird-Concentration Area, and the Bering Strait Area, where the increase would be slight. These small increases in spill risk to bird habitats are attributable to possible Canadian-oil tankering through the Sale 109 area and the Bering Strait. If a large tanker spill of 100,000 barrels or greater occurred in the Bering Strait during the nesting season of over 1.5 million seabirds at Little Diomede Island and Fairway Rock, several thousand to perhaps several-hundred thousand least and crested auklets could be killed. However, the probability of a tanker spill occurring and contacting the Bering Strait is only 2 percent during the winter season and 1 percent during the summer. Therefore, the number of seabirds contacted and killed by oil probably would be no more than a few thousand, representing MINOR effects on bird populations. Oil exploration and possible development associated with

proposed State Sale 45 and proposed Federal OCS Sale 133 in the Hope Basin (Kotzebue Sound) could have MINOR to MODERATE oil-spill effects on marine and coastal birds if coastal-bird habitats were contaminated by a large oil spill of 100,000 barrels or greater, or if the Cape Thompson seabird-foraging-concentration areas were contacted by an oil spill and several thousand to tens of thousands of murres and other seabirds were killed.

Combined oil-spill effects from the proposal--in addition to possible spill effects from Federal OCS Sale 133 and State Sales 45 in Hope Basin, 58 at Icy Cape, and 60 at Point Franklin, Canadian tankering, the Prudhoe Bay Sealift, Red Dog Mine vessel traffic, and Federal OCS lease activites in the Bering and Beaufort Seas--are likely to have MODERATE and possibly MAJOR effects on birds. State Sale 45 and Federal Sale 133 in the Hope Basin could affect the over 400,000 seabirds that nest at Cape Thompson. An oil spill of 100,000 barrels or greater in this area could kill several thousand to perhaps 100,000 birds. Possible fuel-barge spills from the Prudhoe Bay Sealift (as many as 50 barges/year) and supply-ship-fuel spills associated with the Red Dog Mine Project could also result in the death of several thousand birds in the Chukchi Sea--particularly eiders, oldsquaw, murres, and auklets. State proposed Sales 58 and 60 would lease blocks within Kasegaluk Lagoon and Peard Bay--important coastal-habitat areas for thousands of waterfowl and shorebirds. Oil spills from these sales are likely to have long-term MODERATE to possibly MAJOR effects on these birds through contamination of salt marshes and direct loss of thousands to tens of thousands of waterfowl and shorebirds.

Cumulative Effects of Noise and Disturbance: Primary sources of cumulative noise and disturbance to marine and coastal birds are air and vessel traffic associated with industrial activities and air and ground-vehicle traffic from onshore human activities along the coasts of the Chukchi, Bering, and Beaufort Seas. Offshore air traffic would consist primarily of the 124 to 810 helicopter round trips per month to and from platforms associated with the proposal. This traffic would have brief, inconsequential (NEGLIGIBLE) effects on birds on their offshore feeding grounds but could have short-term adverse disturbance effects (MINOR) on colonial-nesting seabirds, staging waterfowl, and shorebird flocks if the helicopters passed near coastal lagoons or seabird colonies during the summer season. Cumulative vessel traffic of perhaps over 100 vessels per year would include barges, drillships, and supporting ice-breakers associated with the proposal; one to as many as 24 tugs; and two to as many as 50 barges associated with Prudhoe Bay Sealift traffic through the Sale 109 area during the open-water period; and approximately 16 to 20 bulk-ore carriers, tankers, and supply ships per year that could be present in association with the Red Dog Mine Project adjacent to the sale area and several hundred vessel trips per year associated with Bering and Beaufort Sea leases. Most of this vessel traffic would remain offshore and not disturb concentrations of nesting and feeding birds; however, some flocks of feeding birds in offshore waters would be briefly disturbed by the traffic.

Onshore air and ground-vehicle traffic (all-terrain vehicles, snowmobiles, "snow cats," gravel trucks) would be associated with the NPR-A, State Sale 53 (if it is reinstated on the State 5-year lease schedule) in the Icy Cape/Kasegaluk Lagoon area, the Sale 109 pipeline corridor, and traffic associated with the Red Dog Mine Project, as well as increased vehicle and air traffic associated with the North Slope Borough. Most exploration on the NPR-A and State Sale 53 would occur during the winter, with ground-vehicle traffic having NEGLIGIBLE effects on birds because most species are absent from the arctic during the winter. During the summer, cumulative onshore-oil-exploration activities--particularly helicopter traffic--are likely to have MINOR effects on bird populations, with small segments of various species populations being temporarily displaced by disturbance or adversely affected by the possible loss of some eggs or offspring.

If development occurs, summer road traffic (several hundred vehicles/day during construction) would have MINOR local disturbance effects on birds along the pipeline corridor. With development, noise and disturbance of nesting birds would be greatest during construction activities and would subside after facilities are in place. These effects are likely to be MINOR for the bird-species populations that occur on the North Slope. MODERATE to MAJOR effects on sensitive waterfowl species, such as Pacific brant and snow geese, are possible if extensive oil development occurs in very important habitat areas such as the Teshekpuk Lake waterfowl-concentration area on the NPR-A, with resulting frequent disturbance of Pacific brant and snow geese and possible displacement of these bird populations for a long period (several generations).

Cumulative Effects of Construction Activities: Cumulative offshore-construction activities would include the installation of nine production platforms; trenching and burial of a 400-kilometer, offshore pipeline associated with the proposal; construction of a short causeway for a ship terminal associated with the Red Dog Mine Project south of the Sale 109 area; and platform installation and pipelaying associated with development of Bering and Beaufort Sea leases. These activities would have local effects on benthic organisms through removal or burial of benthic sediments but would have NEGLIGIBLE effects on the availability of food sources to marine and coastal birds, which do not rely on benthic organisms in local areas but rather prey on a variety of abundant fishes and invertebrates not affected by platform-, pipeline-, and causeway-construction activities.

Cumulative onshore-construction activities would include potential NPR-A oil development, possible State Sale 53 oil development in the Icy Cape/Kasegaluk Lagoon area, the Red Dog Mine Project, as well as the pipeline and support facilities associated with the proposal and with Federal OCS leases in the Bering and Beaufort Seas. There are 11 potential areas where oil discoveries are possible on the NPR-A (Shepard, Bennett, and Gilliam, 1982). Several hundred kilometers of pipelines and roads would be built if several different discoveries of economically recoverable quantities of oil occurred. About 1,036 to 2,331 square kilometers (400-900 mi^2), the total range of bird-nesting and -feeding habitat for all 11 areas, could be exposed to oil development, with perhaps 130 square kilometers (50 mi^2) of habitat altered or destroyed in the construction of gravel pads, roads, pipelines, and other facilities (USDOI, BLM, NPR-A, 1983). This habitat loss would represent a small percentage of the total tundra habitat available on the NPR-A. While this effect probably would represent a MINOR habitat loss to bird-species populations that occur on the NPR-A, the possible habitat loss and displacement of geese from very important habitat areas--such as the Teshekpuk Lake area or the Fish Creek Delta--could represent MODERATE to MAJOR effects on Pacific brant and snow geese, depending on how much displacement of birds and habitat loss occurred. However, if no oil development occurs in these important habitat areas, effects on regional populations of birds on the NPR-A are likely to be MINOR.

If exploration and development occurs from possible State Lease Sale 53 in the Icy Cape/Kasegaluk Lagoon area, onshore marine- and coastal-bird-habitat loss and alteration associated with pipelines and roads could be directly cumulative to habitat loss and alteration from NPR-A oil development and the Sale 109 pipeline corridor. As with other onshore oil development, the actual amount of bird habitat lost to facility construction would be a small percentage of the tundra habitat available in the area and would represent NEGLIGIBLE or MINOR habitat loss. However, the cumulative loss of habitat from possible oil development on the NPR-A and from Sale 109 could represent MODERATE cumulative effects on birds.

Tundra-habitat loss or alteration associated with the Red Dog Mine Project is estimated to include about 541 hectares (1,336 acres) of vegetation in Red Dog Valley and 197 hectares (487 acres) for the road corridor (USEPA and USDOI, 1984). This local-habitat loss would displace small numbers of nesting birds but would have NEGLIGIBLE effects on habitat availability to bird populations. The small amount of habitat loss associated with the Red Dog Mine Project probably would not be significantly additive to the habitat loss associated with the proposal and NPR-A oil development.

<u>Overall Cumulative Effects</u>: Cumulative oil and gas activities of proposed Sale 109 and other offshore (OCS leases in the Bering and Beaufort Seas) and onshore projects (listed in Table IV-2) would subject marine and coastal birds and their summer habitats throughout the sale area and the North Slope to a variety of aggregate effects. Oil-spill risks to bird habitats from possible Canadian tankering in the Chukchi Sea were compared with the oil-spill risks of the proposal (Fig. IV-19). The spill-contact risks to the Cape Lisburne Seabird-Concentration Area and the Bering Strait Area are the only risks that increase over those of the proposal for bird habitats shown in Figure IV-19. Bird habitats south of Cape Lisburne are at little or no oil-spill-contact risk from Canadian tankering or oil spills from offshore-oil activities associated with the proposal. Possible State Sales 45, 58, and 60 in the Hope Basin, Icy Cape-Kasegaluk Lagoon, and Peard Bay-Point Franklin, respectively, could have the most noticeable effects on birds because potential spills from these sales would occur within the coastal habitats. Perhaps thousands or tens of thousands of birds could be killed as a result of oil spills--including one of 100,000 barrels or greater--over the life of these projects. The species likely to suffer high mortality rates (10,000 or more birds killed) from oil spills include common and thick-billed murres, oldsquaw, and eiders. If one or more spills--particularly from State Sales 58 and 60--contaminated coastal salt marshes, oldsquaw, eiders, Pacific brant, and other waterfowl may also suffer high losses and may be affected by contamination of salt marshes. Cumulative oil spills probably would have no more than MODERATE effects on common waterfowl species, such as oldsquaw and common eiders, because these birds are not likely to be exposed to many of the spills that probably would occur during the winter season and because recruitment of birds from unaffected parts of the regional populations is likely to replace lost individuals within one to a few generations.

The cumulative loss of murres, auklets, and other alcids (perhaps 100,000 or more birds) from potential spills contacting seabird-foraging areas could have MODERATE to MAJOR effects on the regional populations of these species because of their low reproductive rates. If a large oil spill of 100,000 barrels or greater occurred within the Bering Strait during the fall, when over one million molting least and crested auklets were present on the water, MAJOR oil-spill effects on these regional populations would be possible but unlikely, given the very low spill-contact probability for the Bering Strait.

Primary sources of cumulative noise and disturbance of marine and coastal birds are offshore air traffic (124-810 round trips from the proposal alone) and vessel traffic (perhaps a total of over 100 vessels/year) and onshore air and ground-vehicle traffic (several hundred vehicles/day). The proposal and OCS activities in the Bering and Beaufort Seas would be the primary sources of offshore air traffic, which would have NEGLIGIBLE effects on birds on their offshore-feeding grounds but MINOR effects on colonial-nesting birds and coastal concentrations of staging waterfowl and shorebirds if the helicopters passed near the seabird colonies and coastal lagoons during the summer-fall season. Most vessel traffic associated with the proposal, other OCS lease areas, and the Prudhoe Bay Sealift would remain offshore and would not disturb concentrations of nesting and feeding birds. Cumulative vessel traffic is likely to have NEGLIGIBLE effects on birds.

Most onshore air and ground traffic would be associated with NPR-A development, State Sale 53, the Sale 109 pipeline corridor, proposed Federal OCS and State lease sales in the Hope Basin as well as in the Bering and Beaufort Seas, and increased vehicle traffic from North Slope Borough communities. Noise and disturbance of tundra-nesting birds from onshore oil development would be greatest during construction activities (several hundred vehicles/day on the roads) and would subside after facilities are in place (perhaps less than 50 vehicles/day).

These effects are likely to be MINOR for most bird populations occurring on the North Slope, but MODERATE effects on sensitive waterfowl species--such as Pacific brant and snow geese--are possible.

Offshore construction that would include the installation of nine production platforms and 400 kilometers of buried offshore pipeline associated with the proposal, and a short causeway to a ship terminal for the Red Dog Mine Project south of the Sale 109 area, are likely to have NEGLIGIBLE effects on the availability of food sources to marine and coastal birds because of the abundance and wide distribution of prey.

Cumulative onshore construction would include the pipelines, gravel pads, airstrips, several hundred to over a thousand miles of roads, and other facilities associated with NPR-A, State Sale 53, the Red Dog Mine Project, and the proposal that could alter or destroy a few hundred square kilometers of tundra habitat. This habitat loss would represent a small percentage of the total tundra habitat available for most species on the North Slope, with MINOR effects on most bird populations. However, the possible habitat loss and displacement of Pacific brant and snow geese from very important feeding and staging habitats near Teshekpuk Lake due to possible development in this area could represent MODERATE to possibly MAJOR effects on Pacific brant and snow geese, depending on how much displacement of their habitat occurred.

In summary, cumulative habitat loss from facility-construction activities (such as gravel mining and road, pipeline, and drill-pad construction); loss of habitat due to bird-population avoidance of habitat areas with high levels of noise and disturbance, and direct loss of birds from oil spills or habitat contamination are likely to have MODERATE effects on some bird populations such as murres, eiders, and oldsquaw. MAJOR effects (loss of several hundred thousand birds) on the murres and auklets of Little Diomede Island could occur if a major oil spill occurred in the Bering Strait during the fall, when over 1 million molting birds are rafting on the water (mortalities would be very high); however, this severe event is very unlikely to occur. MODERATE to MAJOR effects on snow geese and Pacific Brant are possible from onshore oil development in the Teshekpuk Lake area.

Conclusion: The cumulative effect of the above projects and proposed Sale 109 on marine and coastal birds is expected to be MODERATE.

6. Effect on Pinnipeds, Polar Bears, and Beluga Whales: Six species of nonendangered marine mammals--ringed seals, spotted seals, bearded seals, polar bears, walruses, and beluga whales--commonly occur throughout the proposed Sale 109 area and are very likely to have some interaction with OCS activities. Oil pollution, noise and disturbance, and habitat changes due to construction activities could adversely affect these marine mammal populations found in the sale area. This section discusses the nature of the effects of oil and disturbance on marine mammals. OCS Report MMS-85-0031 (Hansen, 1985), which is incorporated by reference, contains a detailed discussion of the various possible direct and indirect effects of oil pollution and other chemical pollutants on marine mammals.

a. Effects of Oil Spills: Direct contact with spilled oil may cause mortality of some marine mammals and have no apparent effect on others, depending on factors such as species involved, age, and physiological status of the animal. Some polar bears and newly born seal pups are likely to suffer direct mortality from oiling through loss of thermo-insulation, resulting in hypothermia. On the other hand, walrus calves' natal pelage, which contains no underfur and is sparse compared to the lanugo pelage of ice-seal pups, is of little insulative value; thus, oiling of walrus calves would not significantly reduce thermo-insulation. However, oiling could increase physiological stress--particularly in very young calves--and contribute to the death of some animals. Adult and subadult ringed, spotted, and bearded seals and walruses that rely on thick layers of blubber for thermo-insulation, may suffer some temporary adverse effects such as eye and skin irritation with possible infection if contact with oil occurs. Such effects may increase physiological stress and perhaps contribute to the death of some individuals (Geraci and Smith, 1976b; Geraci and St. Aubin, 1980). Deaths attributable to oil contamination are more likely to occur during periods of high natural stress, such as during molting or times of food scarcity and disease infestations. The few recorded mammal deaths attributed to oil spills in case histories occurred during the winter months (Duval, Martin, and Fink, 1981), a season of increased natural stress.

Although species-specific effects of oil contact on beluga whales are uncertain, studies by Geraci and St. Aubin (1982) of hydrocarbon effects on dolphins and porpoises, as representative odontocetes, provide sufficient insight on the potential effects of oil-spill contact on beluga whales. The findings of these experiments suggest that smooth-skinned cetaceans such as beluga whales, dolphins, porpoises, and killer whales could suffer some minor skin damage if they were confined to a small surface area contaminated with oil (such as an ice lead). However, such effects on the skin are likely to be short-term or transient (oil is unlikely to adhere to the skin), with recovery occurring within a few days (Hansen, 1985).

Oil ingestion by marine mammals through consumption of contaminated prey and by grooming or nursing could have pathological effects, depending on the amount ingested, species involved, and the animal's physiological state. Death would be likely to occur if a large amount of oil were ingested or if oil were aspirated into the lungs. Ingestion of sublethal amounts of oil can have various physiological effects on a marine mammal, depending on whether the animal is able to excrete and/or detoxify the hydrocarbons. Geraci and Smith (1976b) demonstrated that seals are able to excrete as well as absorb oil. Both seals and cetaceans potentially can metabolize small quantities of ingested oil and detoxify hydrocarbons through the function of an oxygenase enzyme complement (Engelhardt, 1983) demonstrated as cytochrome p-450 in the liver of cetaceans (Geraci and St. Aubin, 1982) and as aryl hydroxylase in the liver and kidney tissues of seals (Engelhardt, 1982), suggesting that seals and whales may not suffer any serious physiological effects if they consume small quantities of oil.

(1) Oil-Spill Avoidance: Seals, walruses, polar bears, and beluga whales are not likely to intentionally avoid oil spills, although they may limit or avoid further contact with oil if they experience discomfort or apprehension as a result of contact with an oil slick (Hansen, 1985). Under some circumstances, they may be attracted to the spill site if concentrations of food organisms are nearby; or they may have little choice but to move through the spill site during migration.

(2) Indirect Effects of Oil: Indirect effects of oil pollution on seals, walruses, polar bears, and beluga whales would be those associated with changes in availability or suitability of various food sources. The arctic-marine ecosystem consists of a relatively simple food web with top-level consumers such as ringed seals, beluga and bowhead whales, and marine birds feeding primarily on a few species of abundant invertebrates or arctic cod. During heavy ice years, primary productivity is comparatively low, and food could be a limiting factor for large areas of the Beaufort and Chukchi Seas (Frost and Lowry, 1981). If a major spill occurred during such a period, the short-term loss of plankton, benthic invertebrates, and arctic cod could--in theory--locally reduce food sources of some marine mammals, such as ringed seals, during one breeding season and could temporarily result in decreased local productivity. The local reduction in ringed seal numbers as a result of direct or indirect effects of oil could, in turn, temporarily affect the local distribution of polar bears because ringed seals are their primary food source. However, ringed, spotted, and bearded seals; walruses; and beluga whales opportunistically prey on a variety of available food organisms and are capable of moving from an area of local prey depletion to other locations of prey abundance. Breeding ringed seals that remain in local areas during the pupping season may be an exception, but the reduction of food

organisms (arctic cod and epibenthic crustaceans) would persist for no more than one season due to rapid recruitment of these food organisms and represent a MINOR effect.

(3) Site-Specific Oil-Spill Effects: Unless otherwise specified, oil-spill-contact probabilities referred to in this section assume the occurrence of development to the extent estimated in Section II.A and associated spill rates (Sec. IV.A.1). Most attention is devoted to spills greater than or equal to 1,000 barrels that have a trajectory period of up to 10 to 30 days for spills occurring during the summer (open-water) season (June 16-October 31) and a trajectory period throughout the winter for spills occurring during the entire winter (ice-cover) season (November 1-June 15). Combined probabilities of oil spills occurring and contacting important marine mammal habitats (migration corridor and typical drifting-pack-ice habitats as ice/sea segments) during the winter season are shown in Figure IV-20.

The drifting-pack-ice habitat of bearded and ringed seals and polar bears west and north of Icy Cape is likely to be contacted by oil, assuming that one or more spills occur during the winter. Ice habitats near Wrangel Island--an important denning area for polar bears--have a greater-than-60-percent chance of being contacted by one or more spills during the winter (Fig. IV-20). However, oil spills that occur during the winter under the ice or within open water are likely to be quickly frozen into the drifting pack ice and remain encapsulated (frozen in the pack ice) until meltout in June (see Sec. IV.A.2.a). Portions of an oil spill remaining on the surface of the ice would become highly weathered within about 10 days. During the spring migration of beluga whales (April 1-June 15), oil spills have about a 50-percent chance of occurring within or hitting the whale-migration corridor somewhere between Point Hope and Point Barrow; oil-spill risk to the migration corridor south of Point Hope is nil (Fig. IV-20).

The combined probabilities of oil spills occurring and contacting important marine mammal habitats (the migration corridor and typical ice-front habitat represented as ice/sea segments) during the summer (June 16-October 31) are shown in Figure IV-21. The migration corridor between Point Hope and Point Barrow and the pack-ice-front habitats of ringed and bearded seals, walruses, and polar bears north and west of Icy Cape are likely to be contacted by oil spills occurring during the summer within 10 days of the spill. Oil-spill-contact risks to coastal habitats of spotted seals and beluga whales, such as Kasegaluk Lagoon, are zero for 10-day trajectories (Appendix A, Table 17, Land Segments 20 and 21). Oil-spill-contact risks to the migration corridor south of Point Hope and to Wrangel Island during the open-water season are also nil (Fig. IV-21). The above oil-spill-trajectory-analysis results indicate that ringed and bearded seals, walruses, polar bears, and beluga whales are most likely to encounter oil spills in the drifting pack ice offshore and north and west of Icy Cape during the winter (Fig. IV-20) and within the migration-corridor habitat during the open-water season (Fig. IV-21).

Under the proposal, seven oil spills of 1,000 barrels or greater are projected to occur over the 30-year life of the field. Assuming that oil spills have an equal chance of occurring during anytime of the year, two or three spills are likely to occur during the spring- and fall-migration periods at sometime over the life of the field. A 100,000-barrel oil spill occurring during the spring-migration period and contacting the migration corridor is likely to

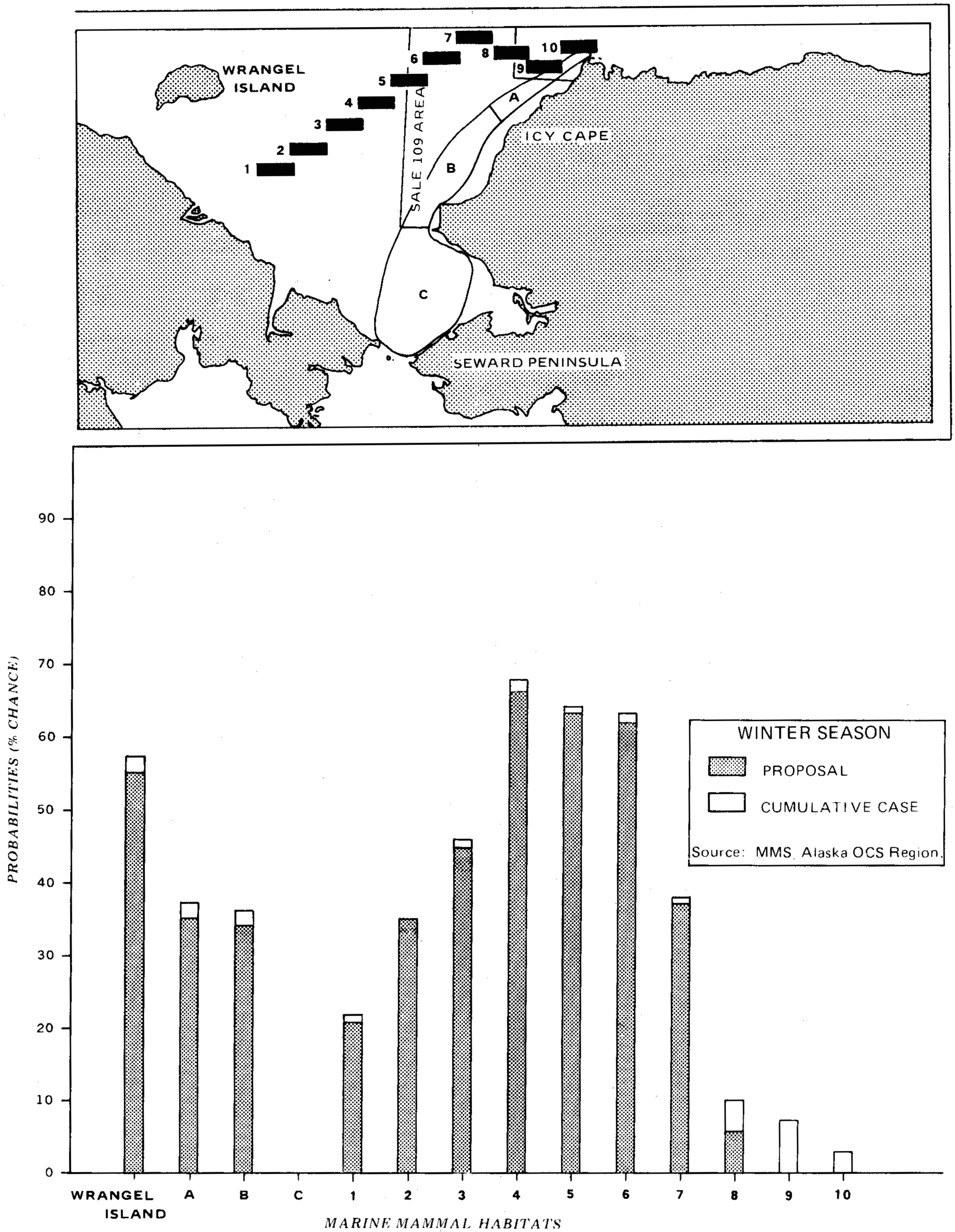


FIGURE IV–20. COMBINED PROBABILITIES OF OIL–SPILL CONTACT TO MARINE MAMMAL HABITATS DURING THE WINTER SEASON

NOTE: PROBABILITIES OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS DURING APRIL THROUGH JUNE 15 FOR MIGRATION–CORRIDOR SECTIONS A, B, AND C AND DURING THE ENTIRE WINTER SEASON FOR WRANGEL ISLAND, AND ICE/SEA SEGMENTS 1–10 OVER THE LIFE OF THE FIELD

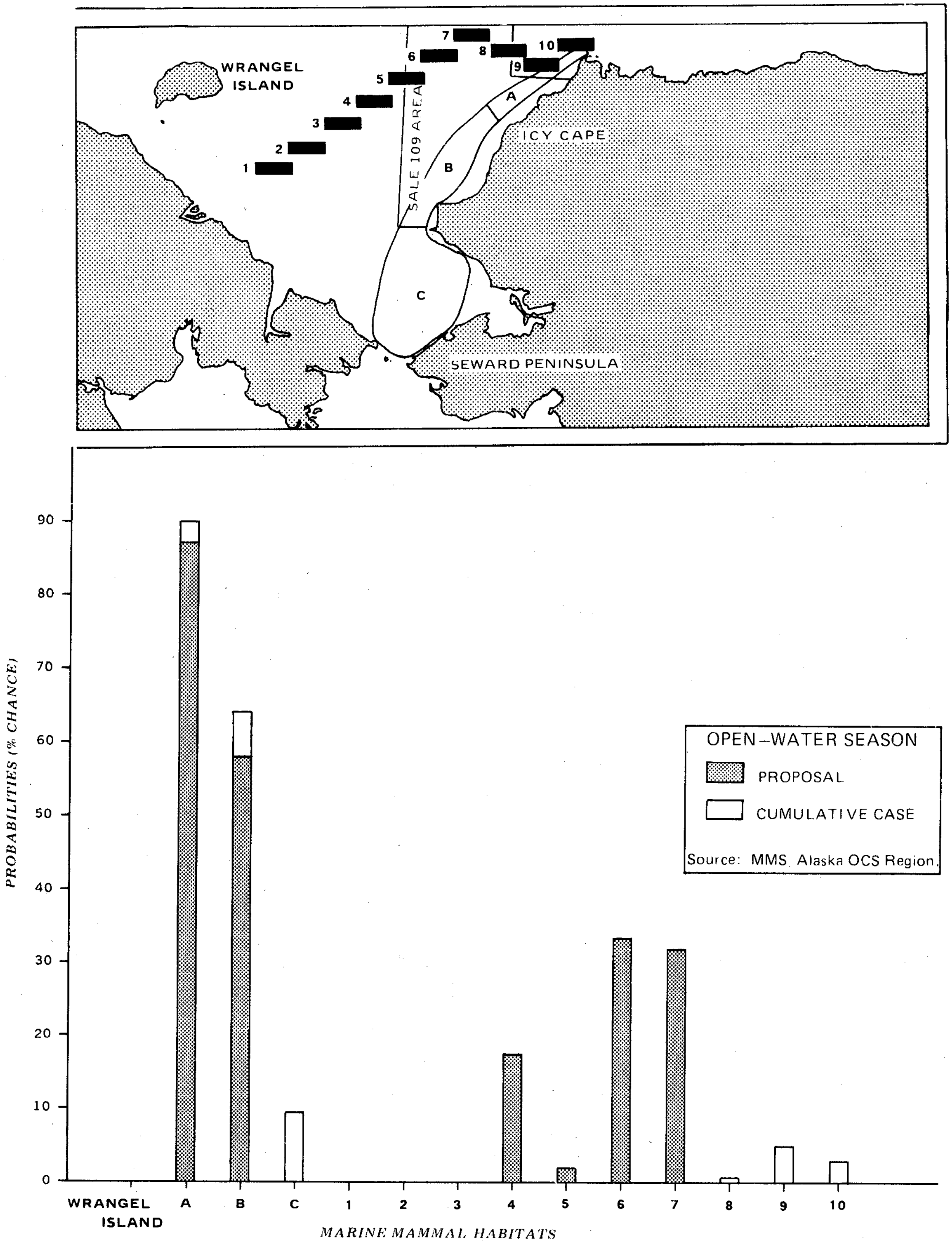


FIGURE IV–21. COMBINED PROBABILITIES OF OIL–SPILL CONTACT TO MARINE MAMMAL HABITATS DURING THE OPEN–WATER SEASON

NOTE. PROBABILITIES OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS (WRANGEL ISLAND; MIGRATION–CORRIDOR SECTIONS A, B, AND C; AND ICE/SEA SEGMENTS 1-10) DURING THE OPEN- WATER SEASON WITHIN 10 DAYS OVER THE LIFE OF THE FIELD contact a small number of ringed, spotted, and bearded seals (less than $10/km^2$) because these seals do not concentrate in large groups and because much of the oil would freeze into the ice within about 1-square-kilometer area until it melted out in June, at which time it would be subject to rapid evaporation and dispersion (see Sec. IV.A.2 [Aspects of Spilled Oil]). Some oil is very likely to adhere to the seals' fur and outer-body surfaces, causing irritation of sensitive tissues and loss of thermo-insulation in newborn pups. These effects may result in the death of a small number of weakened and stressed adult seals and very young seals that have not built up fat reserves. Depending on the location and timing of the 100,000-barrel spill and the density of seals in the area, a few to perhaps several hundred seals could be oiled, resulting in the death of a few to perhaps 100 pups and highly stressed adults. Lost seals would be replaced within one generation or less, representing MINOR effects.

Three or four of the estimated seven oil spills are likely to occur during the winter and contact the drifting pack ice west of Icy Cape and ice habitats near Wrangel Island (Fig. IV-20). However, most of the oil from these spills would remain encapsulated until meltout during late June. By that time, the estimated 200 to 250 female polar bears and cubs would have left denning areas on Wrangel Island (during late March-early April) and dispersed onto the pack ice in search of seals. Thus, the three to four winter spills that could occur sometime over the life of the field are not likely to be a threat to polar bears and cubs during their departure from Wrangel Island. Later on during the summer, some of these female bears and cubs (perhaps 10-30) could encounter oil from one or more of these spills along the pack-ice front north of Wrangel Island. Bears that become heavily contaminated with oil probably would die from hypothermia or physiological complications resulting from oil ingestion after grooming their fur to remove oil.

Considering the rapid evaporation and dispersion of oil spills after meltout from the pack ice and the low density of polar bears on the ice after leaving Wrangel Island, the number of bears encountering oil slicks melting out of the pack ice is likely to be small. Polar bears may also avoid oil slicks, particularly if seals avoid the spill. However, some polar bears could ingest oil by preying on seals that become oiled. Whether bears would die from this oil ingestion would depend on the toxicity of the oil and the amount consumed. The number of bears that encounter oil and become contaminated directly or ingest oil from contaminated seals is likely to be low (perhaps 10-30 bears)--representing a MINOR effect on the polar bear population, with lost individuals replaced within one generation or less.

Two or three oil spills, including a 100,000-barrel-or-greater spill, occurring and contacting the migration corridor between Point Hope and Point Barrow or the pack-ice front west of Barrow during the summer could contact several thousand Pacific walruses. Perhaps several hundred to several thousand walruses could suffer eye and sensitive-tissue irritation for a short period of time while the oil slick remains near ice floes where walruses haul out. There is no evidence to indicate that walruses would be killed by direct contact with an oil spill. The oiling of northern elephant seals (a pinniped of comparable size and comparable lack of dependency on pelage for thermo-insulation) by the Santa Barbara oil spill had no significant short-term or long-term deleterious effects (Le Boeuf, 1971). However, temporary eye and skin irritation and short-term inhalation of some hydrocarbon vapors could reduce the survival of at least highly stressed adults and young calves. Considering evidence that the Pacific walrus population is under high environmental stress due to high population numbers and possible depletion of benthic food sources, oil contact with large numbers of walruses may contribute to the mortality of several hundred or more highly stressed animals that may or may not die from natural causes later on during the same season or year. The death of some highly stressed walruses attributed to one or more oil spills would be considered a MINOR effect on the Pacific walrus population.

Two or three estimated oil spills are likely to occur sometime during the spring and/or fall migration of about 12,000 beluga whales through the Sale 109 area. Oil spills are more likely to contact belugas during the spring, when the whales are known to use the lead system between Point Hope and Point Barrow that has about a 50-percent chance of spill contact (Fig. IV-20). However, actual whale exposure to an oil slick or hydrocarbons in relatively high concentrations in the water column would be very brief, and only highly stressed or diseased individuals are likely to be seriously affected. Even in a severe situation, these oil spills are likely to contribute to the deaths of no more than a few whales and have NEGLIGIBLE effects on the beluga whale population.

Oil-spill risks to ringed seals inhabiting shorefast ice in the Icy Cape and Ledyard Bay areas are low at 8 and 3 percent, respectively, during the winter season (Fig. IV-1, Land Segments 21 and 17). An oil spill of 100,000 barrels or greater occurring under the fast ice is likely to contaminate no more than a few square kilometers of fast-ice habitat at the most (see Sec. IV.A.2). Such an oil spill could contaminate perhaps 10 to 30 breeding ringed seals and pups, assuming densities of four to six seals per square kilometer for this area (Burns, Shapiro, and Fay, 1980). The loss of young pups from the spill and sublethal effects on 10 to 30 adults would be a NEGLIGIBLE effect on the ringed seal population of the Sale 109 area.

If the estimated seven oil spills occur over the life of the field, some local reduction in the availability of food sources is likely to affect some marine mammals, such as breeding ringed seals, for one season. These spills could reduce the number or availability of arctic cod (the primary prey of ringed seals) and epibenthic crustaceans where the oil slick is present or very near the spill site. However, this effect would be short-term (one season or less), with rapid recruitment from adjacent habitats after the spill has dispersed. Oil-spill reduction of pelagic food sources of spotted seals and beluga whales is also likely to be local near the spill site and short-term due to the rapid recruitment of pelagic fish from adjacent areas. However, oil-spill effects on the benthic prey of walruses and bearded seals may be more persistent on a local level, where hydrocarbon contaminants could be incorporated into the sediments. The longer-term (several years) contamination of sediments from an oil spill of 100,000 barrels or greater could reduce the numbers and productivity of the benthos, particularly clams--the primary food source of walruses. However, due to the physical nature of most oil spills and their interaction with winds and currents, very low concentrations of oil (few parts per billion) would reach bottom sediments and benthic habitat. This contamination is not likely to affect overall clam resources in the walrus-feeding area. Thus, the seven oil spills that may occur over the life of the field are not likely to have more than a MINOR effect on the overall benthic food sources of walruses and bearded seals available in the

Sale 109 area (see effects of oil spills in Secs. IV.B.3 and IV.B.4). Oil spills are likely to have MINOR or NEGLIGIBLE effects on the availability of prey for ringed and spotted seals and beluga whales.

b. Effects of Noise and Disturbance: Disturbance of seals, walruses, polar bears, and beluga whales would be caused mainly by airborne and waterborne noise.

(1) Airborne Noise: Major sources of mobile-airborne-noise disturbance are low-flying aircraft and high-speed motorboats as well as other high-frequency, high-pitched sounds. Low-flying aircraft are known to panic hauled-out seals and walruses (Johnson, 1977; Salter, 1979). The disturbance of walrus-nursery herds hauled out on the ice may result in the death or injury of walrus calves from trampling by disturbed adults. If disturbance of hauled-out seals and walruses occurs frequently during molting, the successful regrowth of skin and hair cells may be retarded, thus increasing physiological stress on seals during a normally stressful period. Aircraft-noise disturbance of beluga whales from flyovers generally is very transient, with events lasting not more than a few seconds (Stewart, Aubrey, and Evans, 1983). Such brief disturbances are not likely to have any serious consequences to beluga whales.

Major stationary sources of airborne noise include construction of onshore facilities, dredging, and drilling operations. These activities may disturb hauled-out seals, walruses, and polar bears occurring within a few kilometers of the noise sources. Industrial activities and human presence near polar bear dens pose a potentially serious disturbance. Experience with captive female polar bears suggests that these bears can be especially sensitive to noise and human presence during maternity denning. However, preliminary results of seismic-noise measurements taken within a simulated polar bear den suggest that seismic activities or other noise sources would be detected by denning bears only if such activities occurred very near the dens (Lentfer, 1983, oral comm.). Nevertheless, human scent and other noises near maternity dens also may disturb the bears.

(2) Waterborne Noise: Sound is more efficiently transmitted and travels at a greater velocity in water than in air. Underwater-sound-propagation loss is higher in shallow water than in deep water (Greene, 1981). Bottom material, structure, and the undersurface of ice cover strongly influence sound transmission. Propagation of most sound frequencies is greater in summer than in winter (Greene, 1981). Mobile sources of industrial-underwater noise primarily include support vessels, icebreakers, seismic boats, and aircraft; stationary sources include active dredges, drill rigs, drillships, and offshore-production and -processing facilities.

Underwater noise may alarm beluga whales, pinnipeds, and polar bears, causing them to flee the sound source. For example, Fraker, Sergeant, and Hoek (1978) reported the startled response and flight of beluga whales from barges and boats traveling through a whale-concentration area. Finley and Davis (1984) reported strong fleeing reactions by beluga whales when icebreaker ships approached at distances of 35 to 50 kilometers in two documented cases. The whales were displaced or moved over 80 kilometers along the ice edge, or they stopped moving within 20 kilometers when they reached coastal waters (Finley and Davis, 1984). Stewart, Aubrey, and Evans (1983) reported that beluga whales responded to outboard-motor noises by immediately moving downriver away from the source, but whale exposure to playback recordings of drilling sound had little effect on the movement and general activity of the whales. Reactions of beluga whales or pinnipeds to noise sources, particularly mobile sources such as marine vessels, are likely to be highly variable depending on the animals' prior exposure to the disturbance source and their need to be in a particular habitat area where they are exposed to the noise and visual presence of the disturbance sources. For example, beluga whales foraging within the busy fishing grounds of Bristol Bay may be more tolerant of boat traffic, with shorter recovery times and shorter displacement distances from passing fishing vessels, than the migrating belugas that reacted to icebreaker traffic in Lancaster Sound (high Canadian arctic) as reported by Finley and Davis (1984). The latter whales may have been "naive" with respect to vessel noise (Finley and Davis, 1984).

Underwater noise may interfere with or mask reception of marine mammal communication, or it may interfere with reception of other environmental sounds used by marine mammals for navigation (Terhune, 1981). Noise produced by outboard motors operating at high speeds may have the greatest potential for interfering with beluga whale communication and some echolocation signals (Stewart, Aubrey, and Evans, 1983), but exposure to this interference source is likely to be very transient. Low-frequency noises from drilling platforms would not mask the high-frequency-echolocation signals of beluga or other toothed whales (Gales, 1982). Theoretically, very noisy drill platforms may slightly mask low-frequency whale sounds out to a range of 56 kilometers, but the possible masking range would more likely be limited to about 5 kilometers (Gales, 1982). If the distance between communicating whales does not exceed their distance from the platforms, no appreciable interference is likely to occur (Gales, 1982). Experiments exposing captive beluga whales to recorded drilling sounds suggest that whales can acclimate quickly to typical oil-drilling-sound levels (Aubrey et al., 1984). Anecdotal observations of beluga whales near drilling platforms in Cook Inlet support this suggestion (McCarty, 1981).

Intense noise could damage the hearing of marine mammals or cause other physical or physiological harm (Hill, 1978; Geraci and St. Aubin, 1980). The most intense noise that was associated with offshore industrial activity probably was the use of explosives in seismic-survey work (generally no longer used in seismic exploration). The sound pressure from these sources is very high and might physically injure or kill marine mammals near the explosion site. However, if spherical spreading of sound pressure is assumed, the pressure would fall below a harmful level at 2,752 meters (3,000 yards) from the source; and nonauditory effects would be unlikely (Gales, 1982). Loss of hearing or auditory discomfort still may occur at greater distances from this noise source. Noise levels measured from various existing drilling platforms are generally well below a level of high sensitivity (for toothed cetaceans such as beluga whales and pinnipeds such as harbor seals) at a distance of 15 meters from the platform (Gales, 1982). This information suggests that drilling operations are not likely to cause any annoyance to nonendangered cetaceans and pinnipeds, except perhaps to individuals passing very close to the platforms (within 15 meters). The playback of recorded industrial-drilling, seismic, and track-vehicle noises in the presence of breeding ringed seals indicated no effect or no reduction in ringed seal vocalizations or other sounds made by the seals (Cummings et al., 1984).

Frequent and/or intense noise that causes a flight or avoidance response in marine mammals theoretically could permanently displace animals from important habitat areas. However, the monitoring of beluga whale behavior and distribution for the past 10 years in the Mackenzie River Delta estuary (in association with marine traffic supporting Canadian oil and gas activities) has not shown any long-term or permanent displacement from the estuary, even with the presently comparatively high levels of industrial activity (Fraker, 1983). The presence of several thousand beluga whales, seals, and walruses in Bristol Bay during intensive commercial fishing activity and their exposure to noise from numerous fishing boats strongly suggests that these species and other marine mammals can habituate to fairly high levels of human activity.

(3) Site-Specific Noise and Disturbance Effects: Primary sources of noise and disturbance of pinnipeds, polar bears, and beluga whales would come from the one or two helicopters per platform, an average of thirteen barges per year, two to four drilling units and six support icebreakers, and three supply boats associated with the two to four exploration platforms and nine production platforms of the proposal (see Secs. II.A.2 and II.A.3). Secondary disturbance sources would be low-frequency noises coming from drilling operations on a maximum of four exploration and nine production platforms. Helicopter traffic (124-810 round trips/platform/month) from airports in Barrow or Wainwright to the drilling platforms would be the primary disturbance source to spotted seals hauled out on the beaches along Icy Cape, Kasegaluk Lagoon, and Peard Bay, and to walruses and bearded and ringed seals hauled out on the ice. Most exploration drilling would probably be conducted during the open-water season using two to four ice-strengthened drilling units supported by six icebreakers (ice-management vessels) per year. These vessels would probably enter the sale area from the south when the pack ice retreats in June, and leave the area toward the south when freezeup occurs in September, using the primary lead system. Therefore, this vessel traffic may coincide with walruses, seals, and beluga whales migrating to and from the sale area using the same general lead system or route.

Vessel traffic generally has been demonstrated to temporarily disturb marine mammals within a few kilometers of the vessel and cause flight reactions within about 1 kilometer. However, icebreaker traffic has been demonstrated to disturb beluga whales within 35 to 50 kilometers of the vessel (Finley and Davis, 1984). Other than flight responses, the meaning or importance of behavioral changes correlated with the sound and presence of boats is uncertain. The vessel traffic, especially icebreakers actively breaking ice, could interfere with migration when the vessels are near marine mammal concentrations within a lead system; and it may temporarily interrupt the local movements of beluga whales, seals, and walruses or displace some hauled-out pinnipeds when the vessels pass through the area. However, there is no evidence to indicate that vessel traffic would block or significantly delay marine mammal migrations. In fact, severe ice conditions are likely to have a far greater influence on spring and fall migrations than vessel traffic associated with the proposal. Such traffic is not likely to have more than MINOR effects on marine mammal migrations or distributions, but the displacement of pinnipeds, polar bears, and beluga whales could temporarily affect the availability of these animals to subsistence hunters. Icebreaker activity also may physically alter some local ice habitats along the ships' tracks and destroy a few ringed seal lairs in pack-ice areas, perhaps crushing or displacing a few ringed seal pups and perhaps displacing some denning polar bears on the sea ice. The number of seals lost or displaced and polar bears displaced probably would be few and would result in a NEGLIGIBLE or MINOR effect on the population.

Helicopters flying to and from drilling platforms (124-810 trips/month) could greatly disturb hauled-out seals and walruses, causing them to charge in panic into the water. If walrus-nursery herds hauled out on the ice are greatly disturbed by low-flying aircraft, injury or death to young calves could result from the stampede of cows into the water. Because of frequent low visibility due to fog, aircraft may not be able to avoid disturbing walruses and seals hauled out on the ice. Although this type of disturbance would be very brief, the effect on individual walruses, particularly calves, could be severe. The number of walruses and seals affected would be dependent on the number of disturbance incidents. Because the walrus-nursery herds are widely distributed along the ice front and lead system during the spring and summer, the helicopter flights to and from the drilling platforms are not likely to disturb a major portion of the walrus population. However, death or injury of a small portion of the walrus-calf population is possible. Aircraft disturbance of spotted seals hauled out along the coast or disturbance of ringed or bearded seals on the ice is not likely to result in the death or injury of any seals, although increases in physiological stress caused by the disturbance may reduce the longevity of some seals if disturbances are frequent. Effects of aircraft disturbance on seals and walruses are likely to be MINOR.

Geophysical seismic surveys have been conducted in the Chukchi Sea; more surveys will be conducted in the Sale 109 area using boats during the open-water season rather than on-ice equipment during the winter (7,979 trackline kilometers for exploration and 10,392 trackline kilometers for development [Table II-1]). Thus, ringed seal pupping in shorefast-ice habitats would not be affected by seismic exploration in the sale area. However, seismic boats could disturb marine mammals during the open-water season. As with other boat traffic, active seismic activities are likely to result in startle responses by seals, walruses, and beluga whales near the sound source. This disturbance response is likely to be brief, with the affected animals returning to normal behavior patterns within a few hours after the seismic vessel has left the area. Noise and disturbance from seismic boats and other vessels could be a temporary problem if boat traffic moved north and south along the coast very near Kasegaluk Lagoon and interfered with beluga whale and spotted seal movements to and from the lagoon. If noise and vessel traffic associated with the proposal occurred near this lagoon and reduced or delayed the use of the lagoon by beluga whales or spotted seals, the availability of these subsistence resources to villagers could also be affected for one season. However, because Federal blocks that may be leased are at least 5 kilometers from the coast, disturbance of whales and seals in or near Kasegaluk Lagoon is not likely to occur. Seismic activities in the Sale 109 area are likely to have MINOR disturbance effects on pinnipeds and beluga whales.

c. Effects of Drilling Discharges: Under the proposal, the drilling of an estimated 20 exploration, 23 delineation, and 153 production wells would result in the deposition of over 350,000 maximum total dry metric tons of drilling muds and cuttings over the 30-year life of the field. These discharges could have local effects on the benthic prey of walruses and bearded seals within about 100 meters of the four exploration and nine production platforms. However, the amount of benthic habitat and number of benthic prey affected is likely to be small (probably less than 1% of that available to walruses in the sale area) and would not appreciably reduce the availability or suitability of prey organisms for walruses and bearded seals or other marine mammal populations. The effect of drilling discharges on pinnipeds, polar bears, and beluga whales in the Sale 109 area is likely to be NEGLIGIBLE.

d. Effects of Construction Activities: Under the assumed offshore exploration and development scenario, a maximum of four exploration platforms and nine oil-production platforms would be operating in the sale area. Some seals, walruses, polar bears, and beluga whales could be temporarily displaced by noise and disturbance associated with platform installation, operation activities, and air- and vessel-support traffic. Temporary displacement could occur within a few kilometers of the platforms and along the support-traffic route used during installation (construction) and production operations (MINOR effects). Some benthic habitats and prey organisms could be temporarily disrupted or buried at and near the 400-kilometer-trunk-pipeline and platform-installation sites, but the availability of abundant and widely distributed prey organisms would not be significantly reduced. Effects on prey availability would be NEGLIGIBLE.

Some marine mammals could be temporarily displaced for approximately one season near the nine platform-installation sites and along the estimated 400-kilometer pipeline path during trenching and laying operations. In theory, marine mammals could continue to be disturbed; and perhaps migration movements and habitat use could continue to be diverted a few kilometers away from the nine platforms over the life of the field, possibly representing a MODERATE effect on distribution. However, the amount of displacement and change in habitat use is likely to be very small in comparison to the natural variability in seasonal habitat use and variations in migration patterns. Thus, noise-disturbance and adverse habitat effects associated with platform and pipeline installation and construction in the Sale 109 area are likely to be MINOR.

Under the assumed scenario, onshore development of a 30-hectare pipeline terminal and support facility would take place at Point Belcher with a 640-kilometer onshore pipeline connecting Point Belcher to TAP Pump Station No. 2. During construction activities, this development could disturb and temporarily displace some spotted and ringed seals and polar bears within 1 to a few kilometers of Point Belcher for one season or 1 year. However, the number of animals disturbed would be few; and the amount of coastal habitat altered would be very local near the 30-hectare shorebase and docking facility. Thus, onshore-development effects on marine mammals in the Sale 109 area are likely to be MINOR.

SUMMARY: The seven estimated oil spills are most likely to contact walruses; bearded, spotted, and ringed seals; polar bears; and beluga whales in the migration corridor between Point Hope and Point Barrow during the spring- and fall-migration periods or within the drifting pack-ice front west of Icy Cape during the winter. Large numbers of walruses, perhaps several hundred to several thousand, could come in contact with spills; but only highly stressed adult walruses and calves are likely to die. If oil-spill contact with several thousand Pacific walruses occurred, mortality from the seven spills is likely to be low, even though the possible deaths of several hundred contaminated walruses involved may result from natural causes due to high population stress and overpredation of food sources. These oil spills are likely to have a MINOR effect on the Pacific walrus population. No more than a few hundred seals are likely to contact oil, and only highly stressed adults and young pups are likely to die and be replaced within one generation (MINOR effects). If portions of an oil spill melted out near Wrangel Island during the summer, a few to probably no more than about 30 polar bears could be directly contaminated. However, no more than a few polar bears are likely to come in contact with oil slicks and die as a result because the majority of the polar bears leave the island before ice breakup, when the spills melt out of the ice.

Oil-spill effects on food sources of ringed and spotted seals and beluga whales are likely to be NEGLIGIBLE on the regional populations (or local assemblages) of these species due to the very local number of prey affected by the seven spills and the rapid recruitment of these prey organisms. Oil spills may have some long-term, local effects on the benthic prey of walruses and bearded seals; however, the amount of benthic habitat and benthic prey affected is not likely to reduce the overall amount of benthic-prey organisms available to walruses and bearded seals in the sale area. Therefore, the effect on walruses and bearded seals from local changes in quality and quantity of benthic prey due to the seven oil spills is likely to be MINOR. The overall effect on these marine mammals from oil spills occurring in the Sale 109 area is likely to be MINOR.

Noise and disturbance from air traffic (124-810 helicopter flights/month) associated with the proposal could have some lethal effects on walruses (especially calves) hauled out on the ice while migrating through the sale area during the spring migration and during summer. Disturbance from low-flying aircraft could result in injury or death to walrus calves when the adults stampede into the water; however, the walrus herds are widely distributed along the ice front, and only a small portion of the calf population is likely to be disturbed by aircraft and injured. The occasional disturbance and resultant injury or death of a few walruses are likely to have a MINOR effect on the calf population. Overall aircraft-disturbance effects on the above marine mammals in the Sale 109 area are likely to be MINOR.

Noise and disturbance from marine-vessel traffic (2-4 drillships, 6 icebreakers, 3 supply boats, 1-2 work boats, and an average of 13 barge trips/year) associated with the proposal--particularly traffic through the primary lead system--could temporarily interfere with the migration of some beluga whales, seals, and walruses near the vessels for a few hours up to perhaps a few days. However, marine traffic from the proposal is not likely to block or significantly delay marine mammal migrations. Severe ice conditions are certain to have far greater influence on spring and fall migrations than vessel traffic associated with oil exploration and development. Seismic boats and other marine traffic that may occur near Kasegaluk Lagoon and Peard Bay could temporarily displace (for a few hours) beluga whales and spotted seals from these important habitats. Overall noise and disturbance effects on marine mammals in the Sale 109 area are likely to be MINOR.

Offshore construction involving the installation of nine production platforms and trenching for a 400-kilometer pipeline are likely to have local, short-term-disturbance effects on pinnipeds, polar bears, and beluga whales and

NEGLIGIBLE effects on the availability of food organisms. Shorebase construction at Point Belcher (30 hectares) is likely to cause MINOR disturbance effects (temporary displacement during construction) on ringed and spotted seals. The combined effects of oil spills and other discharges (muds and cuttings), noise and disturbance, and onshore and offshore construction on marine mammals in the Sale 109 area are likely to be MINOR because the number of seals, walruses, polar bears, and beluga whales killed or seriously affected is likely to be replaced within less than one generation and the amount of habitat lost due to development would not affect overall population distribution or abundance.

CONCLUSION (Effect on Pinnipeds, Polar Bears, and Beluga Whales): The effect of proposed Sale 109 on pinnipeds, polar bears, and beluga whales is expected to be MINOR.

CUMULATIVE EFFECTS: The additive effects of other ongoing and planned projects, as well as the proposal, on ringed, bearded, and spotted seals; walruses; polar bears; and beluga whales are discussed in this section. Although the probability of any or all ongoing and planned projects reaching developmental stages is generally unknown, this analysis assumes that all of them reach developmental stages. These projects could affect marine mammals by oil spills, noise and disturbance, and by habitat alteration from construction activities. The State of Alaska lease sales discussed below have been deferred from the current State 5-year lease schedule; however, these sales may be reinstated and are therefore evaluated.

Cumulative Effects of Oil Spills: Cumulative oil-spill risk from possible Canadian-oil tankering through the Sale 109 area and risk from Beaufort Sea oil leases add very little additional oil-spill risk to marine mammal habitats shown in Figures IV-20 and IV-21. Oil-spill risks to Wrangel Island and the drifting pack ice west of Point Barrow increase slightly during the winter season (Fig. IV-20, Sea-Ice Segments 8, 9, and 10), while spill risk to the migration corridor between the Bering Strait and Point Barrow increases slightly during the open-water season (Fig. IV-21, Migration-Corridor Sections A, B, and C). In the cumulative case, a total of seven oil spills of 1,000 barrels or greater is estimated for all Federal and Canadian oil and gas activities in the Chukchi and western Beaufort Seas, with nearly all of the oil-spill risk related to the proposal.

Most of the oil spills that could occur from Beaufort Sea leases would move westward north of the Sale 109 area and would not contact marine mammal habitats within the sale area. Pinnipeds (walruses; ringed, spotted, and bearded seals), polar bears, and beluga whales are likely to suffer low mortality rates from oil-spill contact or habitat contamination associated with the seven oil spills over the life of cumulative oil exploration, development, production, and transportation in the Chukchi Sea, and as the result of cumulative oil spills in the Bering and Beaufort Seas. Only very young seal pups and young walrus calves are likely to die from oil-spill contact due to loss of thermo-insulation and increases in physiological stress, respectively. Oil spills, including one of 100,000 barrels or greater, may contribute to the death of some highly stressed adult pinnipeds and beluga whales. The number of seals and walruses killed from oil-spill contact or habitat contamination from the seven oil spills over the life of the oil-related activities is likely to be no more than perhaps a few hundred, and the number of beluga whales killed is likely to be far less (for example less than 10) due to their probable brief exposure to the oil spills (see discussion above on effects of oil spills under the proposal). Thus, these oil spills are likely to have MINOR effects on pinniped populations and NEGLIGIBLE effects on beluga whales. Polars bears are considered highly sensitive to oil-spill contact and may die from the loss of thermo-insulation and ingestion of large amounts of oil from grooming contaminated fur and perhaps from ingestion of oiled seals. However, because of the polar bears' sparse distribution and low density, few are likely to encounter one or any of the seven oil spills estimated to occur over the life of the oil-related activities in the sale area. In a severe situation, a concentration of perhaps 30 or 40 polar bears may encounter an oil spill in a lead system or polynya and 30 to 40 may eventually die from oil contamination. Even with seven oil spills estimated to occur in the sale area, the loss of perhaps 30 or 40 polar bears is not likely to occur more than once or twice over the life of the oil-related activities in the arctic. The total loss of perhaps 100 bears over the 30-year life of the proposal or over the life of other oil activities is likely to represent a MINOR effect on the polar bear population, with recruitment replacing lost individuals within one generation.

Cumulative Effects of Noise and Disturbance: The primary sources of cumulative noise and disturbance of pinnipeds, polar bears, and beluga whales is air and vessel traffic from offshore industrial activities and air, and to some extent ground-vehicle, traffic along the coasts of the Chukchi, Bering, and Beaufort Seas associated with onshore construction activities. Most of the offshore air traffic would be the 124 to 810 helicopter round trips per month to and from the four exploration and nine production platforms in the Sale 109 area and from similar platforms that could be associated with proposed Federal OCS and possible State Hope Basin oil and gas leases, and OCS leases in the Bering and Beaufort Seas. Because of frequent low visibility due to fog, some of these aircraft flights may not be able to avoid disturbing walruses and seals. Although this type of disturbance would be very brief, the effect on individual walrus calves and seal pups could be severe. Some walrus calves could be seriously injured or killed by trampling from frightened adults, while some spotted and bearded seal pups may be abandoned by disturbed female seals. Because the walrus-nursery herds and pairs or small groups of seals are widely distributed along the pack-ice front, the helicopter flights are likely to temporarily disturb a small portion of the walrus and seal populations. Thus, offshore air traffic is likely to have a MINOR effect on seals and walruses. Disturbance of polar bears and beluga whales from this air traffic is also likely to be very brief, resulting in no injury or abandonment of young and probably having an inconsequential (NEGLIGIBLE) effect on these species.

Cumulative vessel traffic in the Chukchi Sea primarily during the summer (open-water) season would include the following: an average of 13 barges per year, two drillships, three support vessels, and six icebreakers for the proposal; one to as many as 24 tugs, and two to as many as 50 barges associated with the Prudhoe Bay Sealift traffic through the sale area during the summer; and approximately 16 to 20 bulk-ore carriers, tankers, and supply ships per year that could be present in the southern Chukchi Sea in association with the Red Dog Mine Project. Some of this vessel traffic, particularly drillship and icebreaker traffic, may coincide with the spring migration of seals, walruses, and beluga whales into the sale area. However, most of the barge, tug, and ship traffic would occur during the summer when seals, walruses, and polar bears would be congregated along the drifting-pack-ice front north of the vessel traffic. In general, this vessel traffic would temporarily disturb marine mammals within a few kilometers of the vessels and cause flight reactions within about 1 kilometer. However, the icebreaker traffic could disturb and cause flight reactions of some species, such as beluga whales within up to 35 to 50 kilometers of active icebreaking activities, as reported by Finley and Davis (1984). The above boat traffic, especially active icebreakers, could temporarily interfere (for probably no more than a few days) with beluga whales and pinniped migrations when the vessels are within the lead system; and the traffic may temporarily interrupt local movements of beluga whales, seals, and walruses in coastal areas such as Kasegaluk Lagoon or displace some hauled-out spotted, ringed, and bearded seals when the vessels pass nearby. There is no evidence to suggest that this vessel traffic would block or greatly delay beluga whale or pinniped migrations. In theory, active icebreakers could delay migration of belugas for more than a few days if the icebreakers remained in the lead system actively breaking ice for several weeks such that the whales refused to pass by the ships in the lead system and did not habituate to the icebreaker sounds. In theory, a delay in migration of the whales for several weeks could significantly reduce food-source availability and, in turn, reduce productivity and survival of some of the whales for perhaps more than one generation, representing a MODERATE effect on the population. However, the six icebreakers associated with exploration under the proposal (no icebreakers associated with other vessel traffic) are not likely to be used in the sale area or lead system until after most of the whales have migrated through the sale area during the spring. Thus, effects are likely to be MINOR.

Air and ground-vehicle traffic along the coast of the sale area would include the takeoffs and landings of the six helicopters dedicated for use with the proposal at Wainwright or Barrow, fixed-wing air traffic associated with the airstrip assumed to be built at the Point Belcher shorebase, gravel-truck traffic at Point Belcher associated with construction of the pipeline corridor to the TAP, and all-terrain-vehicle and snowmobile traffic associated with the local communities, State of Alaska oil-lease activities, and the North Slope Borough. This traffic would create brief sources of noise and disturbance of spotted and ringed seals that haul out along the coast of the sale area, and occasional disturbance sources to polar bears when they frequent the coastline.

Most disturbance events associated with aircraft and ground vehicles on spotted and ringed seals and polar bears would be brief and of little consequence; but increases in the frequency of disturbance events may reduce the use of coastal habitats by seals and polar bears over time and may have a temporary effect on the distribution of some spotted seals--particularly in their use of some haulout sites, and may reduce polar bear denning along the coast.

Cumulative Effects of Construction Activities: Offshore-construction activities would include the installation of the nine production platforms and the trenching and laying of 400 kilometers of offshore trunk pipeline in the Sale 109 area, and construction of a short causeway for a ship terminal associated with the Red Dog Mine Project south of the Sale 109 area. Although these activities would have local effects on benthic organisms through removal or burial of benthic sediments, they would have NEGLIGIBLE effects on the availability of food sources to ringed and spotted seals and beluga whales--because these species do not rely on benthic organisms in local areas but rather prey on a variety of abundant mobile fishes and invertebrates not affected by platform-, pipeline-, and causeway-construction activities. Very small numbers of benthic prey of walruses and bearded seals would be temporarily reduced at the construction sites for probably one season or 1 year, although some benthic-prey species could be reduced locally for several years at construction (causeway, platform) sites. However, the number of benthic prey of walruses and bearded seals removed or destroyed at platform, pipeline, and causeway sites is likely to have no more than a MINOR effect on the availability of food organisms to walruses and bearded seals.

Cumulative onshore construction would include possible NPR-A oil development, possible State Sale 53 oil development in the Icy Cape/Kasegaluk Lagoon area, the Red Dog Mine Project, as well as the pipeline corridor and support facilities associated with Sale 109. Onshore construction of the proposal's pipeline landfall at Point Belcher may include burial of the pipeline on the beachhead.

During construction, the deposition of gravel and heavy-equipment noise could temporarily displace a few ringed and spotted seals and perhaps polar bears within about 1 kilometer of Point Belcher. Onshore construction near Kivalina of a ship terminal associated with the Red Dog Mine Project and construction of onshore facilities associated with State oil development would have similar temporary-displacement effects on spotted and ringed seals and polar bears along the Chukchi Sea coast during construction activities. Thus, cumulative onshore-construction effects on pinnipeds and polar bears are likely to be MINOR.

Overall Cumulative Effects: Most of the seven potential oil spills estimated to occur in the Sale 109 area are assumed to be associated with the proposal rather than with the other projects listed in Table IV-2. Spill-contact risk to pinnipeds and polar bear habitats on drifting pack ice and in the Wrangel Island area exceed 60 percent during the winter season (Fig. IV-20), while spill-contact risk to the pinniped- and beluga whale-migration corridor offshore between Point Hope and Point Barrow during the summer is 60 percent or greater within 10 days of spill release (Fig. IV-21, combined spill risks to Migration Corridor Sections A and B). Thus, habitat contamination is likely to occur anytime of the year; and all six species of nonendangered marine mammals (ringed, spotted, and bearded seals; walruses; polar bears; and beluga whales) are likely to be exposed to more than one of the seven oil spills, including a possible 100,000-barrel-or-greater spill. However, pinnipeds (walruses; ringed, spotted, and bearded seals), polar bears, and beluga whales are likely to suffer low mortality rates from oil-spill contact or habitat contamination from cumulative oil spills in the Chukchi, Bering, and Beaufort Seas. Only very young seal pups; young walrus calves; highly stressed adult seals, walruses, and beluga whales; and a few polar bears (due to their sparse distribution and low density) are likely to die from oil-spill contact or habitat contamination.

The cumulative reduction in benthic-food organisms from the estimated seven oil spills would occur only in local areas where the oil spills may contaminate bottom material or sediments. The amount of benthos affected by the spills is likely to have no more than a MINOR effect on the availability of walrus or bearded seal food sources and NEGLIGIBLE effects on the availability of ringed and spotted seal, polar bear, or beluga whale food sources.

Cumulative air and vessel traffic associated with Sale 109, the Prudhoe Bay Sealift, proposed Federal OCS Sale 133 in the Hope Basin, and OCS leases in the Bering and Beaufort Seas, possible State oil-lease activities, and the Red Dog Mine Project would include at least 124 to 810 roundtrip aircraft flights per month from the proposal, some icebreaker and drillship traffic (8-10 ships) during the spring and fall, 15 to as many as 100 barge trips per year, as many as 24 tugs, and 16 to 20 bulk-ore carriers and supply ships during the open-water season. The aircraft traffic could cause the death or injury of some walrus calves and the possible abandonment of a few seal pups by their mothers, but these losses are likely to be MINOR to seal and walrus populations. The vessel traffic, particularly icebreaker ships used during exploration under the proposal, could temporarily interfere with beluga whale migration; but the level and timing (late June-July) of icebreaker traffic is not likely to greatly delay beluga whale migration, and effects are likely to be MINOR. Vessel-traffic disturbance of pinnipeds and polar bears would be brief and would have NEGLIGIBLE effects on these species (see Sec. IV.B.6). Cumulative ground-vehicle and air traffic onshore or along the coast could temporarily displace ringed and spotted seals hauled out along the coast, particularly near support facilities such as the shorebase at Point Belcher for Sale 109. In theory, if disturbance of hauled-out spotted seals--such as along Kasegaluk Lagoon--were frequent, some of the primary spotted seal-haulout sites might be permanently abandoned, representing possible MODERATE effects on their distribution. (Coastal air- and ground-vehicle-traffic disturbance of spotted seals from Sale 109 alone is likely to be MINOR.)

Most offshore-construction activities would be associated with Sale 109 and would include the installation of nine production platforms and the trenching and laying of 400 kilometers of pipeline as well as platform installation and pipelaying associated with oil and gas leases in the Bering and Beaufort Seas. This construction would have some local effect on benthic organisms very near the nine platforms and along the pipeline routes, but these local effects are not likely to reduce the availability of food source to any of the seals, walruses, polar bears, or beluga whales (NEGLIGIBLE effects). Onshore construction along the coast would include the pipeline landfall at Point Belcher with gravel deposition, heavy-earthmover-equipment noise associated with facility construction, the building of a ship terminal for the Red Dog Mine Project, and onshore facilities associated with State oil leases. The noise and movement of heavy equipment associated with onshore coastal construction could temporarily displace hauled-out spotted seals during the summer within about 1 or 2 kilometers of construction sites, and could perhaps displace some ringed seals and polar bears from near the sites in the winter or spring during construction activities. The amount of cumulative displacement is likely to include a few square-kilometer areas along the coast where industrial activities are concentrated. This displacement is likely to represent a MINOR effect on the distribution of ringed and spotted seals and polar bears.

The development of industrial facilities along the Chukchi and Beaufort Sea coasts and the attendant increase in the presence of human refuse and galley-food odors, has a strong tendency to attract polar bears to these camps. Human/polar bear encounters are very likely to increase and result in an increased incidental take of polar bears to protect human life and property. At least in theory, this additive loss of polar bears--along with possible increases in subsistence harvest--could have MODERATE effects on the polar bear population.

However, conservation management of the polar bear population would be expected to prevent excessive loss to the population. Thus, cumulative effects are likely to be MINOR.

Conclusion: The cumulative effect of proposed Sale 109 and other ongoing and planned projects on pinnipeds, polar bears, and beluga whales is expected to be MINOR.

7. Effect on Endangered and Threatened Species: Pursuant to the requirements under the Endangered Species Act of 1973, as amended, a formal Section 7 endangered species consultation between the MMS, the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (FWS) was conducted on December 2, 1983, specifically for Barrow Arch Lease Sale 85. On July 12, 1984, Sale 85 was deleted from the revised 5-year leasing schedule. Subsequently, on August 17, 1984, the MMS terminated formal consultation for Barrow Arch Lease Sale 85.

The MMS initiated formal Section 7 consultation for the leasing and exploration phases of Sale 109 on March 25, 1986, with the NMFS and the FWS. The NMFS Biological Opinion for Sale 109 on endangered whales was completed September 1, 1987. The NMFS Biological Opinion concluded that the leasing and exploration phases of Sale 109 are not likely to jeopardize the continued existence of any endangered or threatened marine cetaceans, including bowhead and gray whales. In addition to the Biological Opinion on leasing and exploration, the NMFS also provided its views on the Sale 109 development and production phase: "Based on currently available information and technology and the absence of effective mitigating measures, we believe that development and production activities in the spring lead systems used by bowhead whales for their migration would be likely to jeopardize the population." The NMFS provided the following two reasonable and prudent alternatives that the MMS could adopt to avoid the likelihood of jeopardy from oil spills and noise: ". . .either (1) the lease blocks within 25 miles of the nearshore lead system should be deferred from the lease sale, which would be met by adopting the Coastal Deferral Alternative VI (MMS, 1987), or (2) if leasing and exploration activities occur in these areas, development and production activities should not be approved in these blocks unless and until further consultation results in a no jeopardy conclusion, or a reasonable and prudent alternative is developed and adopted that would avoid the likelihood of jeopardy."

The FWS Biological Opinion on other endangered and threatened species was received on June 24, 1986. The FWS Biological Opinion indicates that Sale 109, as proposed, is not likely to jeopardize the continued existence of the threatened arctic peregrine falcon (the only listed threatened or endangered species considered in this opinion). However, this opinion addresses only those activities pertaining to oil and gas leasing and exploration. Consultation on the aspects of development and production from this sale will require a Biological Assessment addressing activities associated with these phases prior to their commencement. (See Appendix B for documentation of the Sec. 7 consultation process for this lease sale.)

a. Effect on Bowhead Whales: During the 5 months of the year that bowhead whales are most likely to be in the Sale 109 area (see Sec. III.B.5), they would be exposed to the potential for harm and disturbance as a result of spilled oil and noise associated with petroleum exploration and development and production activities. MMS-sponsored studies have provided some answers as to how bowheads react to these activities and what harm, if any, would result to the population if these activities were conducted in the sale area.

(1) Effects of Oil Spills: Should an oil spill occur, bowhead whales may contact the oil, which could result in several short-term or long-term effects. If a whale encountered oil, short-term effects that have been postulated to occur include baleen fouling, inhalation of hydrocarbon vapors, loss of prey, and/or damage to the skin or sensory organs. Long-term effects could include a change in or abandonment of a particular habitat; synergistic effects to previously weakened, very young or old whales; bioaccumulation of hydrocarbons; and genotoxic and/or other factors resulting in a whale's death.

The number of whales contacted would depend on the size and duration of the spill, the density of the whale population in the area of the spill, and the whales' ability or inclination to avoid contact with oil. Unless whales stopped to feed in the area of a spill or were trapped in a lead into which oil was spilled, contact with oil would be brief. Even a large spill of 10,000 barrels under open-water conditions is predicted to produce a slick which, after 10 days, would cover only 1 to 2 square kilometers (Appendix C, Table C-1). Bowheads migrating at an average speed (about 3 km/hour) would be expected to pass through the discontinuous oiled area in less than 4 hours and of this time would pass through or under actual oil slicks for less than 5 minutes. No more than several hundred bowheads would be exposed to lightly weathered oil from a spill of short duration, since the migration continues for approximately 2 months through any one area. After several days, the spill should have moved out of the whale-migration corridor; and weathering should render the oil relatively harmless to the whales. If a prolonged spill (such as an uncontrollable blowout) occurred at the start of the bowhead migration, most of the whale population could be exposed to lightly weathered crude oil. This event would be extremely unlikely. During the period 1971 through 1983 (the period for which statistics are available), over 13,000 wells were started; no oil was spilled as a result of drilling blowouts; and less than 1,000 barrels were spilled as a result of nondrilling blowouts (USDOI, MMS, 1984c).

If an oil spill/whale interaction occurred, baleen fouling could be a factor affecting the bowhead whale's fitness. Braithwaite, Aley, and Slater (1983) conducted experiments on the interaction of bowhead whale-baleen plates with Prudhoe Bay crude oil. He found that baleen-filtration efficiency could be reduced (but not to a high degree) after contact with crude oil in water. Flow-through experiments indicated that a reduction of 5.9 to 11.3 percent of filtering efficiencies occurred. This reduction persisted for as long as 30 days; but after 8 hours of rinsing, the filtering efficiencies began to increase as the baleen fibers tended not to mat together as much as before. Cleansing rates following an actual oil spill may differ from this study's results since this study utilized fresh crude oil, whereas in an actual spill event whales may contact thicker, weathered oil.

If bowheads contacted an oil slick, it is unlikely that they would inhale oil into the blowhole while breathing (Geraci and St. Aubin, 1980); however, bowheads surfacing in a spill of lightly weathered oil could inhale some petroleum vapors. Inhaled petroleum vapor may result in pulmonary distress. Perhaps the most serious situation could occur if oil were spilled into a lead from which bowheads could not escape. In this case, whales could die or suffer pulmonary distress from the inhalation of toxic vapors. The probability of such an occurrence is extremely low; generally, only a small fraction of the bowhead population would likely occupy the affected lead at any given time and thus be subject to mortality. Vapor concentrations in the spill area that could be harmful to whales would be expected to dissipate within several hours after termination of a spill (Geraci and St. Aubin, 1982). If the spill continued for a long period of time, such as during an uncontrollable blowout, the toxic-vapor effects would be prolonged.

While feeding, bowhead whales sometimes skim the water surface, filtering large volumes of water for extended periods, and consequently may ingest some spilled oil. The effects of oil ingestion on whales probably depend on the quantity and toxicity of ingested hydrocarbons and whether or not the oil is regurgitated and aspirated (Geraci and St. Aubin, 1982). Small doses of oil often result in fatal pneumonia if aspiration occurs, while considerably larger quantities can be tolerated if the oil remains in the gastrointestinal tract (Wolfe, Brodeur, and Shields, 1970; Wolfsdorf, 1976). Toothed whales are protected from aspirating vomited material by a muscular sphincter that surrounds the tracheal opening (Geraci and St. Aubin, 1986); but in bowheads, this sphincter does not encircle the laryngeal tube (Henry et al., 1981), thus allowing for a greater possibility of aspirating vomited material. Ingested oil can irritate the lining of the stomach, damage the liver and kidney, and possibly affect the brain (Narasimhan and Ganla, 1967; Toofanian, Aliakbar, and Ivoghi, 1979). Albert (1981) suggested that ingested oil may possibly coat the bowhead's stomach or intestinal mucosa.

Critical doses for petroleum retained in the gastrointestinal tract have not been determined for bowheads or other cetaceans. Extrapolating from critical doses for fuel oil in the gastrointestinal tract of rats, Geraci and St. Aubin (1986) calculated that a critical dose for an adult bowhead might occur between 200 and 625 liters of oil; however, they concluded that it does not appear plausible that bowheads would swallow this much oil. Another source of ingested oil might come from contaminated prey. Copepods and euphausiids consume small particles of oil that persist unaltered in their digestive tracts (Kuhnhold, 1978). Uninterrupted feeding largely on contaminated prey could pose a threat. However, within a few days, planktonic organisms lose their burden of ingested oil without retaining any residual fractions (Neff et al., 1976); therefore, the potential effect on bowheads would decrease rapidly over time.

In fishes and mammals, ingested hydrocarbons are metabolized by enzyme systems in the liver and excreted in urine. These enzyme systems are ubiquitous in mammals (Gillette, Davis, and Sasame, 1972) and also have been demonstrated in other whale and dolphin species (Geraci and St. Aubin, 1982). Thus, it is reasonable to assume that these enzymes also exist in bowhead whales (Geraci and St. Aubin, 1986). Despite the activity of detoxifying enzymes, certain fractions are not readily cleared by the kidneys; and, as previously mentioned, critical doses are as yet unknown.

In arctic waters, oil weathers at a much slower rate than in temperate waters and, therefore, retains toxic properties longer and increases the time during which bowhead prey could be exposed to toxic components. Published studies indicate that pelagic organisms (such as euphausiids) are more sensitive to oil than either benthic or intertidal organisms (Rice et al., 1985). Fishman, Caldwell, and Vogel (1985) conducted experiments on the euphausiid Thysanoessa raschii, one of the bowhead's main prey items (as well as a prey item for other arctic marine predators). Flow-through tests on the water-soluble fraction (WSF) of Prudhoe Bay crude oil and T. raschii showed that gravid females had an LC50 (lethal concentration where 50% of the test organisms died) of 1.37 milligrams per liter (mg/l) at day 4 while other adults had an LC50 of 1.58 mg/l at day 10. Observed sublethal effects included longer periods between molts and the narcotizing of organisms upon exposure to the WSF in the test aquaria. If the WSF was high enough, the narcotized euphausiids eventually died. The highest concentration of WSF observed in experimental situations or predicted by spill-dissolution models was 0.6 mg/l in the top few meters of the water column near the slick. Consequently, direct mortality of eggs, larvae, or adult T. raschii is not expected as the result of a spill. Indirect mortality may occur as a result of increased predation on weakened individuals; however, population losses would likely be minimal. The greatest effect predicted would be that a specific group of individuals of a population in a localized area would be affected over a short period of time (Fishman, Caldwell, and Vogel, 1985). This would likely result in no adverse effects on bowheads, which typically search vast areas of ocean for dense patches of zooplankton on which to feed. (Further information on concentrations affecting food invertebrates is detailed in Sec. IV.B.3 of this EIS and Appendix F of the Sale 100 FEIS [USDOI, MMS, 1985c].)

Should whales ingest oil-contaminated prey, bioaccumulation of hydrocarbons can be expected to occur. Geraci and St. Aubin (1985) found detectable levels of naphthalene residues (a hydrocarbon indicator) in most whale tissues sampled for bioaccumulation. Highest levels were found in toothed-whale blubber, particularly from arctic belugas and narwhals (top-level predators feeding on fish that also accumulate hydrocarbons). Lowest levels were found in baleen whales, which generally feed at lower-trophic levels. Storage in adipose tissues, in particular the extensive blubber reserves, may sequester petroleum fractions until a time of extended caloric balance when these reserves are utilized, releasing stored hydrocarbons to circulation (Engelhardt, 1983). However, bowheads may be capable of metabolizing and excreting polynuclear aromatic hydrocarbons from oil; so it is possible that petroleum hydrocarbons would not accumulate to harmful levels in bowhead tissues (Overton, 1985, oral comm.). Albert (1981) found baleen filaments in the gastrointestinal tracts of bowhead whales and suggested that ingested oil, and long baleen filaments that break off of the baleen plates and are swallowed, may clump together to form a gastrointestinal obstruction. However, it is likely that any small quantity of ingested oil would be broken down by digestive processes and would not block the intestine (Hansen, 1985).

Bowhead skin and eyes are two sensory organs that may be sensitive to contact from oil. Ringed seals (which also inhabit ice-infested waters and could expose themselves to surface contamination when breathing) showed a limited toxic response to a 24-hour, surface-oil-slick-exposure study. Eye irritation (severe conjunctivitis) subsided within 1 day after being returned to clean seawater (Geraci and Smith, 1976b). Bowhead whales are not as likely as ringed seals to surface as high and thereby expose their eyes to a surface-oil slick. After moving away from a contaminated area, contact effects on bowhead eyes should be reversible. In laboratory studies of preserved bowhead skin, Haldiman et al. (1981) found that crude oil adhered to the skin, particularly roughened skin areas (lesions). The lesions examined appeared to be confined to the external skin layer, with little or no degenerative changes occurring in the deeper layers of the epidermis (Migaki, 1981). Haldiman et al. (1984) found that bowhead whale skin is keratinized, including the major airways from the blowhole to the larynx. The keratinization may offer some form of physiological protection to bowhead whale skin from contact with spilled oil.

The most likely number of spills of 1,000 barrels or greater associated with Sale 109 is seven. Combined probabilities describe the probability of one or more spills occurring and contacting a target over the expected 30-year life of the field. In summer, possible contacts with one or more spills of 1,000 barrels or greater include the following targets where fall migrating bowheads may be located (Fig. IV-22): Ice/Sea Segments 6 and 7 (33% and 32%, respectively), and three similar targets--Migration Corridor A (87% chance of 2 contacts), Peard Bay Area (56% chance of 1 contact), and Barrow Subsistence Area (76% chance of 1 contact) within 10 days. In winter, one or more spills of 1,000 barrels or greater may occur and contact the following targets where spring migrating whales may be located: Migration Corridors A and B (32% and 23%, respectively) and Wainwright Subsistence Area (77% chance of 1 spill) within 10 days. The probability of a 100,000-barrel-or-greater spill occurring during this time and contacting Migration Corridors B and A is only 1 and 2 percent, respectively. Actual probabilities of contact with bowheads would be even lower because the values described represent contact with whale habitat, rather than contact with whales.

The migration-corridor areas are important to bowhead whales as calving and mating areas (see Fig. IV-22 and Sec. III.B.5). Should a spill occur and contact the ice leads when the bowheads are present, whales may be more likely to contact oil and suffer adverse effects, particularly if they are confined to a lead into which oil is spilling. A high number of spills (7 of 1,000 barrels or greater) is associated with this proposal over 30 years; but due to the low contact probabilities, it is likely that only a specific group of individuals of the population in a localized area would be affected for less than one breeding cycle (approximately 3-6 years). If a whale/oil-spill interaction occurred, the short-term effects expected would be a minimal loss of prey, baleen fouling, and possibly slight skin and/or sensory-organ damage. Therefore, the effects from oil contact on bowhead whales are expected to be MINOR.

(2) <u>Effects of Noise Disturbance</u>: Noise, including seismic exploration, may be the most likely byproduct of typical OCS industrial activities to significantly affect whales (Fraker, Richardson, and Wursig, 1982). Noise-producing activities associated with oil exploration and development include air and vessel traffic, operation of drillships, dredging,

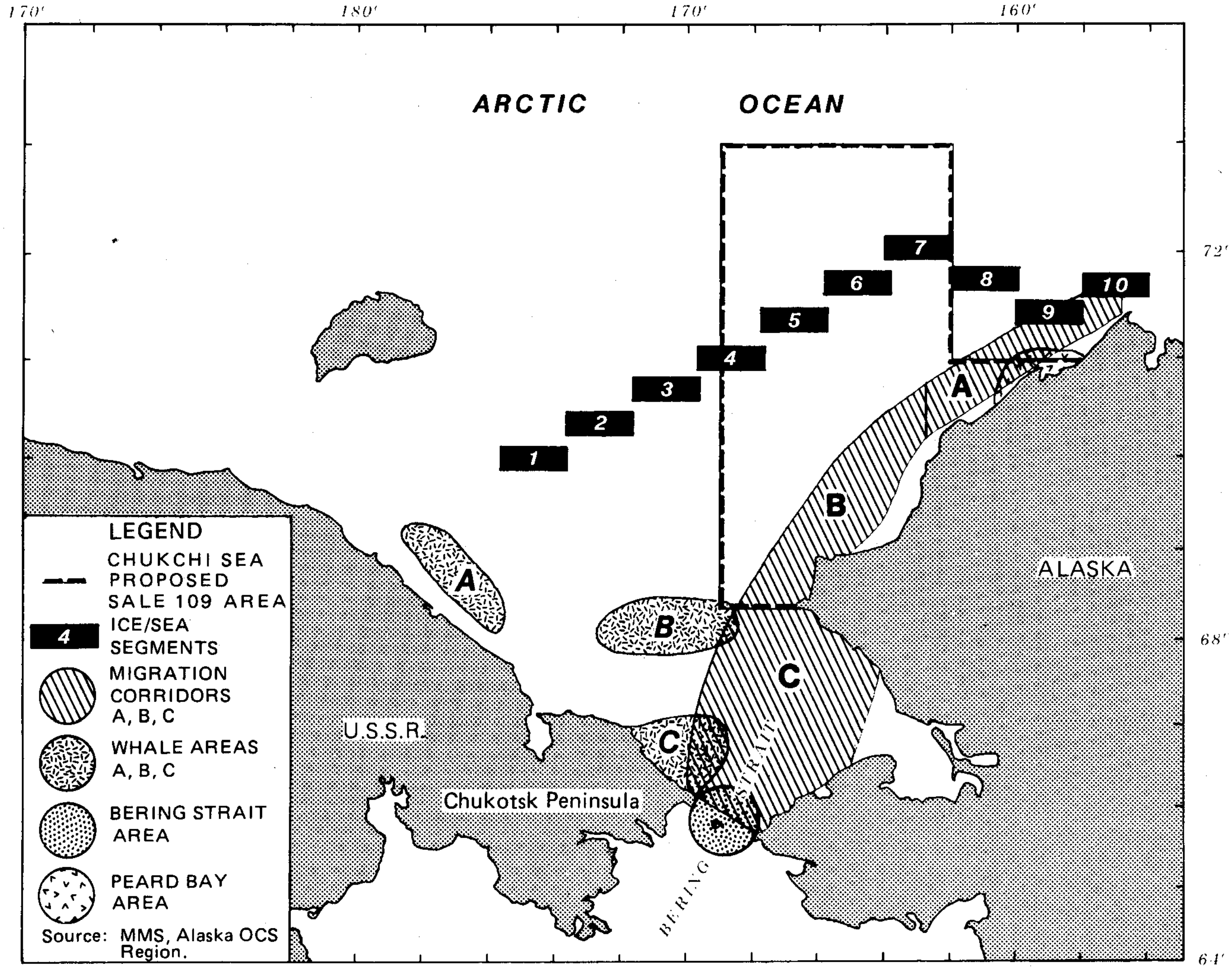


FIGURE IV–22. OIL–SPILL–RISK–ANALYSIS TARGETS USED IN ANALYSIS OF EFFECTS ON ENDANGERED SPECIES and geophysical-seismic exploration. (A Notice to Lessees [NTL] [similar to NTL No. 86-2 for the Beaufort Sea], which specifies performance standards for preliminary activities in the Chukchi Sea, will be issued prior to this sale. This NTL will provide vessel and aircraft operators a description, clarification, and interpretation of requirements and recommendations to avoid disturbance of endangered whales contained in lease stipulations, ITL's, and conservation recommendations provided by the NMFS in its Biological Opinion for Sale 109.)

Some cetacean researchers have expressed concern that, if a sound source is close enough and the intensity loud enough, disturbance and displacement of whales and perhaps physical impairment of cetacean hearing could occur (Braham et al., 1982). Possible effects from high-pressure sounds include startle and flight (rapid escape) responses, hearing loss, and auditory discomfort due to excessive loudness (Gales, 1982). Another possible effect is the masking of desired sounds such as communications. Although little information is currently available on the sounds perceived by large whales (absolute hearing thresholds in baleen whales have not been measured), it is generally assumed that most animals can hear sounds similar to those they produce (Gales, 1982). Therefore, it is assumed that whales are able to perceive sounds associated with typical OCS activities, including geophysical-seismic surveys.

Hearing damage is generally a cumulative process requiring a combination of high sound levels and extended periods of exposure, but damage can be caused by single events over a relatively short period of time (possibly happening during 1 day). The damage process involves a "fatigue" of the auditory-sensory nerves. Because these nerves are able to recover partially during periods of quiet, the time sequence of exposure is important. A continuous exposure is generally more serious than an interrupted one, the latter giving intermittent periods of recovery (Gales, 1982).

For the past several years Richardson, Greene, and Wursig (1985) have studied the reactions of summering bowhead whales to noise disturbance associated with oil and gas development and production in the Canadian Beaufort Sea. All offshore drilling produces underwater noise mainly below 1,000 Hertz (Richardson, Wells, and Wursig, 1983). Available information indicates that the potential zone of influence of most drilling noises may be limited to an area near the drill site (Malme and Mlawski, 1979), since most underwater noise from drilling activities usually cannot be distinguished from the noise associated with support craft. Bowheads have been observed within 4 to 20 kilometers of drillships in the Canadian Beaufort Sea, and industry personnel have reported whales from 0.2 to 5 kilometers from drillships (Richardson, Norton, and Evans, 1984). Therefore, bowhead whales have been observed in areas ensonified by drillships and have appeared to be engaged in normal activities, although exceptions have occurred. These close sightings do not prove that whales are unaffected by drillships, because it is unknown how many more bowheads might have been present had the drillships been absent (Richardson, Norton, and Evans, 1984). Playback experiments (received levels of 100-113 decibels [dB]) showed that some bowheads reacted--although not strongly--to drillship noise at intensities similar to those that would be found 12 kilometers from a real drillship. Some reactions included briefer dives and decreased calling rates. Drilling discharges are not expected to extend beyond a few hundred meters of the drillships, and it is most likely that bowheads will stay out of this area due to ensonification levels.

Observations of bowheads from 1980 to 1983 near artificial-island-construction sites and active dredges in the Canadian Beaufort Sea indicate that some bowheads occasionally tolerate noise levels associated with these activities (Richardson, Norton, and Evans, 1984). In 1983, a few whales remained near the Amerk dredging operations for a couple of days; and, in 1980, many whales were in the vicinity of the Issungnak dredge site for approximately 17 days. Playback experiments showed that bowheads responded to the onset of strong dredging noise, even when the noise level was gradually increased. Reactions to playback noise began at 2.7 kilometers; some whales moved away from the noise source, and others oriented away (Richardson, Greene, and Wursig, 1985).

Experiments with bowheads indicate that they react strongly to closely approaching vessels of any size. Reactions began when boats were as far as 4 kilometers away; at 2 kilometers, travel away from the approaching vessel was more pronounced. Other behaviors consisted of changes in surfacing and respiration patterns and increased spacing within grouped whales. Orientation away from the boat persisted for some time after the boat had passed and sometimes even after the engine had stopped; behavioral patterns returned to normal after several minutes, by which time the boat was several kilometers away. Reactions to boats were stronger and more consistent than to any other type of industrial activity; however, the flight response did not persist for long after the boat had moved away. The scattering of grouped bowheads continued longer than the flight reaction, indicating that some degree of social disruption had occurred (Richardson, Greene, and Wursig, 1985).

Reactions to aircraft were evaluated mostly by assessing bowhead responses to the Islander observation aircraft. Bowheads seem more sensitive to aircraft than other whale species (Richardson, Norton, and Evans, 1984). Bowheads that are engaged in social activities appear to be less sensitive to aircraft than whales engaged in other activities. Reactions to the observation aircraft were conspicuous when the plane was less than 305 meters above sea level, occasional at 457 meters, and seldom at 610 meters. Under near-calm conditions, the aircraft is usually audible for less than 30 seconds when monitored by hydrophones at 9 and 18 meters deep (Greene, 1982).

Studies on bowhead whale responses to acoustical stimuli have been conducted during the summer- and fall-migration periods. Ljungblad et al. (1985b) conducted experiments on the seismic-disturbance responses exhibited by bowhead whales during the fall migration. Data were examined for changes in surfacing, dive characteristics, and respiration. All these behaviors showed changes with exposure to seismic sounds (blow intervals increased, length of surfacing decreased, length of dive decreased, and blow rate decreased). Respiration behaviors began changing at approximately 10 kilometers. As the test vessel approached within 3.5 kilometers, milling and social behavior ceased and all whales moved away from the vessel at a medium-to-fast speed.

In several experiments, a sharp change in behavior was termed a "startle" response--a response to the startup of the airguns. Whales also responded by drawing closer together on the surface (which was termed "huddling") just before swimming away from the vessel. Total avoidance responses began at about 7 kilometers and returned to pre-exposure levels between 30 to 60 minutes after the termination of the experiment. During migration, the strongest responses occurred at less than or equal to 5 kilometers (received levels ranged from 142 to 169 dB relative to 1 micro Pascal [//1uPa]); and recovery began in approximately 30 minutes. Bowheads tested on their summer grounds exhibited strong avoidance reactions (feeding stopped) when vessels were 3 kilometers from them (received levels were less than or equal to 152 dB//1uPa). Thus, during the fall migration, bowhead reactions to seismic surveys occurred at greater distances than during the feeding periods. It was also determined that bowheads could detect the direction from which the impulses were arriving.

This data is in general agreement with the gray whale data in that strong avoidance reactions most often occurred when a seismic vessel was closer than 6 kilometers to the whale and the received level was greater than or equal to 160 dB//1uPa. Richardson, Norton, and Evans (1984) concluded that noise from distant seismic vessels (over 6 km away, received levels less than 160 dB) had no pronounced effect on overt bowhead behavior, despite the high level of seismic noise. Subtle behavior responses (e.g., a brief flight response or a temporary change in migration routes) are possible, although only a few animals would be expected to be temporarily disturbed by distant seismic activities. Direct injury (physical impairment of hearing), even at a close range, is unlikely (California State Lands Commission, 1982).

During observations, whale reactions to noise disturbance range from seemingly undisturbed (slight changes in behavior patterns were evident only after statistical analysis) to strong, overt-avoidance behaviors. During a disturbance interaction, whales are displaced a short distance away and seldom seem to travel more than a few kilometers. The energetic cost of this displacement seems small in comparison to the total energy necessary for migration. However, an interruption of feeding could become significant if industrial activity were sufficiently intense to cause repeated displacement of individuals. A decrease in social interactions (as has occurred in bowheads), or a masking of communication signals might result in cow/calf separations, inability for long-distance communication, or disruption of breeding opportunities. It is generally accepted that whales can hear sound levels similar to those they produce. Therefore, sounds produced by industrial activities in the whales' vocalization range may overlap or mask produced sounds that could limit the whales' acoustical ability to evaluate their environment.

The proposal assumes 20 exploratory and 23 delineation wells, with a maximum of four rigs per year that would operate between August and October. Air support would be out of Barrow and Wainwright with at least one helicopter flight per day per rig. Vessel support would consist of two supply boats and an icebreaker per rig. The production phase would consist of nine platforms and placement of a 400-kilometer offshore trunk pipeline to Point Belcher. All the production platforms would be placed within the 2 years following the end of the exploration phase. For the first 7 years, bowheads would be exposed to industrial noise only during their fall migration; but for the remainder of the life of the field, the whales also would be exposed during the spring-migration period.

During exploration, most disturbance to bowheads would occur during their fall migration around Point Barrow from support traffic (air and vessel) traveling from Point Barrow to the sale area. During development, the concentration of noise-producing activities around Point Belcher may cause bowheads to deflect their migration path farther offshore.

During the exploration phase, approximately 8,000 trackline kilometers of high-resolution seismic surveys are anticipated. During the development and production phases, approximately 1,600 trackline kilometers of high-resolution seismic surveys are expected to facilitate pipelaying activities; and approximately 8,800 trackline kilometers of deep-resolution surveys are expected. Because these surveys would occur during the open-water season, only the fall migration would experience disturbances from these activities. Any displacement or masking of communications would have only short-term effects on a specific group of individuals. These activities would occur until all offshore facilities are permanently in place. Seismic exploration (low-resolution) is the one offshore activity that creates intense sounds over large areas. Greene (1982) found that sleeve-exploder (low-resolution) signals did not diminish to 150 dB until they had propagated 8 kilometers. If baleen whales are as sensitive to low-frequency sounds as other marine mammals are to moderate frequencies, noise within a few kilometers from a seismic ship might cause discomfort (Richardson, Wells, and Wursig, 1983). The seismic surveys occurring around Peard Bay/Point Belcher could result in the most disturbance (seaward displacement could occur), since many whales migrate along this area. Noises produced during the exploration and development/production phases are most likely to result in MINOR effects on bowhead whales.

(3) Effects of Oil Spills and Noise Disturbance in the Spring Lead System: From April through June each year, the entire Western Arctic bowhead whale population passes through the sale area on its northward migration. This migration is thought to be restricted mainly to open-water leads in the flaw zone, although whales have been known to swim under the ice and push up and crack ice in refrozen leads in order to respire (Krogman et al., 1986). A number of agencies and individuals have expressed concern regarding possible adverse effects on spring-migrating bowhead whales from oil spills and petroleum-industry noise associated with Sale 109 in or near the spring lead system. The following discussion represents an assessment of effects of petroleum-industry activity on bowhead whales in the spring lead system. This assessment is necessarily speculative since bowheads have never been observed in the presence of an oil spill; however, inferences from related species have been made where appropriate.

One topic of particular concern is the potential effect on bowheads of oil spilled into the lead system. A number of factors associated with a spill in the lead system could influence the number of whales contacted and the severity of effects, including timing of the spill, volume, spill rate, type of oil or petroleum product, discharge point (surface or bottom), weather conditions (winds and temperatures), currents, size and stability of the lead or polynya, whale-migration characteristics, rate (low rate vs. migratory pulse), age or size of the whales (adults vs. cow/calf pairs, etc.), behavior (purposeful migration vs. feeding or milling), the bowhead's ability or inclination to avoid contact with oil, length of time exposed to oil, sources of noise or disturbance in the vicinity of the spill, and effectiveness of the containment or cleanup operations. Given the number of factors involved in governing potential effects on bowheads, the levels of effects are likely to be variable.

The fate and behavior of oil spilled into arctic waters is discussed in Section IV.A.2 and is supplemented by this discussion. Both surface and subsurface spills form surface slicks and weather similarly. Ice present in the lead could restrict the spread of the oil, resulting in a spill area smaller than that predicted for open-water conditions. The combination of lead/matrix pumping and agitation of grease (newly formed)-ice against larger ice floes would result in an initial increase in oil dispersion into the water column; however, this process would quickly cease as small-scale grease-ice/oil mixing and agitation against the more stationary ice floes can result in significant water-in-oil emulsification in as short a time as a few hours. The water-in-oil emulsification may reside just under the grease-ice at the grease-ice/seawater interface. Grease-ice and any spilled oil would be blown downwind and would eventually accumulate in a band along the downwind edge of open leads. When the lead closed, the accumulated grease-ice and oil would be pushed onto the adjacent ice (Payne et al., 1984b). In this way, leads could be purged relatively soon after cessation of a spill. In any case, it is unlikely that oil would completely cover the surface of the water, except in cracks and very small pools sheltered from the wind. Also, with the oil situated along the downwind edge of the lead, any toxic vapors would be carried away from the lead by the wind. Volatile compounds are lost from an oil slick within 24 to 48 hours, much of this by evaporation (Jordan and Payne, 1980). Geraci and St. Aubin (1986) predict that, at the source of a fresh spill of light crude oil, vapor concentrations of several thousand parts per million could occur (and might be harmful) but should not persist for more than a few hours. Oil spilled under winter ice would pool and freeze to the underside of the ice. First-year arctic ice--the most prevalent type of ice in the Sale 109 area--can store up to 150,000 to 300,000 barrels of oil per square kilometer in under-ice relief. Thus, oil would not spread appreciably along the underside of the ice before being frozen into the ice. The spilled oil would then move as part of the ice pack. Oil would either melt out at the southern ice edge as the pack retreated or otherwise migrate through brine channels in the ice and pool on top of the ice in late May or June. Most oil would be released through the first summer following the spill, but some may be released during subsequent summers.

Oil spilled into the spring lead system might contact northward-migrating bowhead whales as they surface to breathe. Unless whales stopped to feed in the area of a spill or were trapped in a lead or pond into which oil was spilled, contact with oil would likely be brief. As was previously mentioned, wind or water currents would cause the oil to accumulate along the downwind or downcurrent edge of the lead, where the oil would tend to be contained by accumulating grease-ice until the lead closed, at which time the oil would be pushed up onto the surface of the adjacent pack ice. A substantial portion of the bowhead population could be exposed to spilled oil if it were spilled into a heavily used lead at the time a migrational pulse arrived in the area. Effects of contact with the whales would be similar to those described in Section IV.B.7.a(1) and could include baleen fouling, inhalation of toxic vapors, ingestion of oil, ingestion of contaminated prey, and irritation of sensitive tissues exposed to oil. Generally, effects of an oil spill within the spring lead system would be expected to be similar to the effects of a spill under open-water conditions, with two possible exceptions: (1) if bowheads were trapped in a pond or small lead into which oil was spilled, or (2) if a large spill occurred, covering a major lead and, in effect, blocking the spring migration.

On occasion, bowheads have been observed continually returning to the same small area of open water, presumably because there was not more readily available open water where they could surface (Carroll and Smithhisler, 1980). If a substantial quantity of fresh crude oil or an aromatic refined petroleum product were spilled into such an area of open water, it is possible that the animals trapped there could die or suffer pulmonary distress from the inhalation of toxic vapors. However, this would be expected to affect a rather low number of whales.

Should a large oil spill occur which covers a substantial stretch of a major spring lead used by migrating bowheads, a majority of the spring bowhead migration might be delayed or temporarily blocked. The MMS does not believe that bowheads normally would migrate through the pack-ice zone to avoid an oil spill blocking a lead, unless the pack-ice zone had sufficient cracks or small ponds that the bowheads could use for respiration. In this case, bowheads probably would move through the pack ice far enough to avoid the spill and then would re-enter the lead system. This situation could affect a substantial portion of the bowhead population, but it is likely to be rather short-lived. Within several hours to several days after the spill, the oil should have accumulated along the downwind or downcurrent edge of the lead and should no longer impose an impediment to the migration. Such a short-term delay in the migration should not result in significant effects on the population, since there is considerable natural variability in the migration due to ice conditions. A considerable number of bowheads could contact oil as individuals; driven by the migratory urge, they might attempt to find a safe passage through the oil. Some of these individuals might succumb to toxic vapors if the spill were very fresh.

Another topic of concern is noise disturbance in the spring lead system. This concern is more applicable to the period of development and production, since the heavy ice conditions present during the bowhead spring-migration period generally would preclude most exploration activities during this period.

Those activities most likely to produce noise in or near the spring lead system during the bowhead spring migration would include helicopter traffic, production-well drilling, and production-platform operations. Helicopters would be used during development and production to ferry personnel and equipment from support bases to production platforms. Richardson, Greene, and Wursig (1985) reported no overt bowhead responses to single helicopter passes on five occasions and concluded that single helicopter passes at low altitudes could reduce blow intervals temporarily--as do fixed-wing aircraft circling at low altitudes; however, occasional single passes by helicopters are not expected to produce significant or long-term reactions by bowhead whales. On some occasions (such as during inclement weather conditions), at least a few whales probably would be overflown at a low altitude. When overflown, some of these whales will dive quickly in response to aircraft sound, but this sound generally is audible for only a brief time (less than 30 seconds) (Greene, 1985); and the whales should resume their normal activities within minutes.

Production-well drilling and production-platform operations would result in a more constant source of noise during the bowhead spring migration. There are currently no OCS petroleum-production operations within the Alaskan and Canadian range of the bowhead whale; consequently, bowheads have not been observed in the presence of production platforms. The MMS is planning to conduct a study on the effect of production activities on the bowhead whale; however, until such study results are available, the assessment of production-platform noise on bowheads remains speculative.

Concern has been expressed that noise from production operations could displace, delay, or block the bowhead migration through the spring lead system. While we cannot address this issue definitively at this time, it appears--from noise conditions in and around the lead system and from gray whale behavior in the presence of production platforms--that there often would be no adverse effect upon the bowhead migration from production platforms located in or near the spring lead system.

One consideration regarding the issue of noise disturbance of spring-migrating bowheads by production platforms must be the fact that production platforms are stationary, whereas the lead system is not. Consequently, a platform present within an open-water lead one day may be well outside the lead the next day, due to the shifting ice pack. As a result, the platform might pose an obstacle to the spring migration when present within heavily used leads, particularly narrow leads; however, when the lead system develops some distance away from the platform, it is unlikely to hinder the migration.

Another consideration regarding the potential effect of a production platform in or near the spring lead system is the ambient-noise level in the area of the lead system. Measurements have shown maximum ambient noise levels at the boundary between open water and pack ice as a result of interactions between wind-generated waves and sea ice at the ice/water boundary (Diachok, 1980). Consequently, it appears that ambient-noise levels may be high in the area of the lead system. This could be significant in that high ambient-noise levels would tend to mask petroleum-industry sounds and make them less audible and perhaps less disturbing to bowhead whales. In this case, if the production platform were located some distance outside the lead, platform noise might be masked by the ambient noise of the lead.

Another bit of pertinent information to be considered is the fact that gray whales, which appear to react to noise disturbance at levels similar to bowheads, show little avoidance of production-platform noise. As a result of noise-playback experiments off the California coast, Malme et al. (1984) estimated that the point at which 50 percent of migrating gray whales would avoid noise was 56 meters for production platforms and 40 meters for drilling platforms. Furthermore, they concluded that behavioral observations for playback stimuli suggest that only the loudest industrial-noise sources evoke avoidance behavior from migrating gray whales at ranges greater than 100 meters. The effective decoupling of elevated platforms from the water probably is very useful in reducing the amount of acoustic energy radiated into the water from this type of source. Sightings of migrating gray whales immediately adjacent to production platforms off the California coast (Brown, 1986) support the findings from the playback experiments. While precise response distances may vary somewhat due to possibly different sound-propagation characteristics in the waters of the sale area, it should be noted that the response distances observed for production platforms were very small, much less than for drillships (1.1 km), seismic arrays (2.5 km), or single airguns (400 m). After examining behavioral data from both bowheads and gray whales, Miles et al. (1986) concluded that both whale species responded to noise sources at about the same received level. Consequently, one might expect migrating bowheads to show avoidance of only production operations, as was observed for gray whales, the only difference perhaps being that gray whales have had time to habituate to production-platform noise.

As mentioned previously, our ability to assess the effects of oil spills on bowhead whales in the spring lead system is somewhat limited by the fact that bowheads have never been observed in the presence of an oil spill; however, given the best available scientific information as presented above, the MMS believes that oil-spill effects in the spring lead system are expected to be MINOR. Greater effects might be possible if a number of unlikely circumstances were to occur contemporaneously; however, the probability of such an event is believed to be extremely small. Likewise, the effects of noise disturbance in or near the spring lead system are expected to be MINOR. Bowheads may slightly delay or make small diversions in their migratory paths to avoid closely approaching noise sources within or near the lead system; however, these slight changes are not expected to overly stress or present a significant energy drain on individuals. Any slight delays or diversions in migration as a result of activities associated with the sale are expected to be insignificant in comparison with probable natural variation in migration timing and routes.

In summary, the sale area is important to bowhead whales for calving and breeding in the spring and may represent a minor concentration area in the Peard Bay/Point Belcher vicinity before the whales move toward the Chukotsk Peninsula for fall feeding. Effects on bowhead whales from exploration activities are expected to be MINOR, consisting of local avoidance of vessels, seismic surveys, dredging, drilling, and drillship operations. The estimated number of exploratory operations (up to 4/year) would not be expected to significantly displace bowhead whales from their normal migration route or to pose an impediment to their migration. The probability of a major oil spill occurring during exploration is very low; should a spill occur during the exploration period, effects are expected to be minimal loss of prey, baleen fouling, and slight skin and/or sensory-organ damage. Exposure of bowhead whales to up to nine production platforms and a most likely number of seven spills of 1,000 barrels or greater probably would affect only a specific group of individuals in localized areas for less than one breeding cycle. Most disturbance reactions in response to OCS activities generally would be short-term in nature. Long-term effects could include loss of newly born calves or displacement of spring- and fall-migration routes. Overall effects on the bowhead population from OCS activities associated with the proposal are expected to be MINOR.

CONCLUSION (Effect on Bowhead Whales): The effect of proposed Sale 109 on the bowhead whale population is expected to be MINOR.

CUMULATIVE EFFECTS: Cumulative effects could result from individually minor--but collectively significant--actions that take place over a period of time, or from individually significant actions that occur within a short period of time. As defined in the CEQ regulations, "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" describes cumulative effects. Of concern are the cumulative effects of oil spills, other pollutants, and noise-producing activities associated with the projects described in Table IV-2.

This proposal would expose bowhead whales to more noise-producing activities and higher risks of contacting oil spills than expected with Beaufort Sea Sale 97, but slightly lower activity levels than Navarin Basin Sale 107. During exploration, Sale 109 has the potential to adversely affect bowhead whales more than Sale 107, since exploration activities would not be occurring in the Sale 107 area when the whales are present (December-March). Therefore, Sale 109 has the highest potential to affect bowhead whales on a cumulative basis. Because the sale area is most likely an important breeding and calving area, disturbance activities probably would have a greater influence on the population than if whales were exposed to the same level of activity on their feeding grounds. Ljungblad et al. (1985b) found that migrating bowhead whales were somewhat more sensitive to active seismic boats than were summer-feeding whales.

In the cumulative case, up to 30 spills of 1,000 barrels or greater could occur within the migratory range of the bowhead whale over the collective lives of Sales 97, 109, and 107 as compared to seven spills of 1,000 barrels or greater associated with the Sale 109 proposal. Bowhead whale habitat could be exposed to seven spills from Sale 109, one spill from Sale 97 (USDOI, MMS, 1987a), 10 spills from Sale 107, and 12 spills from Canadian production and tankering (USDOI, MMS, 1987a). Migration Corridor A (fall migration), between Point Barrow and Icy Cape, has a 90-percent combined probability of one or more spills of 1,000 barrels or greater occurring and contacting this target (within 10 days) over the production life of the field for spills starting in summer, with a mean number of two spills. For a spill of 1,000 barrels or greater starting in winter, Peard Bay has the highest combined probability of contact--59 percent within 10 days. Oil spills that contacted bowhead whale habitat would not necessarily contact whales, since bowheads generally are sparsely distributed and may actively avoid oil contact.

At the present time, it is difficult to distinguish between habituation and tolerance. Animals that tolerate disturbing or stressful situations are not necessarily unaffected. Marine mammals that are under stress during molt, reproduction, or disease may be more vulnerable to the effects of additional stress resulting from human activities (Geraci and St. Aubin, 1980). Cetaceans that have had little contact with vessel traffic (bowheads) may have greater reactions than those species that inhabit areas with high levels of marine traffic (gray and humpback whales) (Richardson, Wells, and Wursig, 1983).

The effects of several stimuli could be purely additive or, in combination, could have synergistic effects that would lead to changes that are greater than the sum of changes due to the individual stimuli or sources. This would occur if mammals exhibited a threshold of tolerance to disturbances and other effects. Thus, mammals might remain in an area and appear unaffected by a variety of disturbing stimuli until a threshold is reached, whereupon they might vacate the area (Richardson, Wells, and Wursig, 1983).

Should all activities occur at projected levels, bowheads will be exposed to significant increases in disturbing activities (e.g., vessel traffic) throughout their range, which may cause a portion of the regional population to shift its distribution, lasting more than one breeding cycle but less than one generation (less than 10 years). If calf losses occur over several years due to continued activities in the sale area, the population fitness might be adversely affected. On a cumulative basis, bowhead whales in the Sale 109 area could experience MODERATE effects from OCS oil and gas activities.

Conclusion: Cumulative OCS oil and gas activities are expected to result in MODERATE effects on bowhead whales.

b. Effect on Gray Whales: Gray whales are most likely to be in the Sale 109 area during the summer-feeding and fall months (see Sec. III.B.5). Berzin (1984) estimated that 10,000 gray whales (58% of the population) inhabit the Chukchi Sea, and between 4,000 and 5,000 others (23-29%) summer in the Bering Sea. Based on Berzin's (1984) and Rice and Wolman's (1971) estimates, it is possible that between 25 and 60 percent of the gray whale population inhabits the Chukchi Sea. The number of gray whales present in the Chukchi Sea will vary from year to year, depending on various environmental conditions. Most calves are sighted in the Chukchi Sea--not the Bering Sea. In 1985, 17 calves were observed between Icy Cape and Point Barrow as compared to two calves in the Chirikov Basin (Ljungblad, Moore, and Clarke, 1986), which may represent a partial segregation of cow/calf groups on the summer-feeding range. Phillips (1986, oral comm.) observed several hundred gray whales and their calves off the Point Belcher area during 1984 and 1985.

(1) Effects of Oil Spills: Gray whales are expected to be affected by spilled oil similarly to bowhead whales. (Refer to the Sale 92 FEIS for further details [USDOI, MMS, 1985b].) The potential for harm to whales from contact with spilled oil may result from skin contact, inhalation of toxic vapors, and/or ingestion of hydrocarbons. Gray whales are known to pass through natural oil seeps with no direct evidence of acute reactions. Gas chromatograph analysis of tissues from gray whales stranded in the vicinity of the Santa Barbara Channel oil spill indicated no presence of crude oil, so none of the strandings were linked to the oil spill (Brownell, 1971). Geraci and St. Aubin (1982) conducted a 3-week field program to observe the reactions of migrating gray whales to various concentrations of naturally occurring oil films, from thick oil to small patches and light sheens. On several occasions, aerial observers noted that, when approaching oil, the whales changed their swimming direction; however, some whales swam through the oil while modifying their swimming speed. In oiled waters, the whales seemed to spend less time at the surface, blowing less frequently but at a faster rate. A study by Kent, Leatherwood, and Yohe (1983), observing gray whales migrating in the vicinity of oil seeps near Coal Oil Point, California, found that most whales observed showed apparent indifference to the oil. At other times, whales were observed to radically change their swimming direction.

Baleen whales face a threat from oil spills when the hair-like fringes of the baleen become fouled, which can occur even after a brief exposure to oil. Geraci and St. Aubin (1982) monitored water flow through gray whale-baleen plates before and after contaminating them with three types of crude oil. Light- to medium-weight oils caused transient changes in water flow, which returned to normal within 40 seconds. Repeated oiling with the same preparation produced no additive effect. A heavy residual oil (Bunker C) restricted water flow for up to 15 minutes. Thereafter, although the plates were still noticeably fouled, normal flow patterns were restored. Geraci and St. Aubin (1982) found that light oils were undetectable on the baleen plates after 1 hour of flushing, whereas the heavier fractions persisted for 15 to 20 hours. Results from these experiments indicated that crude oil does not irreversibly obstruct water flow through gray whale baleen and that filtering efficiencies might be jeopardized for less than 24 hours after a feeding foray in oil. Geraci and St. Aubin (1985) designed a system to measure absolute changes in flow resistance after oil fouling. Gray whale baleen was relatively unaffected by Bunker C, even at temperatures below 5°C. The researchers also determined the cleansing rate for the oil-fouled baleen, finding that most of the oil (70%) was gone within 30 minutes, and after 24 hours less than 5 percent of the oil remained. Geraci and St. Aubin determined that this level of fouling would not affect resistance to flow and therefore presumed that it would not impair function in a living whale.

Reduction of food sources from acute or chronic hydrocarbon pollution is a possible indirect effect of oil-industry activities. Individual whales may experience indirect effects on a localized or temporary basis. In laboratory and field experiments of Prudhoe Bay crude and indigenous arctic-benthic amphipods, amphipods avoided recolonizing oil-contaminated areas. Sublethal behavioral changes in feeding, moving, and burrowing activities were also evident. The amphipods selectively burrowed in unoiled areas, and recolonization of oiled areas was significantly different in species composition from that formed in reference unoiled areas (Busdosh et al., 1978). Temporary contamination may result in reduced productivity of plankton; however, effects are likely to be limited and are not expected to stress endangered-whale populations.

If spilled oil reached the bottom sediments, such as occurred after the Amoco Cadiz and Potomac spills, gray whales might ingest some oil when feeding. Gray whales feed predominantly on benthic amphipods that they suck from the bottom sediments. Oil can reach bottom sediments by various mechanisms--one is direct mixing of oil with sediments by wave action in shallow water and subsequent transport to deep water by density currents. Sorption onto particulate matter suspended in the water column, with subsequent sinking, can occasionally occur in deeper water. Another mechanism for sedimentation of oil is uptake by zooplankton, packaging as fecal pellets, and subsequent sinking of the pellets. Heavier-molecular-weight hydrocarbons typically reach ocean sediments in proportion to the supply in surface waters. Once in the sediments, hydrocarbons are taken up by benthic organisms with greater uptake of the heavier, relative to the lighter, molecular-weight aromatic compounds.

The data do not support the theory that gray whales are likely to ingest heavy, weathered oil that has settled to the bottom. Oil that has been transported and incorporated into the sediment by sorption or fecal-pellet transport probably would not re-form into thickened, weathered oil. In summary, short-term effects on gray whales from contact with oil include baleen fouling, behavior modification, and localized elimination of prey.

Oil-spill-risk-analysis targets--where gray whales are most likely to be vulnerable during the summer and fall periods--include the Peard Bay Area, Migration Corridors A through C, Ice/Sea Segment 9, and Seabird-Concentration Area I (see Fig. IV-22). Targets with high combined probabilities of contact where gray whales have been observed include Migration Corridors A and B (87%

and 58%, respectively), the Peard Bay Area (56%), and the Wainwright Subsistence Area (76%) within 10 days. It is estimated that two spills of 1,000 barrels or greater and one spill of 1,000 barrels or greater could occur and contact the migration corridor and the subsistence area, respectively. These two areas have 8- and 6-percent chances, respectively, of a 100,000-barrel-or-greater spill occurring and contacting them.

This area is important to gray whales as a calf-rearing (especially around Point Belcher) and feeding area. Oil has been demonstrated to be toxic to zooplankton, upon which gray whales may feed. Gray whales would be nursing, so substantial ingestion of contaminated prey might be passed to calves in their mothers' milk; however, based on the localized effects of spills on prey species, it is unlikely that contaminated prey would provide a major portion of the food source for many whales. If a sufficient number of cow/calf pairs avoided an oil-contaminated area (similar to that observed off California), a weakened year-class might occur due either to insufficient nutrient assimilation of adults or to poor-quality milk. Newly pregnant females may produce less viable calves if food is unavailable in the necessary quantities or is in an altered form. If a gray whale/oil-spill interaction occurs from any or all of the spills associated with the proposal (7 spills of 1,000 barrels or greater), it is likely that only a specific group of individuals of the population in a localized area will be affected for less than one breeding cycle (2-3 years). If a whale/oil interaction occurs, the expected short-term effects are localized loss of prey, baleen fouling, and possibly slight skin damage. Therefore, effects on gray whales from oil contact associated with Sale 109 are expected to be MINOR.

(2) Effects of Noise Disturbance: Reeves (1977) identified potential conflicts of disturbance sources to breeding gray whales in Baja, California. Consiglieri and Braham (1982) reported that the use of Laguna Guerrero Negro as a calving area for gray whales declined for 6 years, and the area was not used for a subsequent 7 to 8 years due to intensive use by Mexican salt barges and the channel dredging that occurred between 1957 and 1972. When the dredging stopped (by Federal action to protect the whales), the animals gradually returned to the lagoon in their original numbers over a 6-year period.

Malme et al. (1983) conducted playback experiments during the gray whale migrations off central California. The playback tests demonstrated that gray whales have hearing thresholds below those of the prevailing ambient-noise levels in the observation area (central California). Whales exposed to drilling-platform, helicopter, and production-platform stimuli showed avoidance responses in which migration tracks (routes) were deflected away from the source of the playback stimulus. The sound levels at this range were about 111 to 118 dB//1uPa at 1 meter. An annoyance reaction was considered to have occurred since an avoidance of the source area (playback stimulus) occurred out to ranges of about 250 meters from the source of the drilling platform and helicopter sounds. Avoidance reactions to drillship sounds began at about 2.7 kilometers from the source. A decrease in swimming speeds occurred in reaction to these noises. Studies of feeding gray whales near St. Lawrence Island found that whales generally began to move away from the source location of playbacks of drillship noise at levels above 110 dB//1uPa. It was determined that feeding gray whales appear to have acoustic-disturbance sensitivity comparable to that of migrating gray whales (Malme et al., 1986). The noise associated with construction activities (such as pipeline dredging) is more likely to disturb the whales than the physical presence of such activities.

Available information indicates that gray whales display a high degree of tolerance to geophysical seismic noise in certain areas. Extensive geophysical exploration has been conducted off the California coast for more than 35 years, yet during that same period the gray whale has recovered to population levels at or above precommercial-whaling levels. Experiments were conducted during the gray whale migration off California using both a single airgun and an airgun array (Malme et al., 1983, 1984). Estimated peak-sound levels produced in the areas of the whales were 180 dB ±10 dB//1uPa at 1 meter. No reactions by mother/calf pairs (April/May experiments) were noted during line runs of seismic-airgun arrays at distances of 5 to 83 kilometers. The whales came as close as 5 kilometers to the airguns before some behavioral changes were noted, including changes in the swimming patterns of the cow/calf pairs. The whale groups were seen to change direction (orienting south), exhibit confused swimming, move inshore into the surf zone, and mill about for varying lengths of time--often followed by rapid swimming to avoid the source area.

On four occasions, whales were observed moving into the surf zone and within the sound shadow of a nearshore rock or outcropping. It is important to note that, in each of these cases, the airgun array was turned on when whales were within 1 kilometer; therefore, they were immediately exposed to a level greater than 160 dB. This dramatic response could, therefore, be considered a startle response. The distances between the airgun-array vessel and a group of whales when it showed a response, obvious at the time of observation, were consistently on the order of 2.5 kilometers. The distance at which these groups resumed normal migrations ranged between 3.6 and 4.5 kilometers.

Preliminary analysis of experiments conducted in the Bering Sea during the summer of 1985 found that feeding gray whales occasionally interrupted these activities in the presence of airgun-sound levels of 170 dB//1uPa and higher. The 170 dB avoidance behavior occurred at 2.3 kilometers in areas with soft bottoms and at 4.5 kilometers in areas of hard substrate (Malme, 1986, oral comm.). The measurements of surface-dive parameters for the airgun tests did not return to pre-exposure values for at least 1 hour after exposure.

Ljungblad et al. (1982) reported observing normal behavior of gray and fin whales in the Chukchi Sea during exposure to geophysical-exploration sounds from a vessel using an airgun array at a distance of 36 kilometers. Behaviors observed included feeding, and a calf nursing. No reactions to audible airgun noises were observed. Peak levels were estimated to be approximately 150 dB//1uPa at the location of the whales.

Refer to Section II.A (Table II-1) for details and timeframes associated with the scenario for the proposal. (A Notice to Lessees [NTL] [similar to NTL No. 86-2 for the Beaufort Sea], which specifies performance standards for preliminary activities in the Chukchi Sea], will be issued prior to this sale. This NTL will provide vessel and aircraft operators a description, clarification, and interpretation of requirements to avoid disturbance to endangered whales contained in lease stipulations, information to lessees, and conservation recommendations provided by NMFS in its Biological Opinion for Sale 109.) If all proposed activity occurred at the levels projected, gray whales would be exposed to a significant increase in noise levels, especially around Point Belcher, where most of the activity and infrastructure construction would occur. If the noise levels similar to those that caused the whales to abandon the breeding lagoon become annoying to the cow/calf pairs feeding around Point Belcher, an abandonment of this area is possible. Since it is assumed that whales feed at optimal locations, abandonment of this area (in response to increases in noise levels) could force cow/calf pairs to feed at suboptimal habitats. A lack of adequate nutrients may result in death to a few previously weakened whales. It is possible that as Sale 109 field production decreases and noise-producing activities decrease, gray whales may again use the Point Belcher area--similar to their reoccupation of the Baja breeding lagoon when noise levels decreased. It is likely that this portion of the population would experience a change in distribution lasting longer than one breeding cycle but less than one generation (less than 8 years). Effects of noise-producing activities associated with the proposal could have MODERATE effects on the local population, but only MINOR effects on the regional population are expected.

In summary, the Sale 109 area--especially the Point Belcher vicinity--is important as a gray whale summer-feeding and calf-rearing habitat. Exposure of gray whales to seven spills (of 1,000 barrels or greater), nine production platforms, and construction of a pipeline to Point Belcher could have negative effects on the local population in the sale area. Most disturbance reactions in response to OCS activities generally would be short-term in nature. Long-term effects could include loss of calves or displacement from primary feeding habitats. Overall effects on the gray whale population from OCS activities associated with the proposal are expected to be MINOR.

CONCLUSION (Effect on Gray Whales): The effect of proposed Sale 109 on the gray whale population is expected to be MINOR.

CUMULATIVE EFFECTS: The Sale 109 area is an important calf-rearing area, and effects on gray whales associated with the proposal would have more long-term effects on the entire population than effects on whales in other sale areas. The long-term nature of production and development would affect more calves than would be expected with other whales. An effect such as continued displacement from feeding grounds in the Sale 109 area and the Norton Basin area (which includes a major feeding area for adult whales without calves), a decline in group whale abundance, or a leveling off of the population may be a remote possibility. Cow/calf pairs are more likely to react to disturbing activities than other whale groupings because female mammals tend to be protective of their young.

Cumulative acoustical disturbance associated with possible State and additional Federal lease sales would affect gray whales, although habituation to acoustical disturbance is a possibility. Responses to the increased ambient-noise levels would be similar to those described in the proposal but may last several years and extend over several additional whale-use areas, increasing the exposure levels and time periods. For the gray whale, offshore development associated with the proposal could constitute a limited portion of the total acoustical stimuli to which they would then be exposed. If several proposed lease sales yielded commercial discoveries of oil and gas (intensive production activities, resultant increases in human activity, increased localized or shipping-corridor disturbance, and increased pollution), the cumulative effects from noise disturbance could be MODERATE. Effects from increased acoustical disturbances are expected to lead to rerouting of migrations routes, abandonment of habitats, or delay in migration movements. Cumulative industrial disturbances, especially during migratory periods, are expected to be greatest at locations where tanker traffic would be focused from several lease sales (i.e., Unimak Pass).

In the cumulative case, up to 18 spills of 1,000 barrels or greater could occur within the northern range of the gray whale. Gray whales could be exposed to seven spills from Sale 109, one spill from Sale 92 (USDOI, MMS, 1985b), and 10 spills from Sale 107. The area between Point Barrow and Icy Cape has a 90-percent probability of one or more spills of 1,000 barrels or greater occurring in summer and contacting this area (within 10 days) over the production life of the field. It is most likely that two spills of this size would contact this area when gray whales are feeding there. The Peard Bay area has a 60-percent probability of contact by a 1,000-barrel-or-greater spill within 10 days. Combined probabilities of contact are the same as described in the bowhead and gray whale sections. Oil spills that contacted gray whale habitat would not necessarily contact whales, since gray whales generally are sparsely distributed and may actively avoid oil contact.

Should all activities occur at projected levels, gray whales (especially cow/calf pairs) would be exposed to significant increases in disturbing activities (noise and hydrocarbon levels) throughout their range, which might cause a portion of the regional population to shift their distribution, lasting more than one breeding cycle but less than one generation. If calf losses occurred over several years due to continuing activities in the sale area, no increases in the gray whale population would be expected, which would affect the population fitness (a factor determining a species' endangered status). On a cumulative basis, gray whales could experience MODERATE effects from OCS activities.

Conclusion: Cumulative OCS activities are expected to result in MODERATE effects on gray whales.

c. Effect on Fin Whales: The Sale 109 area probably represents the northern range of the fin whales, which are most likely to be in this area at the same time as gray whales (see Sec. III.B.5).

Geraci and St. Aubin (1982) reported that crude oil temporarily reduced filtering efficiencies of fin whale-baleen plates, but normal flow patterns were restored after 15 minutes. Since fin whales prefer euphausiids, copepods, and small schooling fishes as their primary prey, oil-spill effects on the whales would be more indirect by locally eliminating prey that would be killed by the toxic components of an oil spill.

It has been suggested that whale skin may be vulnerable to effects from a surface contact with spilled oil. The healthy skin of terrestrial mammals is colonized by microorganisms but is able to resist invasions by pathogens. The protective function is provided, in part, by the physical continual shedding of the skin and by antimicrobial substances secreted by sebaceous glands, sweat glands, and resident microflora. Lacking these glands, cetacean skin could rely on intercellular lipids to control cutaneous microorganisms. Geraci and St. Aubin (1985) found that fin whale lipids caused mild growth suppression in local microorganisms. They have interpreted this finding as an indication that delipidation after exposure to oil would not necessarily sensitize a whale to disease by altering microbial flora on the skin or by removing inhibitory substances.

Fin whale habitats would have the same probability of contact as previously described for summering gray whales and fall use by gray and bowhead whales. Since fin whales are seldom in the Sale 109 area, the probability of a fin whale being in a particular target area that has been contacted by oil would be low. Effects on fin whales from oil contact in the Sale 109 area would be NEGLIGIBLE.

Fin whales probably would react to acoustical disturbances similarly to gray and bowhead whales, but no testing of fin whales has occurred. Since fin whales are occasional visitors to the sale area, effects would occur only to a few individuals. Therefore, effects on fin whales from acoustic disturbances associated with Sale 109 are expected to be NEGLIGIBLE

CONCLUSION (Effect on Fin Whales): The effect of proposed Sale 109 on the fin whale population is expected to be NEGLIGIBLE.

CUMULATIVE EFFECTS: Refer to the previous cumulative-effects sections for general discussions of effects that would also apply to fin whales. The proposal would add only NEGLIGIBLE effects on fin whales, compared to effects from all other Alaskan OCS activities that they may experience along migrations and in overwintering or summer-feeding areas. The proposal is not expected to contribute significantly to cumulative factors that would affect fin whales. Since so few fin whales enter the Sale 109 area, the probability of adverse effects on fin whales in the cumulative case would be NEGLIGIBLE.

Conclusion: Cumulative effects from noise disturbance and oil spills on fin whales are expected to be NEGLIGIBLE.

d. Effect on Humpback Whales: Humpback whales are most likely to be in the Sale 109 area at times and with distributions similar to fin whales. Refer to Sections III.B.5 and IV.B.7.a through IV.B.7.c for an analysis of oil-spill effects that are also applicable to humpback whales. Due to the low number of humpback whales expected to be in the area, the probability of a humpback whale contacting any or all of the expected seven spills of 1,000 barrels or greater would be low. Therefore, the risk of contacting oil spills would be low; the chance of adverse reactions to contact also would be low; and the effects of the proposal on humpback whales would be NEGLIGIBLE.

Humpback whale reactions to acoustical stimuli range from apparent indifference to startle-avoidance behaviors. Reactions to the same type of stimulus may vary depending on which part of their range they are occupying. In their Hawaiian breeding and calving grounds, there is increasing evidence that humpbacks are less likely to be found in areas heavily used by vessels (Bauer et al., 1985). Breaching is one behavior frequently associated with boat disturbances. In both Alaska and Hawaii, whales presented their ventral surfaces toward the approaching vessel 40 percent of the time (a 12.5% frequency would be expected by chance). It has been hypothesized that this behavior may serve as a type of communication and also allow the whale a more effective visual scan. A change in distribution of cow/calf pairs in nearshore Hawaiian waters was observed between 1977 to 1979 and in 1985. In the earlier years, 80 percent of the cow/calf sightings occurred within 0.4 kilometers of shore; in 1985, only 5.8 percent occurred there. Increased human activities and coastal development have been suggested as the main factors in the distribution shift (Glockner-Ferrari and Ferrari, 1985).

In 1981, Baker et al. (1982) studied responses of humpback whales to marine traffic in southeast Alaska and found that the whales' behavior, size, and distance from vessel contributed to the effect on the respiratory behavior of the whales. Through regression analysis, they determined that approximately 1 kilometer represented the minimum distance at which passing vessels might have no effect on the respiratory behavior. They also found that the whales moved away more rapidly as their distance to the vessel decreased. Whale reactions to close approaches by vessels consisted of moving directly away from the vessel. Overall vessel approaches resulted in decreased blow interval and increased dive time (i.e., longer dives are followed by less surface time and more frequent blows while at the surface).

Malme et al. (1985) investigated the potential effects of OCS noise on feeding humpback whales in southeast Alaska. No clear evidence of avoidance of the area near the sound source was obtained; however, this may be partially attributed to the inability to follow individual, or groups of, whales during the experiments and to the fact that the sound levels used were generally less than would be expected from an actual industrial source. They concluded that in the absence of evidence showing that humpbacks are adversely affected by short-term exposure to noise levels achieved in their study, the avoidance criteria derived from the gray whale study could be used as a conservative interim guide for the maximum industrial-noise exposure levels for feeding whales. Distances derived were 500 meters for a drilling platform, 79 meters for a helicopter, 1 kilometer for a drillship, and 2.5 kilometers for seismic surveys. These values represent radii within which whales would display active surface movements away from the sound source, increases in aerial displays, and rapid dives (where whales are leaving the area). If humpback whales were more common in the Sale 109 area, effects would be expected to be MINOR. However, since so few whales are in the sale area, effects on humpback whales from acoustical disturbances associated with the proposal are expected to be NEGLIGIBLE.

<u>CONCLUSION (Effect on Humpback Whales)</u>: The effect of proposed Sale 109 on the humpback whale population is expected to be NEGLIGIBLE.

<u>CUMULATIVE EFFECTS</u>: Refer to the previous cumulative-effects sections on other whales for general discussions of effects that would also apply to humpback whales. The proposal would only add NEGLIGIBLE effects on humpback whales compared to effects from all other Alaskan OCS activities that they may experience along their migration routes and in other summer-feeding areas. The proposal is not expected to contribute significantly to cumulative factors that would affect humpback whales. Since so few humpback whales enter the Sale 109 area, the probability of adverse effects occurring on humpback whales in the cumulative case would be NEGLIGIBLE.

<u>Conclusion</u>: Cumulative effects from noise disturbance and oil spills on humpback whales are expected to be NEGLIGIBLE.

e. Effect on Arctic Peregrine Falcons: The threatened arctic peregrine falcon is an occasional visitor to the western Alaskan coast adjacent to the sale area. Peregrines are most sensitive to disturbances when nesting, from approximately late April to mid-August. Peregrines typically nest on cliffs and bluffs overlooking rivers and along coastal areas. The Colville River drainage has been identified as the center of the peregrine distribution on the North Slope. Although the bluffs along the Chukchi Sea coast in the Sale 109 area are not known to be important nesting habitats for peregrine falcons, a few nests have been reported. Peregrines have been reported from the Kivalina area north to Icy Cape. Vessel- and air-support-traffic corridors are likely to extend from Barrow and Wainwright to offshore sites. Peregrines have not been reported in Chukchi Sea coastal areas this far north; consequently, it is not expected that peregrines would be disturbed by aircraft or vessel operations associated with the lease sale.

Effects from oil spills could occur from direct contact or via contaminated prey. If seabirds died as a result of oil contact, a reduction of peregrine prey would occur. Seabird-Concentration Area I has a greater-than-99-percent probability that a spill starting at Launch Point J15 would contact it within 10 days. Even though the potential feeding area has a high probability of contact, peregrines are not common in this area; and thus adverse effects on the peregrine from reduced food availability would be minimal.

The development and production phase includes a pipeline from Point Belcher to TAP Pump Station No. 2. At this time, only a hypothetical corridor has been identified. The corridor has the potential to pass within close proximity to a number of peregrine falcon nesting locations. Consultation with the FWS will likely be reinitiated at the time of actual pipeline-corridor planning. At this time, it is assumed that pipeline-construction activities in the vicinity of any peregrine falcon nesting locations will occur during the fall and winter seasons, when falcons are not present. As a result, pipeline construction should not disturb peregrine falcon nesting or foraging activities; and the presence of an unattended or sparsely attended pipeline in the vicinity of nesting sites would be expected to disturb few nesting pairs.

CONCLUSION (Effect on Arctic Peregrine Falcons): The effect of proposed Sale 109 on the arctic peregrine falcon is expected to be MINOR.

CUMULATIVE EFFECTS: The proposed sale is expected to contribute little to cumulative factors that could affect peregrine falcons. The infrequent usage of the coastal area would result in few peregrine falcon/OCS-activities interactions. If pipeline construction along the Colville River resulted in failure or abandonment of a number of clutches, effects on population fitness could be expected. However, this is an unlikely scenario since construction activities in the vicinity of peregrine nesting sites are expected to occur during the fall and winter seasons, when falcons are not present; and the presence of an unattended or sparsely attended pipeline in the vicinity of nesting sites would be expected to disturb few nesting pairs.

Conclusion: Cumulative effects on arctic peregrine falcons are expected to be MINOR.

OVERALL CONCLUSION (Effect on Endangered and Threatened Species): The effect of proposed Sale 109 is expected to be MINOR on bowhead and gray whales and arctic peregrine falcons and NEGLIGIBLE on fin and humpback whales. Cumulative effects are expected to be MODERATE on bowhead and gray whales, MINOR on arctic peregrine falcons, and NEGLIGIBLE on fin and humpback whales.

8. Effect on Caribou: Among the terrestrial mammals that occur along the coast of the Sale 109 area, the over 200,000 caribou of the Western Arctic herd could be affected by the proposal. The primary potential effects of OCS activities on caribou would come from onshore support and development activities adjacent to the Sale 109 area and, to a minor degree, oil spills. The primary concerns are disturbance of caribou and habitat changes. Human activities can cause temporary and possibly permanent displacement of caribou, particularly cows and calves, from important habitats such as calving grounds, insect-relief areas, and preferred feeding habitats (see Fig. IV-23).

a. Effects of Disturbance:

General Effects: Caribou can be briefly disturbed by low-flying aircraft, fast-moving ground vehicles associated with an onshore pipeline, and the construction of other facilities (Calef, DeBock, and Lortie, 1976; Horejsi, 1981). The response of caribou to potential disturbance is highly variable--from no reaction to violent escape reactions--depending on their distance from human activity; speed of approaching disturbance source; frequency of disturbance; sex, age, and physiological condition of the animals; size of the caribou group; and season, terrain, and weather. Cow and calf groups appear to be the most sensitive to vehicle traffic, especially during the summer months, while bulls appear to be least sensitive during that season.

Tolerance to aircraft, ground-vehicle traffic, and other human activities has been reported in several studies of hoofed-mammal populations in North America including caribou (Davis, Valkenburg, and Reynolds, 1985; Valkenburg and Davis, 1985; and Johnson and Todd, 1977). The variability and instability of the arctic ecosystem dictate that caribou have the ability to adapt behaviorally to some environmental changes. Consequently, repeated exposure to human activities such as oil exploration and development over several hundred square kilometers of summer range has lead to some degree of tolerance by most caribou of the Central Arctic herd. Some groups of caribou that overwinter in the vicinity of Prudhoe Bay and near Camp Lonely on the NPR-A, and that have been continually exposed to disturbance stimuli, apparently have become accustomed to human activities; however, the majority of the North Slope caribou herds that overwinter south of the Brooks Range are less tolerant to human activities to which they are seasonally or intermittently exposed than some caribou that overwinter on the Arctic coast.

Some displacement of the Central Arctic caribou herd from a small portion of the calving range near Prudhoe Bay facilities has occurred (Cameron, Whitten, and Smith, 1981, 1983). This displacement of some caribou cows and calves has occurred within about 4 kilometers (2.5 miles) of some oil facilities (Dau and Cameron, 1986). However, the use of specific calving sites within the broad calving area varies from year to year; and the amount of displacement is probably of secondary importance due to the low density of caribou on the calving range and the abundance of calving habitat of the Central Arctic herd.

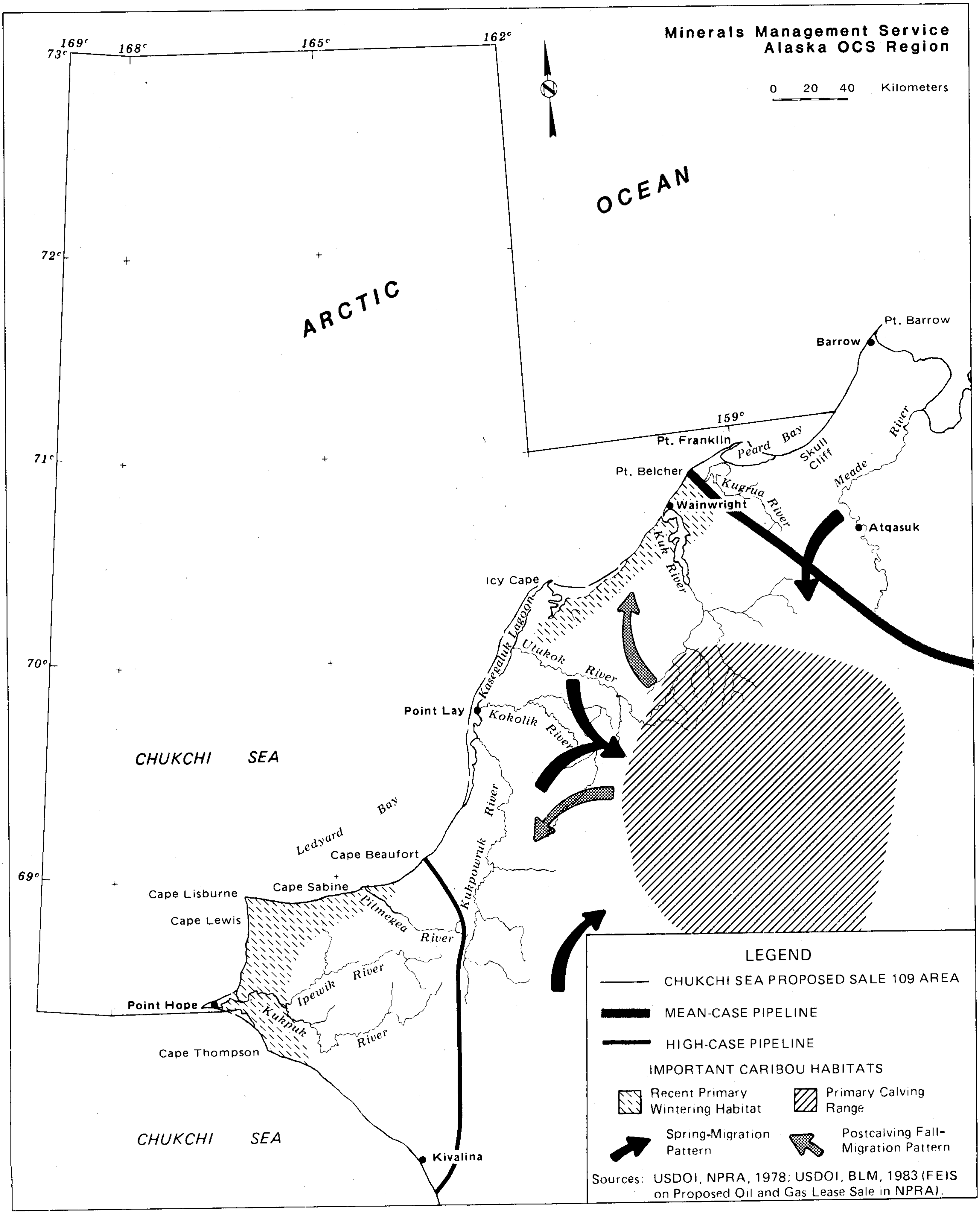


FIGURE IV-23. ONSHORE-PIPELINE ROUTES ACROSS HABITATS OF THE WESTERN ARCTIC CARIBOU HERD

Disturbance Effects Associated With Pipelines: Recent studies (Roby, 1978; Cameron, Whitten, and Smith, 1981, 1983) indicate significant seasonal avoidance of habitat near Prudhoe Bay facilities by cows and calves during calving and postcalving periods (May through August). Cameron, Whitten, and Smith (1983) also reported that caribou cow/calf groups avoid the 200-kilometer northern portion of the trans-Alaska pipeline (TAP) Dalton Highway (Haul Road) corridor, particularly during the postcalving period. However, caribou cow/calf groups may be avoiding the TAP corridor because it runs primarily along the riparian habitat of the Sagavanirktok River valley, a habitat type that cows and calves normally avoid using during the postcalving season due to the possible presence of hidden predators such as wolves (Carruthers, Jakimchuk, and Ferguson, 1984). Carruthers, Jakimchuk, and Ferguson (1984) reported no significant differences in cow/calf distribution between the TAP corridor and other riparian habitats on the summer range of the Central Arctic herd. Also, caribou cow/calf groups did not avoid a portion of the TAP corridor on the North Slope, which is separate (4 kms away) from riparian habitat and the Dalton Highway (Carruthers, Jakimchuk, and Ferguson, 1984). The latter investigators concluded that the differences in the distribution of caribou cows with calves along the TAP corridor reported by Cameron, Whitten, and Smith (1983) reflect the seasonal-habitat preference of caribou cows with calves in avoiding riparian habitats, on which most of the corridor is located. However, Carruthers, Jakimchuk, and Ferguson (1984) did not investigate the question of whether caribou cows with calves avoid the Dalton Highway during periods of heavy truck traffic. The mere physical presence of the pipeline and associated facilities probably has no effect on the behavior, movement, or distribution of caribou, except perhaps when heavy snowfall may prevent some animals from crossing under or over the pipeline in local areas. On the other hand, human activities associated with transportation routes--particularly road traffic--can have short-term effects on the behavior and movement of caribou.

Vehicle traffic (particularly high traffic levels such as 40-60 vehicles/hour) on a road adjacent to a pipeline has the greatest manmade influence on caribou behavior and movement while they are crossing the Prudhoe Bay and Kuparuk oil fields and pipeline corridors (Murphy and Curatolo, 1984). A decline in the frequency at which caribou cross pipeline corridors is attributed to high traffic levels on the adjacent road and the frequency of severe disturbance reactions exhibited by caribou during crossing (Curatolo, 1984). Caribou generally hesitate before crossing under an elevated pipeline (there is no problem with buried pipelines) and may be delayed in crossing a pipeline and road for several minutes or hours during periods of heavy road traffic, but successful crossing does occur.

Site-Specific Effects: This analysis assumes that transportation activities associated with exploration would be centered out of Barrow and Wainwright and no roads would be built during exploration (see Sec. II.A.2). Other exploration-support activities are assumed to occur by offshore barges located near the drilling sites. Therefore, exploration alone in the proposed Sale 109 area would not substantially increase industrial development on the North Slope, nor would it disturb caribou or cause noticeable habitat effects.

Oil from the proposed Sale 109 area is assumed to be transported by 400 kilometers of offshore trunk pipelines coming onshore at Point Belcher on the Chukchi Sea coast. From there, the 640-kilometer onshore pipeline and support road (Sale 109 pipeline corridor) would cross NPR-A south of the lake district (but probably north of the Colville River) and connect with the TAP and Dalton Highway (TAP corridor) at Pump Station No. 2. The onshore Sale 109 pipeline corridor and support road would transect movements of the Western Arctic caribou herd to the Beaufort Sea coast from wintering habitat south of the Brooks Range and also would transect the southward spring migration of several thousand up to about 60,000 caribou that overwinter north of the caribou-calving range and along the arctic coast (Fig. IV-23). The pipeline would not cross the calving range of the Western Arctic herd. Caribou that winter on the North Slope apparently do not use well-defined migration routes to the calving range. The pipeline would not cross the major well-defined migration routes through the Brooks Range mountain passes south of the calving area, where the majority of the Western Arctic caribou herd overwinter (see Fig. IV-23).

Construction of the onshore 640-kilometer Sale 109 pipeline corridor could temporarily interfere with the movements of some caribou north of the calving range--particularly cows and calves--during construction activities and during periods of heavy vehicle traffic (several hundred vehicles/day). In a severe situation during construction activities, such motor-vehicle traffic associated with the Sale 109 pipeline corridor could affect the local seasonal distribution and movement of the Western Arctic herd within about 4 kilometers of the pipeline corridor if it acts as a temporal barrier to cow/calf movements. However, caribou-migration movements would not be blocked. Some caribou would have temporary difficulty crossing the pipeline and road during heavy traffic periods, but successful crossings would still occur throughout the summer and the duration of the migration. Caribou successfully cross the TAP and Dalton Highway, the Dempster Highway in Canada, and other highways in Alaska. Development of the Sale 109 pipeline corridor across the NPR-A would increase hunter access to the Western Arctic caribou herd thereby increasing hunter pressure on the population, and may lead to overharvest and decline of the herd. However, current regulation of the caribou harvest should prevent overhunting. The road traffic along the Sale 109 pipeline corridor and daily aircraft surveillance (1 helicopter flight/day) of the pipeline would cause brief flight reactions by some caribou and would temporarily delay--for perhaps a few hours or no more than a few days--caribou movements across the pipeline corridor. This would represent a MINOR effect on the caribou of the Western Arctic herd.

b. Effects of Habitat Alteration:

General Effects: The construction of pipelines and other onshore facilities on the North Slope necessitates the use of very large quantities (several million tons) of gravel. With the construction of roads and gravel pads for facility-building sites, small areas of tundra vegetation are excavated at the gravel-quarry sites and several square kilometers of caribou tundra grazing habitat are destroyed with the laying of the gravel. However, the amount of grazing habitat destroyed by onshore development represents a very small percentage of the range habitat available to the caribou herd. The construction of roads and gravel pads provides the caribou with additional insect-relief habitat on the roads and gravel pads, particularly when there is little or no road traffic present.

Site-Specific Effects: The onshore development associated with the proposal would include a 640-kilometer pipeline and support road, and 10 helicopter pads that would alter about 64 square kilometers of grazing habitat of the Western Arctic herd on the North Slope. The shorebase at Point Belcher would remove about 30 hectares of rangeland near Point Belcher, and the 1,800- to 1,900-meter airstrip at this location would require about 500,000 cubic meters of gravel. These facilities would destroy or alter less than 1 percent of the available grazing habitat of the Western Arctic herd and represent NEGLIGIBLE habitat effects on caribou.

c. Effects of Oil Spills:

General Effects: Caribou sometimes frequent barrier islands and shallow coastal waters during periods of heavy insect harassment and may possibly become oiled or ingest contaminated vegetation. Caribou that become oiled are not likely to suffer any serious (lethal) effects (such as loss of thermo-insulation) through fur contamination. Oiled caribou hair would be shed during the fall before caribou grow their winter fur. Toxicity studies of crude-oil ingestion in cattle (Rowe, Dollahite, and Camp, 1973) indicate that anorexia (significant weight loss) and aspiration pneumonia leading to death are possible adverse effects of oil ingestion in caribou. However, caribou frequent coastal areas to avoid insects and thus are not likely to be grazing on coastal or tidal plants that may become contaminated. In the event of an onshore oil spill that contaminated tundra habitat, caribou probably would not ingest oiled vegetation because they are selective grazers that are particular about the plants they consume.

Site-Specific Effects: Unless otherwise specified, oil-spill-contact probabilities referred to in this section assume the occurrence of development to the extent estimated in Section II.A and associated spill rates. Attention is devoted to seven spills equal to or greater than 1,000 barrels and to spill contacts that occur within 10 to 30 days of summer spillage. There is essentially no chance of any of the seven oil spills contacting coastal spits, barrier islands, or other coastline habitats used by caribou for insect relief within 10 days of the spill release (Appendix A, Table A-17). Within 30 days of the spill release during the summer, there is only a 5-percent chance of one or more spills contacting the coastline at Ledyard Bay and a 2-percent chance of spill contact at Icy Cape. Spill-contact probabilities for other segments of the Alaskan Chukchi Sea coastline are zero. If a spill contacted the coastline at more than 10 days after spill release, the oil would be highly weathered and would have lost most of its toxicity.

If a spill occurred during the open-water season, caribou that frequent coastal habitats--such as in the Icy Cape or Ledyard Bay areas--could possibly be directly exposed to weathered oil along the beaches and in shallow waters during periods of insect-pest-escape activities. However, even in a severe situation of a 100,000-barrel spill, a comparatively small number of animals are likely to be exposed to the oil spill and die as a result--an effect that is likely to be NEGLIGIBLE on the Western Arctic caribou herd.

Onshore-Oil-Spill Effects: In the event of an onshore-pipeline spill, some tundra vegetation in the pipeline corridor would become contaminated. An estimated 188 small oil spills averaging from 6 to 1,500 barrels (see Table II-1) could be associated with the proposal. However, caribou probably would not ingest oiled vegetation because they are selective grazers and are particular about the plants they consume (Kuropat and Bryant, 1980). When a pipeline spill occurs, it is likely that control and cleanup operations (ground vehicles, air traffic, and personnel) at the spill site would frighten caribou away from the spill and prevent the possibility of caribou grazing on the oiled vegetation. Thus, onshore oil spills associated with the proposal are not likely to directly affect caribou through ingestion of oiled vegetation (NEGLIGIBLE effect).

Onshore oil spills on wet tundra kill the moss layers and above-ground parts of vascular plants, or they kill all macroflora at the spill sites (McKendrick and Mitchell, 1978). Thus, pipeline oil spills can destroy or alter the local grazing habitat along the pipeline corridor. Damage to oil-sensitive mosses may persist for several years if the spill sites are not rehabilitated (e.g., by applying phosphorus fertilizers to spill sites) (McKendrick and Mitchell, 1978). For the most part, onshore oil spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter caribou range within the pipeline corridor. The effect of onshore oil spills on caribou is therefore expected to be NEGLIGIBLE.

SUMMARY: The primary proposal-related disturbance source to caribou of the Western Arctic herd on their summer range is motor-vehicle traffic associated with the construction and presence of the 640-kilometer onshore pipeline and support road from a 30-hectare shorebase facility at Point Belcher to TAP Pump Station No. 2. Cows and calves of the Western Arctic herd are particularly sensitive to disturbance during the calving and postcalving seasons and would be especially disturbed during periods of heavy traffic (perhaps 40-60 vehicles/hour) associated with the 2-year construction period. Approximately 20 percent of the Western Arctic caribou herd (that portion of the herd that winters on the North Slope) may be temporarily disturbed by vehicle traffic associated with the Sale 109 pipeline corridor during spring migration, while other caribou could be disturbed during summer movements (see Fig. IV-23). Disturbance of caribou along the pipeline would be most intense during the construction period (about 2 years), when the motor-vehicle-traffic count would be highest (perhaps 40-60 vehicles/hour), but would subside (to perhaps 10 or fewer vehicles/hour) after construction is complete and over the remainder of the 30-year life of the field. Caribou movements across the pipeline corridor would be retarded or delayed during periods of heavy traffic; but caribou are likely to return to crossing the pipeline corridor after construction is complete, with little restriction in movements. Caribou have returned to habitat areas of previous disturbance and displacement after construction was complete in other development areas (Hill, 1984; Northcott, 1984). Vehicle traffic along the pipeline corridor would cause flight reactions by some caribou and would temporarily delay--for perhaps a few hours or no more than a few days--caribou movements across the pipeline corridor. This would represent a MINOR effect on caribou of the Western Arctic herd. Caribou distribution and/or abundance are not likely to be significantly affected by the proposal.

The 640-kilometer onshore pipeline, support road, and 10 helicopter pads associated with the proposal would alter or destroy about 64 square kilometers of range habitat of the Western Arctic herd, while the associated shorebase would cover 30 hectares of range habitat near Point Belcher. The habitat altered or destroyed by these facilities would represent less than 1 percent of the available range habitat of the Western Arctic herd--a NEGLIGIBLE habitat loss. Possible oil spills are likely to contaminate few caribou due to the very low chance of oil spills contacting the coast and thus would probably have NEGLIGIBLE effects on caribou. Although many small (6- to 1,500-barrel) onshore oil spills are estimated from the proposal (Table II-1), these spills would contaminate very local caribou range near the pipeline and not significantly affect the availability of caribou range (NEGLIGIBLE effect).

CONCLUSION (Effect on Caribou): The effect of proposed Sale 109 on caribou is expected to be MINOR.

CUMULATIVE EFFECTS: The additive effects on caribou of other ongoing and planned projects, as well as the proposal, are discussed in this section. Although the probability of any or all planned and ongoing projects reaching developmental stages is generally unknown, this analysis assumes that all of the projects discussed reach developmental stages. Motor-vehicle traffic and construction associated with these projects could disturb caribou and alter or destroy some calving and summer range.

Cumulative Effects of Disturbance: The primary sources of disturbance of caribou are ground-vehicle traffic (perhaps several hundred vehicles/day), aircraft traffic, and associated human presence (several hundred to several thousand people). Disturbance of caribou associated with cumulative oil exploration, particularly from helicopter traffic, is likely to be very brief and have MINOR effects on some caribou--particularly cow/calf groups--with animals being briefly displaced from feeding and resting areas when aircraft pass nearby. The greatest concern related to motor-vehicle disturbance of caribou is that associated with roads adjacent to pipelines. Caribou are most hesitant to cross (1) under an elevated pipeline adjacent to a road and (2) when motor-vehicle traffic is present on the road. The success of crossing the pipeline corridor in the presence of traffic depends on motivation. During the mosquito and oestrid-fly seasons, caribou are highly motivated to seek relief from insect harassment; and the frequency of pipeline crossings in the Prudhoe Bay/Kuparuk area increases (Curatolo, 1984), although increases in the percentage of disturbance reactions tend to reduce crossing frequency.

However, caribou successfully cross pipeline corridors and numerous highways in Alaska and Canada with no apparent effects on herd distribution, abundance, or integrity. Cumulative disturbance of caribou from pipeline corridors and associated motor-vehicle traffic is likely to cause MINOR, or short-term, disturbance of caribou. Road traffic temporarily delays the successful crossing of pipelines and roads by some animals but has no apparent effect on herd abundance or distribution. The only exception to this level of effect may occur when disturbance levels are very high and development facilities (drilling platforms, pump stations, pipelines, roads, etc.) on the calving grounds are spaced close together (within about 100-200 meters) and cause some displacement of cows and calves from a small portion of their calving range--within about 4 kilometers of these facilities.

At present, cumulative oil development in the Prudhoe Bay/Kuparuk area has caused minor displacement of caribou from a small portion of the calving range, with no apparent effect on herd abundance or overall distribution. The cumulative displacement of cow/calf groups from additional parts of the calving range with the development of additional oil fields in the Prudhoe Bay/Kuparuk area, in the NPR-A and Arctic National Wildlife Refuge (ANWR), and as a result of Canadian oil development could represent a long-term displacement (over the life of the oil fields) of caribou from a portion of the available calving habitat and represent a MODERATE effect on the overall distribution or abundance of caribou.

Cumulative Effects of Habitat Alteration: Cumulative oil development in the Prudhoe Bay/Kuparuk area encompasses over 800 square kilometers, and hundreds of kilometers of gravel roads cross a major portion of the calving range of the Central Arctic herd (see Fig. IV-23 and Graphic No. 3). A small percentage of the tundra grazing habitat has been destroyed where roads, gravel pads, gravel quarries, pipelines, pump stations, and other facilities are located. The cumulative loss of range habitat from facility construction during future oil development (such as in the NPR-A and ANWR) and the Red Dog Mine Project would also represent a small percentage of the available grazing habitat of the Western Arctic and Porcupine caribou herds, respectively, and would represent MINOR or NEGLIGIBLE habitat loss.

Cumulative Effects of Oil Spills: Potential oil spills from offshore as well as onshore oil activities associated with Federal, State, and Canadian leases probably would have NEGLIGIBLE effects on the caribou herds in general, since few caribou are likely to be contaminated or ingest contaminated vegetation and die as a result of oil spills (see discussion under the proposal).

Overall Cumulative Effects: Combined proposed and ongoing onshore oil and gas activities in the Prudhoe Bay, NPR-A, ANWR, and Canadian Mackenzie River Delta could have some long-term, MODERATE disturbance/displacement effects on caribou herds if the animals avoided significant parts of the core calving areas of either the Western Arctic, Central Arctic, Teshekpuk, or Porcupine herds for the life of the projects and a resulting reduction in caribou distribution or abundance occurred. Depending upon the timing, extent, and specific location of oil development and the duration (a few hours to several years) and intensity (few vehicles and aircraft/day to several hundred/day) of the disturbance, effects on caribou could range from MINOR to MODERATE. Transportation facilities associated with Federal and State offshore oil activities alone would have MINOR cumulative disturbance and habitat-alteration effects on caribou because onshore development associated with offshore leases would generally be limited to small shorebases and would not affect caribou over a large geographic area.

Cumulative reduction in local habitat use very near (within about 4 km of) facility construction (such as gravel mining, hundreds of kilometers of roads and pipelines, and a few square kilometers of drill pads) and the avoidance of caribou cows with calves of habitat areas with high levels of road and air traffic could have a MODERATE effect on the distribution of one or more of the North Slope caribou herds.

In theory, MAJOR effects are possible if caribou are displaced from or avoid calving habitats and summer ranges, causing a long-term reduction in herd productivity and leading to a population decline. However, because present levels of onshore-oil development in the Prudhoe Bay area have not demonstratively affected the abundance or overall distribution of any North Slope caribou herds, such effects are not expected.

Conclusion: Cumulative effects of the above projects, as well as the proposal, on the distribution of one or more North Slope caribou herds are expected to be MODERATE.

9. Effect on the Economy of the North Slope Borough: Most of the following information on the economic effects of proposed Sale 109 on the North Slope Borough (NSB) is incorporated by reference from "Economic and Demographic Projections on the North Slope Borough: Beaufort Sea Lease Sale 97 and Chukchi Sea Lease Sale 109" (University of Alaska, ISER, 1986). This report was based on employment projections prepared by the MMS for Sale 109 (see Appendix F, Table F-2). Neither the report nor MMS' projections assume any effects on existing economic conditions in the NSB that might be associated with proposed Beaufort Sea Sale 97.

a. Revenues and Expenditures: As discussed in Section III.C.1.a, the total NSB-property-tax value and NSB revenues are projected to steadily decline under existing conditions. However, actual revenues will be determined by several different factors. Therefore, these revenue projections are used with the understanding that many uncertainties exist regarding the future course of these factors. The proposed sale is projected to increase property-tax values starting in 1988. These sale-affected values are projected to be 10 percent or more above the declining existing-condition projections between 1998 and 2010. The peak absolute effect ($1.43 billion above the existing-condition projection) is projected to occur in 1998, and the peak relative effect (15% above the existing-condition projection) is projected to occur in 2010.

The two NSB-expenditure categories that affect employment--operations and the Capital Improvements Program (CIP)--are projected to steadily decline under existing conditions. Of these two categories, only expenditures on operations would be affected by the proposed sale's effects on taxable-property value. CIP expenditures, which have generated many high-paying jobs for residents, would not be affected. The constraint on the size of the effect of higher property-tax revenues as a result of Sale 109 is the "population" of the NSB, as it is defined for fiscal purposes. For fiscal purposes the "population" of the NSB includes commuters--people working in the region even though they reside elsewhere. The proposed sale is projected to affect the "population" through two types of effects on employment in the region: (1) more petroleum-industry-related jobs as a consequence of Sale 109 exploration and development and production activities--referred to as sale-related employment, and (2) more NSB-funded jobs as a result of higher NSB operating revenues and expenditures, as discussed above--referred to as sale-induced employment. The population effect of additional employment, primarily sale-related (resident and nonresident), would affect NSB revenues by allowing collection of additional property-tax-operations revenues that are proportional to the NSB "population."

Projected operations expenditures with and without the sale are shown in Figure IV-24. Sale 109 is projected to increase operating expenditures by 10 percent or more above the declining existing-condition projections between

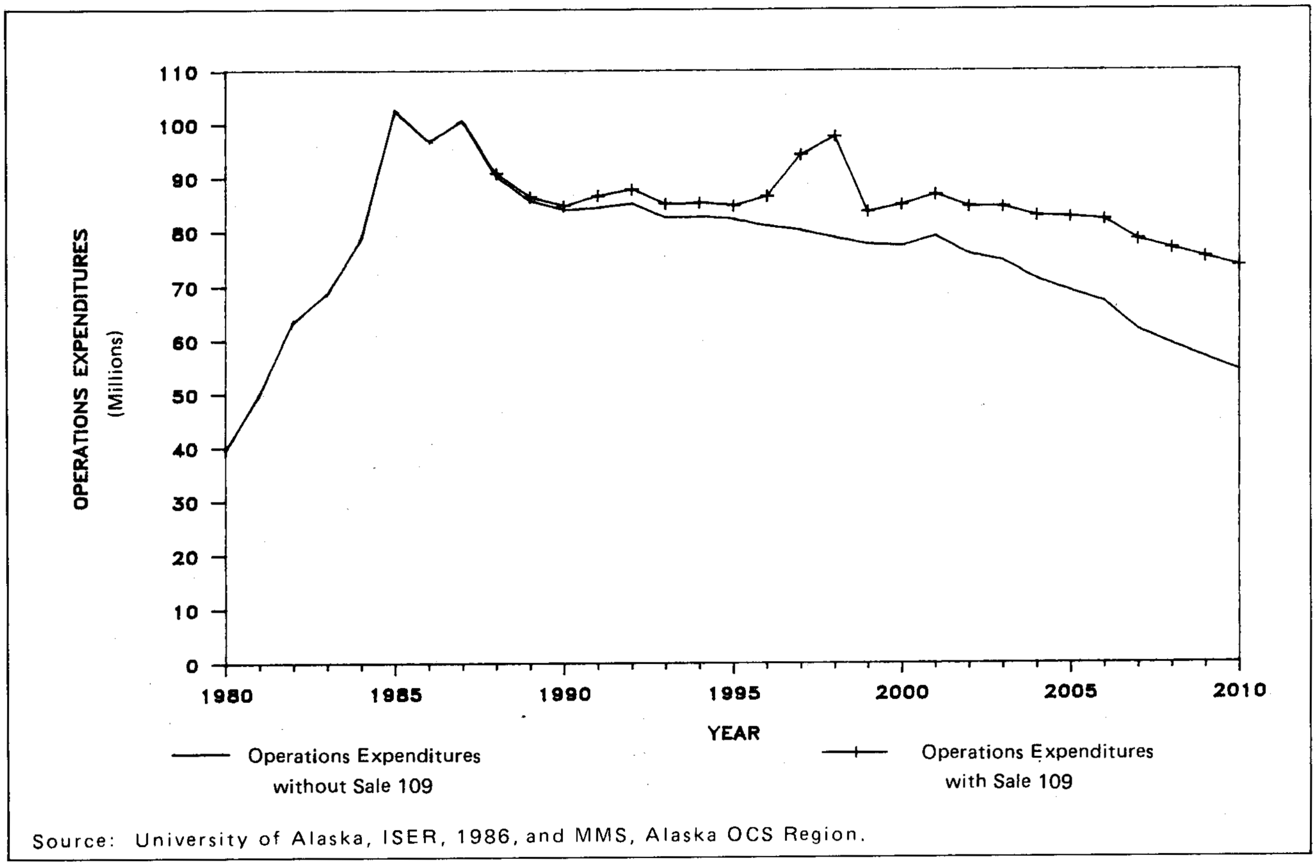


FIGURE IV-24. ACTUAL AND PROJECTED NORTH SLOPE BOROUGH-OPERATIONS EXPENDITURES WITH AND WITHOUT SALE 109

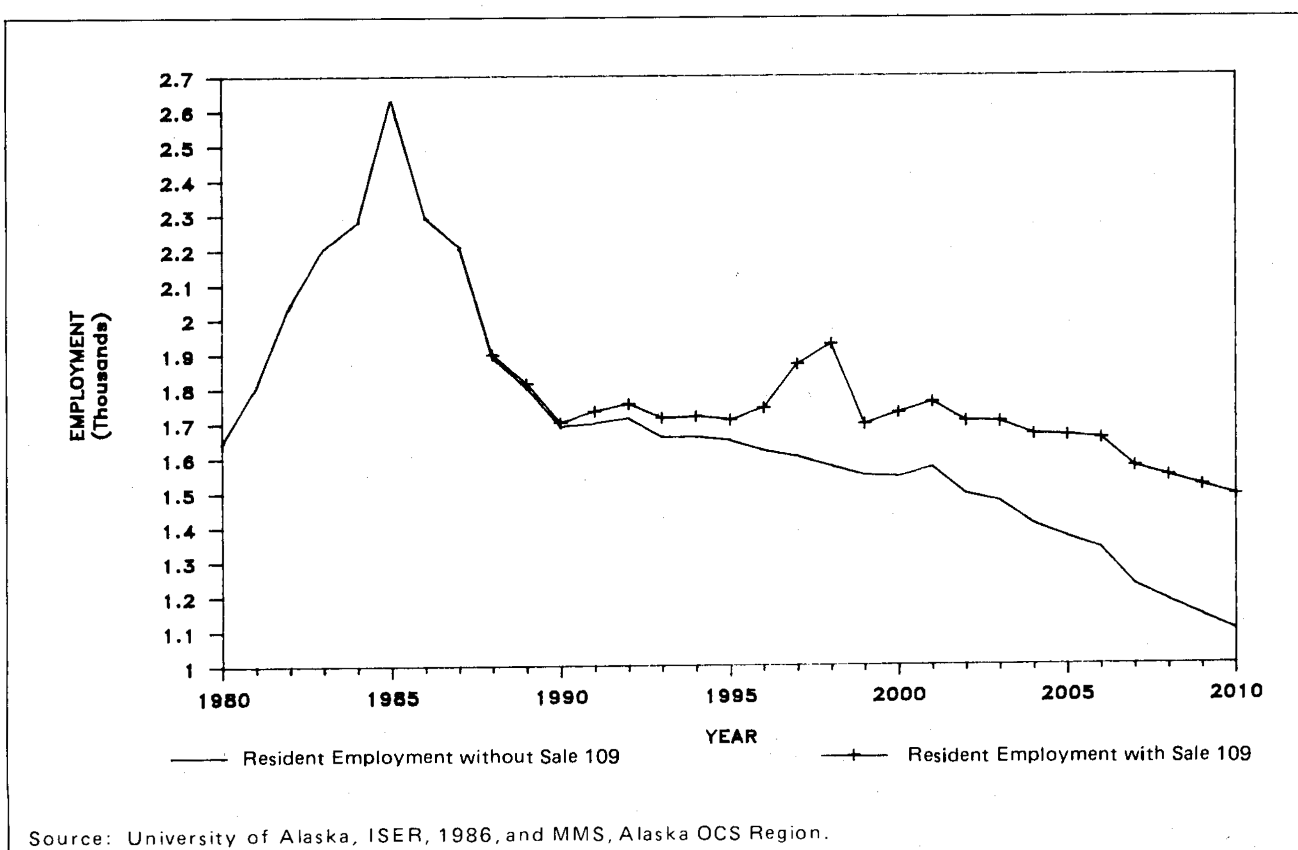


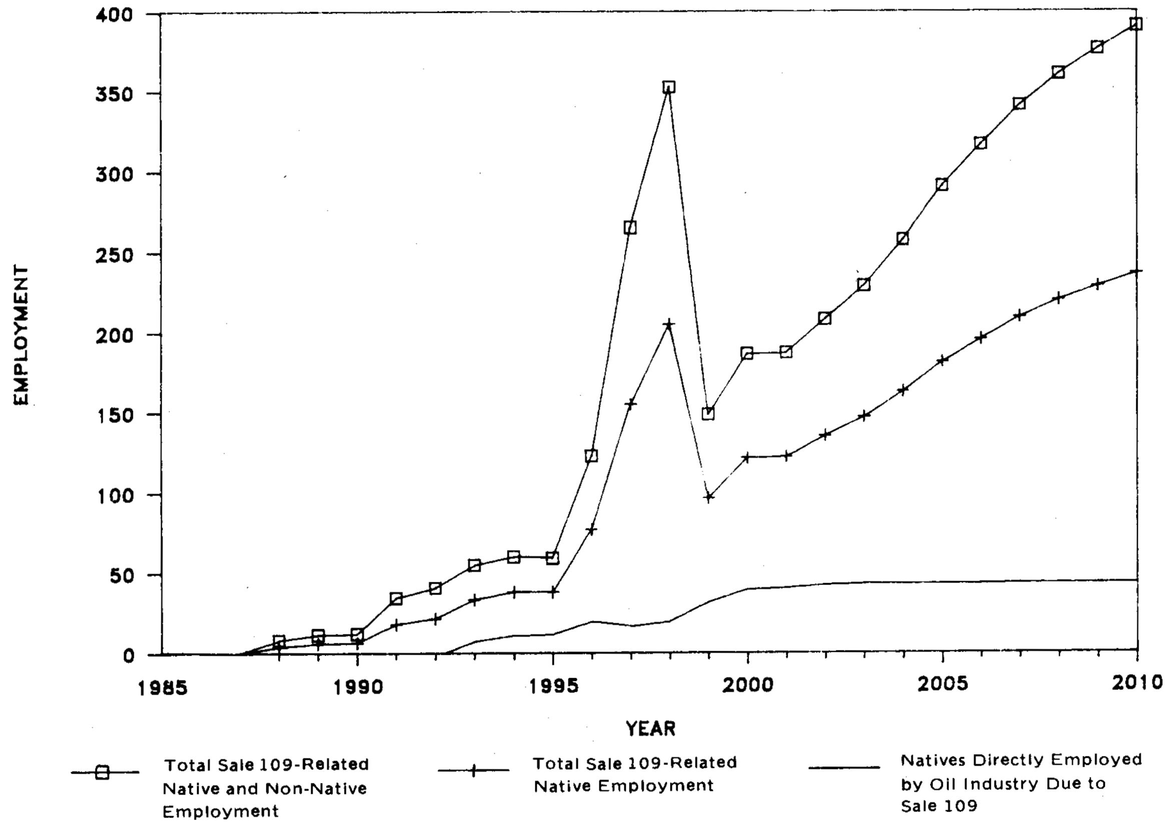
FIGURE IV-25. ACTUAL AND PROJECTED NORTH SLOPE BOROUGH-RESIDENT EMPLOYMENT WITH AND WITHOUT SALE 109

1997 and 2010, except for a slightly smaller effect in 1999. Expenditures are projected at 18 percent and 24 percent above the existing-condition projections in 1997 and 1998, respectively, as a result of the construction activity concentrated in this 2-year period that would affect both property-tax value and "population." The expenditure effects are projected to reach 20 percent above existing-condition projections by 2005 and 30 percent by 2008. The peak absolute effect ($19.3 million above the existing-condition projection) and the peak relative effect (36% above the existing-condition projection) are both projected for the year 2010.

b. Employment: The gains in direct employment from Sale 109 would include jobs in petroleum exploration and development and production and jobs in related activities. Excluding petroleum-industry-headquarters jobs in Anchorage, the estimated peak employment is estimated to be 4,887 jobs in 1998 (see Appendix F, Table F-2), of which 3,781 would be offshore and 1,106 would be onshore. Throughout the production phase, total employment is estimated to average about 2,200 jobs, of which approximately 300 would be onshore. All of these jobs would be filled by commuters who would be present at the work sites approximately half of the days in any year. Most workers would commute to permanent residences in the following three regions of Alaska--Southcentral, Fairbanks, and, to a much smaller extent, the North Slope. Some workers would commute to permanent residences outside of Alaska, especially during the exploration phase.

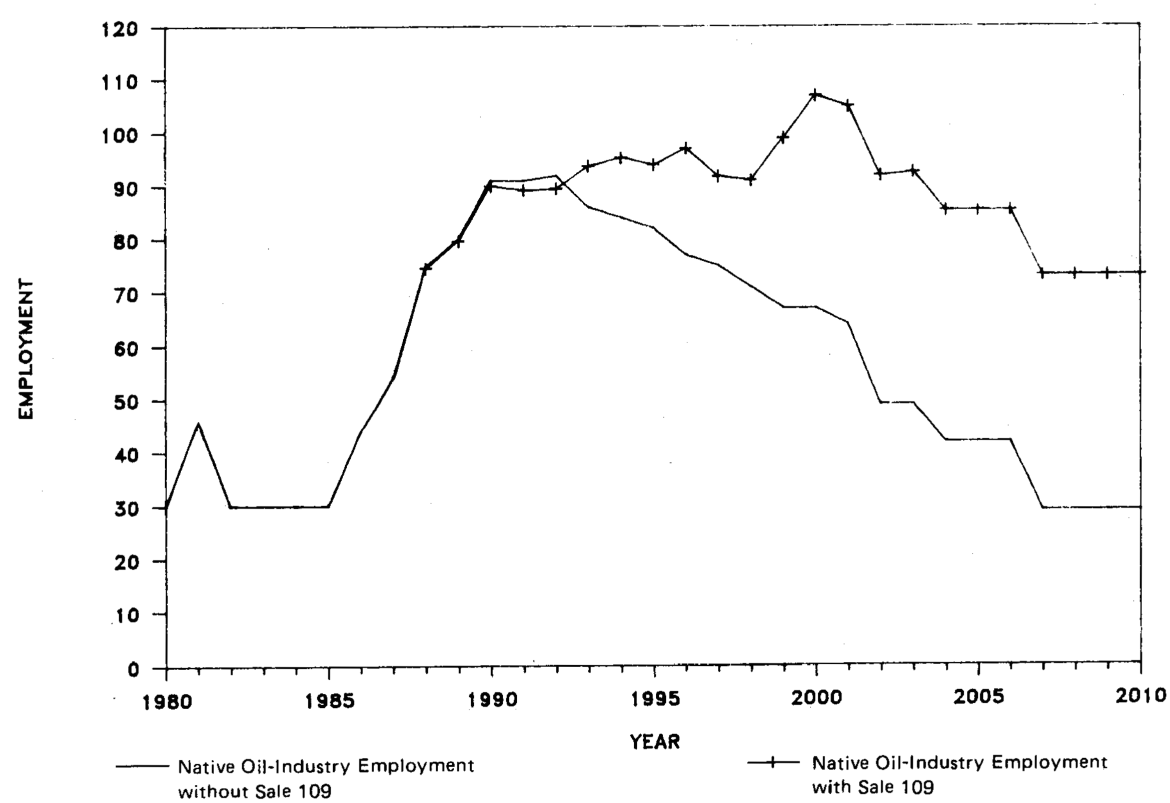
While the proposed sale is projected to generate a large number of petroleum-industry jobs in the region, the number of jobs filled by the region's permanent residents is not projected to be large. Figure IV-25 shows projected resident employment with and without the employment effects of proposed Sale 109. Declining NSB expenditures are the predominant factor in the general decline of employment in both cases. Sale 109 is projected to increase resident employment by 10 percent or more above the declining existing-condition projections between 1997 and 2010, except for a slightly smaller effect in 1999. Employment is projected to be 17 percent and 22 percent above the existing-condition projections in 1997 and 1998, respectively, as a result of the construction activity concentrated in these 2 years. The employment effect over the existing-condition projections is projected to reach 20 percent by 2005 and 30 percent by 2008. The peak absolute effect (391 jobs above the existing-condition projection) and the peak relative effect (36% above the existing-condition projection) are both projected for the year 2010, when increases in sale-related employment and decreases in total existing-condition employment would combine to produce this peak effect. The increase in sale-induced employment opportunities would partially offset declines in other job opportunities and, therefore, delay expected out-migration.

Sale-related and -induced resident employment is shown in Figure IV-26. The three lines represent (1) sale-related resident employment with petroleum-related industry (assumed to be all Natives), (2) total Native employment (sale-related and -induced), and (3) total resident employment (Natives and non-Natives). As can be observed, most of the additional employment is projected to be outside the petroleum industry. In addition to the constraints on industry employment of Native residents discussed in Section III.C.1.b, the small sale-related effect can be attributed to a combination of an already historically high level of industry employment (non-Native and



Source: University of Alaska, ISER, 1986, and MMS, Alaska OCS Region.

FIGURE IV-26. EFFECT OF SALE 109 ON PROJECTED NORTH SLOPE BOROUGH-RESIDENT EMPLOYMENT



Source: University of Alaska, ISER, 1986, and MMS, Alaska OCS Region.

FIGURE IV-27. ACTUAL AND PROJECTED OIL-INDUSTRY EMPLOYMENT OF NORTH SLOPE BOROUGH NATIVES WITH AND WITHOUT SALE 109

Native) assumed under existing conditions and declining petroleum-related Native employment in the North Slope region (see Fig. IV-27). As industry employment declines in the region, there might be less effort made to recruit and retain Native workers.

Just as is the case under existing conditions, the unemployment rate for Natives is projected to rise to 50 percent by 2005 and to remain at that level until the end of the projection period in 2010. While the unemployment rates are about the same for both cases, the Sale 109 case is projected to have a larger number of unemployed in 2010 (1,035 vs. 851) and a larger labor force (1,882 vs. 1,461), which result in similar rates. As under the existing-conditions projection, non-Native residents who lose their jobs are assumed to leave the region.

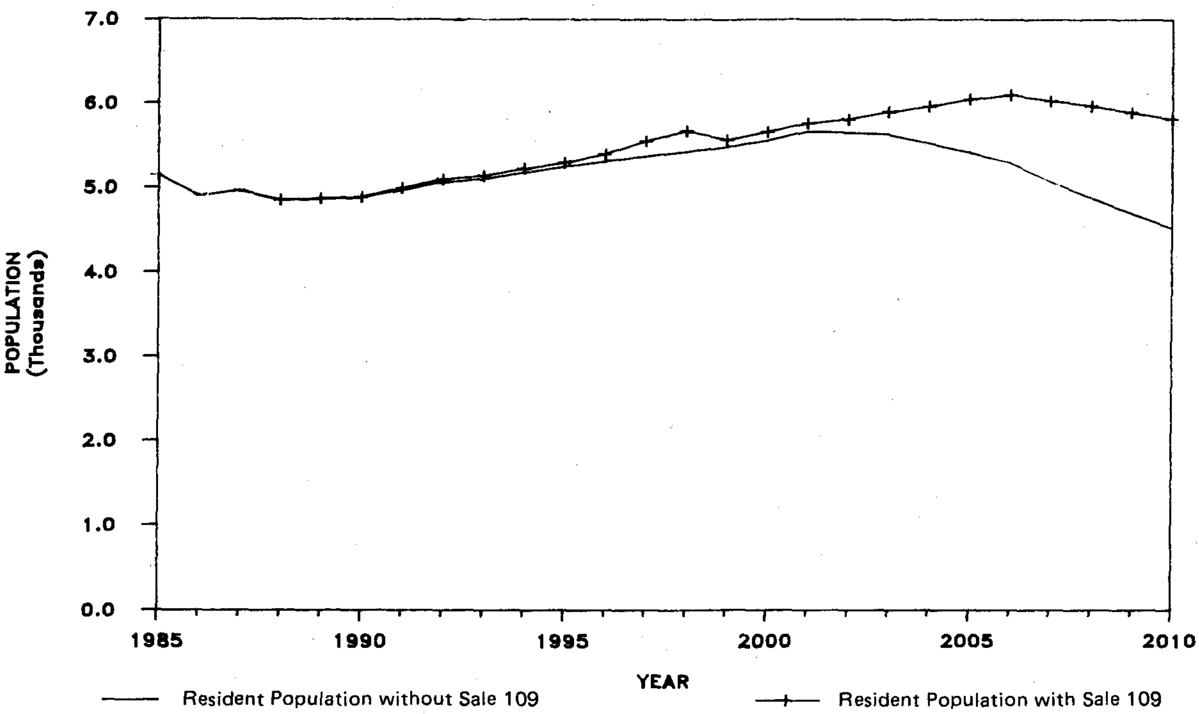
c. Population: The projected resident population with Sale 109 is shown in Figure IV-28. The sale's effect is projected to increase the NSB population by less than 10 percent above the existing-condition level until 2005. By 2008, the effect is projected to be over 20 percent greater. As can be seen in Figure IV-28, the NSB population peaks out later (in 2006 rather than in 2001) and does not decline as rapidly (-1.1%/year rather than -2.5%/year) as a consequence of the sale. In both cases, the projected decline in population is assumed to be caused by the decline in employment opportunities discussed above. By the end of the forecast period, the Native proportion is projected to be the same as under the existing-condition forecast (86%).

SUMMARY: While most of the jobs in sale-related activities would be filled by commuters from outside the region, the effects of proposed Sale 109 on the economy of the North Slope Borough region is expected to be NEGLIGIBLE. The effect of the proposed sale on resident employment is expected to be about 10 percent or greater above employment without the sale from 1997 onward. Barrow--the regional center and the least traditional of the North Slope communities--is likely to benefit the most from sale-related and -induced employment increases. Even though the petroleum-related facility assumed to be located near Wainwright is expected to be an enclave, the proximity of Wainwright may encourage more Wainwright residents to apply for sale-related jobs. The number of Wainwright residents who obtain these jobs will depend on whether the industry modifies its staffing policies to emphasize more local hires.

Effects of proposed Sale 109 on Native- and non-Native-resident employment are expected to be slightly higher and slightly lower than the total resident-employment effect, respectively. However, the unemployment rate for Native residents is still expected to reach 50 percent by 2005, with or without the proposed sale.

CONCLUSION (Effect on the Economy): The effect of proposed Sale 109 on the economy of the North Slope Borough region is expected to be NEGLIGIBLE.

CUMULATIVE EFFECTS: Cumulative-case projects would provide additional revenues to the NSB in the form of property taxes and additional employment opportunities for residents. Projects that increase NSB property-tax revenues are expected to allow increased NSB hiring of residents. Projects that expand employment opportunities in the region without significantly increasing NSB



Source: University of Alaska, ISER, 1986, and MMS, Alaska OCS Region.

FIGURE IV-28. ACTUAL AND PROJECTED NORTH SLOPE BOROUGH-RESIDENT POPULATION WITH AND WITHOUT SALE 109 property-tax revenues are likely to generate strong interest in industry employment from residents. The economic effects of the cumulative-case projects are considered by category--existing developments, exploration and potential development, and future lease sales. All of the existing developments were considered as part of the existing-conditions case. Projects in the exploration and potential development category are expected to have MINOR economic effects and moderately increase the economic benefits. Future lease-sale projects are expected to have MINOR economic effects and moderate economic benefits. The effects in both categories are considered to be MINOR because of the modest scale of the potential resources to be developed.

The overall revenue and employment effects of these projects would be beneficial, but the magnitude and timing of these effects are extremely difficult to estimate. Major uncertainties exist about future world-energy prices; arctic-development technology; scale, timing, and location of developments; and hiring practices. When a downturn of development activity occurs, households--especially in the smaller communities--may have trouble maintaining the standards of living attained during boom periods.

Conclusion: Cumulative effects on the economy of the North Slope Borough region are expected to be MINOR, as compared to NEGLIGIBLE for the proposal.

10. Effect on Subsistence-Harvest Patterns: Section III.C.2 (1) describes the subsistence-harvest patterns characteristic of Inupiat communities adjacent to the Sale 109 area, (2) outlines the important seasonal subsistence-harvest patterns by community and by resource, (3) provides figures depicting the areal extent of each community's general subsistence-harvest area and the timing of harvests, and (4) presents estimated quantities of subsistence resources harvested. Section IV.B.10.a below summarizes the subsistence-harvest patterns. Sections III.C.2 and III.C.3 demonstrate that significant aspects of each community's economy, culture, social organization, normative behavior, and beliefs interact with--and depend on--patterns of subsistence harvest. The sociocultural aspects of subsistence are addressed in Section IV.B.11.

a. Introduction: This section analyzes the effects of the proposal on subsistence-harvest patterns of communities close to the Sale 109 area. This analysis is organized by subsistence resource and discusses effects on subsistence-harvest patterns as a result of oil spills, noise and traffic disturbance, and construction activities. Following this analysis is a discussion of effects on subsistence-harvest patterns that is organized by community.

The Sale 109 area includes the entire marine-subsistence-resource areas of Wainwright, Point Lay, and Point Hope, as well as a substantial portion of Barrow's marine-subsistence-resource area (also used by Atqasuk residents [see Sec. III.C.2]). Moreover, if economically recoverable amounts of oil were discovered, onshore pipelines and other facilities associated with its development could affect the terrestrial subsistence resources that are harvested by these four coastal communities as well as the inland communities of Atqasuk and Nuiqsut.

As noted in Sections III.C.2 and III.C.3, onshore-oil developments at Prudhoe Bay have already affected the subsistence-harvest system. Many of these effects are the indirect result of increased wage employment made available through projects and services funded by the North Slope Borough (NSB). Wage employment has led to an upgrading of hunting technology but, alternatively, has constricted the total time available for hunting. However, over the 30-year life of the project, household incomes and available jobs are expected to decrease (see Secs. III.C.1 and IV.B.9). If this decrease occurs, hunting technology will remain constant while the time available for hunting will increase. Currently constricting household incomes are encouraging increased harvest levels for many subsistence resources, and this trend is expected to continue.

Access to subsistence resources, subsistence hunting, and the use of subsistence resources could be affected by reductions in subsistence resources and changes in subsistence-resource-distribution patterns. These changes could occur as a result of oil spills, noise and traffic disturbance, and construction activities. The following analysis examines the effects of each of these causal agents on the subsistence resources harvested by the Inupiat living near the Sale 109 area, with specific information by community, where applicable. This analysis includes the marine and terrestrial resources harvested by the residents of Barrow, Wainwright, Point Lay, and Point Hope, and the terrestrial resources and marine and coastal birds harvested by the residents of Atqasuk and Nuiqsut. Because Atqasuk residents also harvest marine mammals--but only in conjunction with Barrow harvests and in the same areas--Atqasuk is included in the discussion of Barrow. Although Nuiqsut's marine-subsistence-harvest area is outside of the Sale 109 area, the community's terrestrial-mammal-resource area is considered because the proposed pipeline from Point Belcher to TAP Pump Station No. 2 would run through a portion of Nuiqsut's caribou-subsistence-harvest area.

The factors affecting the subsistence-harvest patterns of Barrow, Wainwright, Point Lay, Point Hope, Atqasuk, and Nuiqsut are summarized as follows (the information on harvests is taken from records of annual subsistence-resource harvests averaged over 20 years [Stoker, 1983, as cited by ACI/Braund, 1984]):

1. Heavy reliance on caribou (30-58% of the annual average harvest for Barrow, Wainwright, and Point Hope and 90% for Nuiqsut [see Table III-15]).

2. Reliance on bowhead whales (9-21% for Barrow, Wainwright, Point Hope, and Nuiqsut [see Table III-15]).

3. Reliance on fish (7-10% for Barrow, Wainwright, and Point Hope [see Table III-15]).

4. Hunting ranges overlap for all species harvested by Point Lay, Wainwright, and Barrow.

5. Hunting and fishing are cultural values that are central to the Inupiat way of life and culture.

6. In 1985, the population of Barrow was 3,075; Wainwright was 507; Point Lay was 129; Point Hope was 570; Atqasuk was 214; and Nuiqsut was 337.

Causal Agents Affecting Subsistence-Harvest Patterns:

Oil Spills: Subsistence-resource areas for Barrow, Wainwright, Point Lay, and Point Hope are shown in Figure IV-29 to indicate important marine mammal-harvest areas used by communities that would be vulnerable if an oil spill occurred and contacted these areas. Seven oil spills are estimated to occur during the 30-year life of the project. A most likely number of two or three spills is estimated to contact the Wainwright subsistence-harvest area. No other subsistence-harvest area is anticipated to have more than one spill contact. During the open-water (summer) months, there is a 76-percent chance that an oil spill of 1,000 barrels or greater would occur and contact the Wainwright subsistence-resource area within 10 days, and a 24-percent chance that such a spill would occur and contact the Point Lay subsistence-resource area within 10 days. Contact in either community could affect seal, bird, walrus, and beluga whale hunting; ocean-fish netting; and bowhead whaling in Wainwright (see following discussions in Sec. IV.B.10.b on each subsistence resource for analysis of these effects, including the number of animals that might be affected). During the winter, there is a 77-percent chance of an oil spill of 1,000 barrels or greater occurring and contacting the Wainwright subsistence-resource area, while there is a 45-percent chance in winter of such an oil spill occurring and contacting the Point Lay subsistence-resource area within 10 days. These probabilities indicate that Wainwright's and Point Lay's harvests of seals and polar bears could be affected by contact from a spill during winter (see following discussion in Sec. IV.B.10.b on seals and polar bears for an analysis of effects). During the summer or the winter, there is a less-than-0.5-percent chance of such a spill occurring and contacting Barrow's and Point Hope's subsistence-resource areas. While the effects of an oil spill of 100,000 barrels or greater would be likely to cause more than MINOR effects on more harvests than the effects of a 1,000-barrel spill, a spill of 100,000 barrels is unlikely. There is a 1-percent chance of such a spill occurring under the proposal and only a 7-percent chance of such a spill contacting any subsistence-resource area. Analyses of the effects of oil spills on each subsistence resource are provided in Section IV.B.10.b. Cleanup activities associated with an oil spill would have only short-term, localized effects on biological resources and subsistence-harvest patterns.

Onshore oil spills from the proposed pipeline from near Point Belcher to the TAP are also of concern. An expected 22 major onshore spills of, on average, 1,500 barrels each are expected during the life of the project (see Table II-1). Onshore spills would have NEGLIGIBLE biological effects on all terrestrial caribou (see Sec. IV.B.8), MINOR biological effects on marine and coastal birds (see Sec. IV.B.5), and MODERATE biological effects on fishes, although a MAJOR biological effect on fishes is possible if the Colville River were contaminated (see Sec. IV.B.4). An analysis of how these biological effects would affect subsistence harvests follows in this section.

Noise and Traffic Disturbance: Animals may avoid areas of high noise and disturbance and, thus, become unavailable to a particular community or become more difficult to harvest. Short-term effects, such as flight behavior or increased wariness, may also make animals difficult to harvest. This is a particular concern in the case of bowhead whaling because these whales may flee into the broken-ice zone. Noise and disturbance may lower fertility rates of waterfowl by causing them to leave their nests, which could adversely

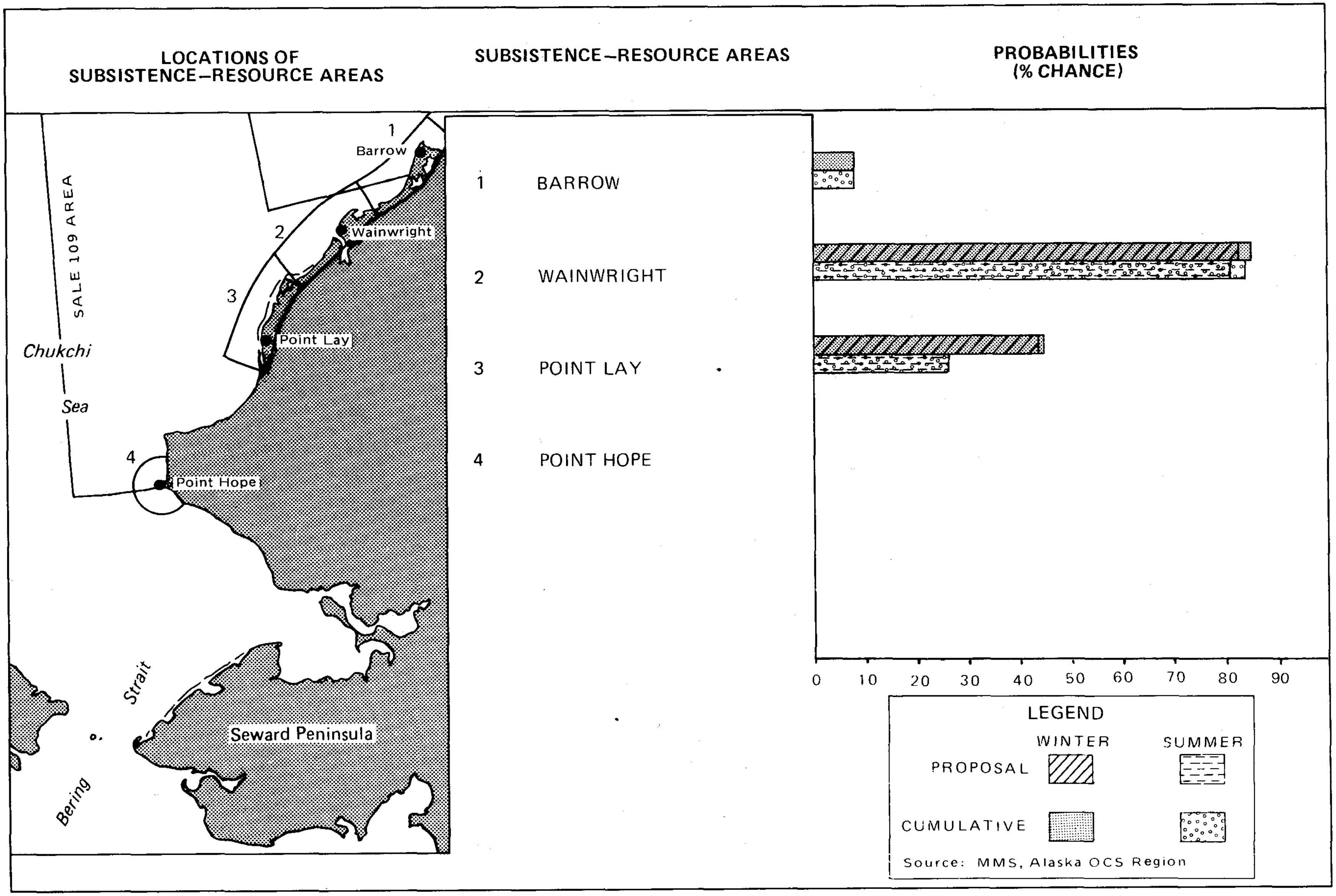


FIGURE IV–29. COMBINED PROBABILITIES OF OIL–SPILL CONTACT TO SUBSISTENCE–RESOURCE AREAS DURING THE OPEN–WATER SEASON IN COMPARISON TO THE ENTIRE WINTER SEASON

NOTE: PROBABILITIES OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING SUBSISTENCE–RESOURCE AREAS 1 TO 4 DURING THE OPEN–WATER SEASON IN COMPARISON TO THE ENTIRE WINTER SEASON WITHIN 10 DAYS OVER THE LIFE OF THE FIELD affect the availability of some species. Finally, fishes and fish eggs may be killed by seismic activities; and this, too, might affect the availability of harvestable resources.

Noise and disturbance would be associated with the (1) surveys that are part of the preliminary activities of the lease-sale phase; (2) movement, installation, and operation of drilling units and production platforms; (3) well drilling during the exploration and development and production phases; (4) offshore-pipeline-trenching and -laying operations; (5) onshore-pipeline and road construction; (6) aircraft and marine support of the preceding activities (see following analysis); and (7) cleanup activities in the event of an oil spill. Noise and traffic would be a factor throughout the life of the proposed action during exploration, development, and production (see Sec. II.A). (An analysis of the effects of noise and traffic disturbance on each subsistence resource is provided below in Sec. IV.B.10.b). During exploration, 43 wells are expected to be drilled from a maximum of 4 drilling units. Seismic activity will occur on 301 days over 8 years of exploration. There will be 6 ice-management vessels and 1 to 8 barges per year servicing the exploration phase. During development, a 25- to 30-hectare shorebase is predicted in the scenario established at Point Belcher. The following activities are predicted for development: 9 production platforms would be constructed throughout the sale area; there would be 68 barges in the peak year (1988) and 270 to 540 work-boat trips per month; helicopters would make 270 to 810 round trips per month; and offshore trunk pipelines (400 km) from the 9 platforms would converge at Point Belcher and form one onshore pipeline to TAP Pump Station No 2. Support activity would drop during production to 75 helicopter round trips per month, and 3 support/supply boats and 13 barges per year to service the area.

<u>Construction Activities</u>: Construction activities that may adversely affect subsistence include the installation of mobile bottom-founded drilling units and production platforms; the excavation of glory holes if floating units are used in exploration; offshore-pipeline-trenching and -laying operations; and onshore construction of support facilities, pipelines, or roads. During construction, disturbance from such activities may cause some animals to avoid areas in which they are normally harvested or to become more wary and difficult to harvest. The latter is a particular concern in the case of bowhead whaling because bowheads may flee into the broken-ice zone. In some instances, as in the case of nesting birds, construction activities may decrease the biological productivity of an area. Restrictions may be placed on the use of firearms in areas surrounding new oil-related installations (such as roads, pipelines, and drilling platforms) in order to protect oil workers and valuable equipment from harm. Finally, structures such as pipelines may limit hunter access to certain active hunting sites.

Installation of the mobile, bottom-founded exploration-drilling units is expected to take several days. Glory-hole excavation could take about 1 week if the hole is excavated by a large-diameter rotary bit or between 10 and 30 days if a clam-shell dredge is used. The excavated material is expected to be loaded onto barges for disposal at a site approved by the EPA; however, some material may be lost to the water column.

Trenches for the offshore pipeline would be cut and the pipe would be laid during the open-water season, although these pipe-laying activities may require ice-management operations. Construction of the onshore segments of the pipeline and support road from Point Belcher to TAP Pump Station No. 2 would take about 3 years. These onshore construction activities could take place at anytime of the year.

Construction activities associated with the onshore pipeline and support road and shorebase could affect Wainwright's and a portion of Barrow's, Atqasuk's, and Nuiqsut's subsistence-harvest patterns. (An analysis of the effects of construction activities on each subsistence resource is provided below in Sec. IV.B.10.b.) Although Point Lay and Point Hope are too distant from these construction activities to be affected, they could be affected by noise and traffic disturbance from icebreakers, seismic and work boats, and offshore platforms (see following section).

b. Effects on Subsistence Resources by Resource: The following discussion analyzes the potential effects of oil spills, noise and traffic disturbance, and construction activities on specific subsistence resources within the Sale 109 area. Section IV.B.10.c follows this resource-specific discussion and summarizes and assesses the effects on each community in the Sale 109 area.

(1) Bowhead Whales: The bowhead whale is the Inupiat's most culturally important subsistence resource (see Sec. III.C.3). It is also the resource that provides the second- or third-most meat to Barrow, Wainwright, and Point Hope residents (see Sec. III.C.2 [Tables III-12 and III-13; see Fig. III-22 for harvest areas]). Section IV.B.7.a(1) concludes that MINOR biological effects from oil spills are anticipated on bowhead whales because it is anticipated that not more than a specific group of individuals of the whale population in a localized area would be affected for less than one breeding cycle (approximately 3-6 years). Only one to three whales are harvested annually by each whaling community (with the exception of Barrow, which has recently had a higher quota of 5 to 7 whales). Whaling begins in late March to early April and ends in late May to early June in Point Hope, Wainwright, and Barrow (Barrow also conducts fall whaling in late August-early October, but this occurs outside of the Sale 109 area). Although the whaling season is approximately 2 months long, poor whaling conditions can reduce the whale hunting to as little as a few weeks.

Whaling activities are localized and occur within a short time period; consequently, an untimely oil spill could disrupt a community's subsistence effort for an entire season. There are so few bowhead whales harvested that a decrease in the harvest could mean a reduction from one to zero whales--an elimination of the harvest. Even if oil did not affect the entire population of bowhead whales and only a number of individuals in a localized area were oiled, or even if oil were in the area but did not affect the whales, the bowheads still would be rendered inedible or perceived as such and consequently would not be harvested. The consequences of such effects would be multiplied if seven oil spills occurred during the whaling season in consecutive years. This is most likely in Wainwright where the most likely number of spills estimated to contact the Wainwright subsistence-harvest areas is two or three. In other areas no more than one spill is expected during the life of the project. Although it is possible that an oil spill might eliminate the whale harvest, it is more likely that a spill would force hunters to move to a new location. The forced move would shorten the whaling season and might decrease the number of whales harvested--an effect that could occur in the Wainwright subsistence area.

Point Lay residents do not hunt the bowhead whale (although some Point Lay residents travel to Wainwright to be on Wainwright's whaling crews); and the low probability (less than 0.5%) of oil spills occurring and contacting Barrow's and Point Hope's subsistence-resource areas indicates that disruption to the whale harvests of those communities is not likely to occur. For Wainwright, there is a 76-percent chance of an oil spill occurring and contacting the coast within 10 days during the open-water months. If this occurred, whalers would be likely to move to another whaling site and thereby shorten the whaling season.

In the event of an oil spill that occurred and contacted the bowhead whale migration, it is possible that the Native bowhead whale hunt could be suspended by the IWC, the NOAA, or, less likely, the AEWC. The NOAA has a Cooperative Agreement with the AEWC and is responsible for ensuring that the bowhead hunt occurs within the guidelines and restrictions set forth in the Cooperative Agreement. It is possible that, in response to public pressure of perceived effects on the bowhead from an oil spill, the NOAA or the IWC might suspend bowhead whaling without waiting for scientific evidence of effects on the regional population (Braund, 1987, oral comm.; Brownell, 1987, oral comm.; Crichton, 1987, oral comm.; Lefevre, 1987, oral comm.). Such an event occurred in 1969 after the Santa Barbara oil spill off the coast of California. A limited scientific catch of gray whales had been permitted. During the oil spill, a few dead whales were found on the beach. Without waiting for scientific evidence to prove that the whales were dead as a result of the oil spill, the Bureau of Commercial Fisheries (which had jurisdiction over endangered whales at the time but was later absorbed into the NOAA) ceased permitting a scientific catch of gray whales strictly because of public pressure and perceived fears regarding what the oil spill could do to the gray whale (Brownell, 1971). Despite these concerns, however, there were no efforts to suspend or terminate the subsistence harvest of gray whales in Alaska. No scientific evidence was ever documented to demonstrate that these whales died because of the oil spill; in fact, it was later revealed that there were no more whales found dead on the beach in 1969 than in the previous 20 years (Brownell, 1971).

Although a precedent has been set for curtailing a scientific catch of gray whales without evidence of oil-spill effects, this does not mean that in 10 years or more when development in the Chukchi Sea might occur (28 years after the Santa Barbara spill), the NOAA would suspend the Native catch of bowheads in the event of an oil spill. There is currently much more information known about the effects of oil spills on whales (see Sec. IV.B.7). In addition, the bowhead whale population has increased considerably each year; and the NOAA has learned to look for scientific evidence of effects before responding to public perceptions and fears. If evidence were produced to indicate that the bowhead whale population was affected by an oil spill, it is probable that either the AEWC, the NOAA, or the IWC could consider the possibility of suspending the bowhead hunt or decreasing the quota (Montanio, 1987, oral comm.; Roots, 1987, oral comm.). A suspension is not likely since the whale-population count has been increasing (and should continue to increase during the 30-year life of the Sale 109 field), and more than MINOR effects on the bowhead are not expected in the Sale 109 area (see Sec. IV.B.7). Thus, suspension of the bowhead whale hunt certainly might be considered by the AEWC, the NOAA, or the IWC in the event of an oil spill that occurred during the whale migration; however, it is expected that no agency would react out of perceived fears but rather would wait until scientific evidence indicated a level of effects that would warrant a suspension.

Industrial activity is not expected to result in distributional changes in the bowhead population (Sec. IV.B.7). However, support vessels and platforms in the vicinity of the subsistence-harvest area could disturb the harvest without disturbing the general bowhead population. Exploration drillships and their associated support activities are not likely to affect bowhead whaling in the Sale 109 area because bowhead whaling occurs in the spring, when narrow leads are formed and little open water exists. Exploration drillships are not likely to be moved into operation until open water has formed after the whaling season. However, bottom-founded exploration-drilling units and production platforms would be in place year-round and could be located in the vicinity of the bowhead whale-harvest area. The whaling camps may be as far as 16 to 24 kilometers offshore. Later in the spring, when the leads widen, the Wainwright whalers could possibly travel another 25 kilometers offshore to look for whales.

Noise from bottom-founded exploration-drilling units, production platforms, support vessels, or icebreakers associated with the platforms could disrupt the whaling effort. If a vessel or rig were in the way of a whale chase, it could cause that particular harvest to be unsuccessful. Icebreakers moving through the whale-harvest area also could cause an unsuccessful harvest. Icebreakers could be sent to the Sale 109 area prior to the open-water season during the bowhead whale-migration (beginning mid-April [see Sec. III.C.2]) and the whale-hunting season. Whaling usually occurs in the open-water area between the pack ice and the fast ice or the shore at a time when the length and width of the open-water area is restricted. If disturbed, bowheads might move into the pack ice and thus might become unavailable to whalers. Recent evidence indicates that a whale may react to vessel-engine noise as far as 12 kilometers away from the source (Sec. IV.B.7), although disruption is likely to be short-term and temporary. Such disturbance would most likely be short and temporary enough that, during a normal whaling season of a couple of months' duration, there would be plenty of opportunities to harvest other whales. However, during a year when the weather and ice conditions are poor and the whalers' ability to harvest any whales is limited, the noise disruption could occur during the only brief period when harvesting a whale is possible. The probability of a drilling rig being located in an area critical to whaling during the whaling season cannot be determined; however, if this condition did occur, potential conflict could be mitigated by the cessation of drilling operations during the whale migration. Since fall ice conditions are not predictable events, the second effect--user conflicts between vessels and whalers due to bad ice conditions--might be more difficult to mitigate. This problem has been reported once for the Alaskan Arctic: in the fall of 1985, extreme ice conditions curtailed the length of Kaktovik's whaling season and, at the same time, caused vessels traveling to their overwintering sites to operate near whaling locations (Smythe, 1985, oral comm.).

As a result of this conflict, a cooperative program was formed in 1986 between the NSB, the AEWC, the Nuiqsut and Kaktovik whaling captains, and those petroleum companies that were interested in conducting geophysical studies and exploration drilling activities in the Beaufort Sea. This program was approved through a Memorandum of Understanding between the NOAA and the AEWC pursuant to the 1983 Cooperative Agreement, as amended. The 1986 Oil/Whalers Working Group established a communication system and guidelines to assure that industry vessels avoided interfering with or restricting the bowhead whale hunt, and to establish criteria whereby the oil industry would provide certain kinds of assistance to the whalers. The program was successful. Kaktovik harvested three whales and Nuiqsut harvested one. This cooperative program is a good example of how interference with a subsistence harvest can be effectively mitigated. In the absence of such mitigation, such a curtailment of the whaling season for the year due to noise and traffic disturbance associated with Sale 109 would cause the bowhead to become locally unavailable for no more than 1 year, representing MODERATE effects on the bowhead whale harvests of Wainwright and Point Hope. Barrow's subsistence-whale-harvest area is too distant from areas of sale-related industrial activity and would not be affected by noise and traffic disturbance; therefore, effects are expected to be NEGLIGIBLE.

During the development and construction phase, an offshore pipeline to Point Belcher might disturb Wainwright's bowhead whale hunt. Point Belcher lies in the center of an important bowhead whaling area for Wainwright (see Fig. III-22). A landfall and shorebase at Point Belcher would concentrate noise and traffic disturbance in this harvest area. The ice conditions in the Chukchi Sea are less predictable than in the Beaufort Sea. It is unlikely that construction activities would begin before the open-water season; however, this is not a certainty, and this analysis assumes that such activities would occur during the whaling season. Since bowhead whales may be particularly sensitive to noise and traffic disturbance associated with construction activities, Wainwright's bowhead whale harvest could become locally unavailable for 1 year or more, representing MAJOR effects on the harvest of bowhead whales. Due to the absence of construction activities in the Barrow, Point Lay, and Point Hope subsistence-harvest areas, and the absence of bowhead whaling in Point Lay, effects on the bowhead harvest of those communities from construction activities would be NEGLIGIBLE.

(2) Beluga Whales: Point Lay residents are the primary hunters of beluga whales. Belugas are also Point Lay's most important marine resource; in 1983, 28 belugas were harvested (the percentage of belugas to the total annual subsistence harvest is not available). Other coastal communities in the Sale 109 area depend on belugas to a much lesser extent (less than 6%) than does Point Lay--primarily because those communities are able to harvest the bowhead whale, which is a preferred food (see Sec. III.C.2 [Table III-15]; see Fig. III-23 for harvest areas). However, during years when a bowhead is not harvested, other marine resources--including belugas--become more crucial to compensate for the lost bowhead harvest. Beluga whales are sometimes harvested in Barrow, Wainwright, and Point Hope in conjunction with bowhead whales in the ice leads, although they are more likely to be hunted after the bowhead hunt is over--during the open-water months throughout the summer from June to August. Point Lay residents occasionally harvest beluga whales from early May to late August, but the peak beluga hunting season--when the majority of belugas are harvested--occurs in the first few weeks of July (see Sec. III.C.2).

Beluga whales may avoid areas where oil is present, so only a small portion of the beluga population would be affected over a short period of time if an oil spill occurred when the belugas were present. Biological effects on beluga whales (Sec. IV.B.6) from oil spills associated with Sale 109 are expected to be MINOR. Although oil spills are not likely to affect beluga whales--even if they were oiled or ingested oil, the belugas would likely be rendered inedible or be perceived as such and consequently would be unharvestable. The harvest could also be hindered by oil-spill-cleanup efforts if cleanup were conducted during the harvest. Since beluga whales are hunted by Point Lay residents during a short timeframe--no longer than a few weeks (Sec. III.C.2), an oil spill that occurred during this period could cause belugas to become unavailable in Point Lay for that year, representing MODERATE effects on the Point Lay beluga whale harvest. The beluga-hunting season in Barrow, Wainwright, and Point Hope is much longer than in Point Lay--from the beginning of the bowhead whaling season (late March) until August; consequently, an oil spill most likely would not eliminate the entire beluga-hunting season. During the past 20 years, Wainwright has annually harvested only an estimated 11 belugas (estimated 2.7% of their total annual subsistence harvest [Table III-15]). However, if the whalers could not harvest a bowhead, they would most likely actively hunt belugas. The Wainwright beluga harvest has a much higher probability of being affected by an oil spill during the summer (76%), particularly since the beluga harvest occurs in the Peard Bay region and along the coast by the community (Wainwright's subsistence-harvest-concentration areas in Fig. III-23). The longer period of time during which belugas are available would ensure that the entire beluga-hunting season is not totally eliminated in Wainwright; however, although beluga whales would not become unavailable, the Wainwright beluga harvest would be affected for a period of less than 1 year, resulting in MINOR effects on Wainwright's beluga whale harvest. As in Wainwright, an oil spill could cause MINOR effects on the Barrow and Point Hope beluga harvests; however, the low probability (less than 0.5%) of an oil spill occurring and contacting these subsistence-resource areas indicates that effects on beluga harvests in these communities would be NEGLIGIBLE.

Like bowhead whales, beluga whales also may avoid industrial activities in the Arctic. Beluga whales can react to active icebreaker noise 35 to 50 kilometers away from the source (Sec. IV.B.6). Since the peak season for harvesting beluga whales occurs during the summer (open-water) months in all of the communities near the Sale 109 area, a platform, vessel, or icebreaker located near an open-water area used for beluga whaling could disturb a community's whaling. Although disruptions are most likely to be short-term, they could affect harvest levels. In the early summer, belugas are harvested in the pack-ice leads. Vessels--other than icebreakers--probably would not be in the leads at that time because it is too dangerous; however, icebreakers or platforms in the area could cause disturbance (Sec. IV.B.6). Because the beluga-hunting season for Barrow, Wainwright, and Point Hope takes place under two different conditions (in ice leads and in open water) and hunting is possible at different times over a 6-month period, noise and traffic disturbance would be expected to cause some effects but would not cause the harvest to be unavailable (MINOR effects) during the beluga-hunting season. Since Point Lay's beluga whale harvest is concentrated during a few weeks, disruptions from noise and traffic during that time period could have greater consequences to Point Lay's harvest and potentially could cause the beluga to be locally unavailable for the year. Unavailability of the beluga whale as a result of noise and traffic disturbance in the Point Lay area would cause a MODERATE effect.

During construction of the shorebase at Point Belcher and an offshore pipeline from drilling platforms to Point Belcher, the beluga whale hunt might be disturbed. Point Belcher lies several miles from Peard Bay--an important area for beluga whale harvesting by Wainwright residents. A landfall at Point Belcher would concentrate noise and traffic disturbance in Peard Bay. Since beluga whales may be particularly sensitive to noise and traffic disturbance, the beluga could become unavailable to Wainwright hunters for no more than 1 year, resulting in a MODERATE effect. Belugas are also harvested right along the coast by the community of Wainwright and could be harvested there if they were not available in Peard Bay. Because no construction activities associated with Sale 109 would occur in the Barrow, Point Lay, and Point Hope subsistence-harvest areas, such activities are expected to have NEGLIGIBLE effects on the beluga harvests of those communities.

(3) Caribou: Caribou, the largest source of meat for the communities of the Sale 109 area, contributes to an estimated over 50 percent of the subsistence diets of Barrow, Wainwright, Atqasuk, Point Lay, and Nuiqsut, and 30 percent of Point Hope's. Annual harvest levels (averaged from 1962-1982) were 3,500 in Barrow; 1,200 in Wainwright; 756 in Point Hope; 400 in Nuiqsut; others are not reported (see Sec. III.C.2 [Table III-15]; see Fig. III-24A for harvest areas). The proposal is expected to have MINOR biological effects on caribou, with local disturbance of caribou near the shorebase and pipeline corridor subsiding after construction is completed. Caribou movements, distribution, or abundance are not likely to be significantly affected by the proposal (see Sec. IV.B.8). All of the communities adjacent to the Sale 109 area harvest caribou from the Western Arctic herd, and Nuiqsut and Barrow harvest caribou from the Central Arctic herd (see Sec. IV.B.8). Caribou that move to barrier islands and shallow coastal waters in summer could become oiled or could ingest contaminated vegetation. Since only a small number of animals are likely to be involved, biological effects on the population would be insignificant (Sec. IV.B.8). There is virtually no chance of oil spills contacting the habitats used by caribou within 10 days of a spill (Appendix A, Table A-17). Within 30 days of a spill during summer, there is only a 5-percent chance of one or more spills contacting the coastline at Ledyard Bay and a 2-percent chance of a spill contacting Icy Cape. Caribou are harvested at Ledyard Bay by Point Lay residents and at Icy Cape by Point Lay and Point Hope residents. Only a small number of animals are likely to be involved, and biological effects would be insignificant (Sec. IV.B.8). Spill-contact probabilities for other segments of the Alaskan Chukchi Sea coastline are zero. Effects on the subsistence harvest of caribou in the communities near the Sale 109 area as a result of oil spills are expected to be NEGLIGIBLE. An onshore-pipeline oil spill from the pipeline near Point Belcher to the TAP would contaminate tundra vegetation. However, onshore oil spills are expected to have NEGLIGIBLE biological effects on caribou (see Sec. IV.B.8 for the analysis). Effects would be localized and are not expected to significantly contaminate or alter the caribou range within the pipeline corridor. Since the caribou would not be affected by an onshore oil spill, NEGLIGIBLE effects would be expected on the subsistence harvest of caribou.

Noise- and vehicle-traffic-disturbance effects on caribou are more likely to occur as a result of construction of the 640-kilometer onshore pipeline projected to carry oil from Point Belcher to TAP Pump Station No. 2 and the associated support road. Effects would also occur throughout the life of the project as a result of traffic along the pipeline corridor. This pipeline would not cross major calving areas of the Western or Central Arctic herds. Section IV.B.8 concludes that the proposal's biological effect on caribou would be MINOR, with temporary disturbance of caribou and short-term delays in caribou movements across the pipeline corridor.

Since the landfall at Point Belcher is not located centrally to caribou-harvest areas (see Fig. III-24A), it is not likely to reduce Wainwright-hunter access to caribou. The caribou-wintering area is adjacent to the Point Belcher landfall and surrounds Wainwright. However, an onshore pipeline could create a physical barrier to subsistence access that could make Barrow, Wainwright, Atqasuk, and Nuiqsut hunters' pursuit of caribou more difficult (Kruse, Baring-Gould, and Schneider, 1983). But, because arctic pipelines are constructed to allow for the passage of caribou, the pipeline corridor would not be a major problem. The mere physical presence of the pipeline, support road, and associated facilities probably would have no effect on the behavior, movement, or distribution of caribou, except perhaps if heavy snowfall prevented some animals from crossing under or over the pipeline in local areas (see Sec. IV.B.8). During construction, caribou movement could be temporarily blocked and crossings might be slower; but successful crossing would still occur (see Sec. IV.B.8). Although traffic associated with a support road might serve as a temporary barrier to cow/calf movements, it would not block migration movements. Development of the pipeline corridor would increase hunter access to the Western Arctic caribou herd and thus increase pressure on the population, but current regulation of the harvest should prevent over-hunting. There may also be some disturbance from aircraft surveillance of the pipeline, but this would only cause brief flight reactions of some caribou and is not likely to delay movement for more than a few hours to a few days (see Sec. IV.B.8). Such a delay in movement could temporarily disrupt the caribou harvest, with possible short-term reductions of the season's harvest; but caribou would not become locally unavailable, resulting in MINOR effects on the Barrow, Wainwright, Atqasuk, or Nuiqsut caribou harvests.

Construction of the pipeline corridor would not interfere with Point Lay's or Point Hope's caribou harvest--even though these communities harvest caribou from the Western Arctic herd--because of the distance of the harvest areas from the pipeline. Construction effects would be short-term and localized; therefore, effects on the Point Lay and Point Hope caribou harvests are expected to be NEGLIGIBLE.

(4) <u>Fishes</u>: While fish do not serve as Inupiat cultural symbols--as do bowhead whales and caribou, their reliability and year-round availability make them an important subsistence staple. In the Sale 109 area, fish provide an estimated 7 to 10 percent of the total annual subsistence harvest (Table III-15; see Fig. III-26 for harvest areas). However, there currently is no data on proportions of specific fish species harvested. A rough estimate of total kilograms of fish harvested annually is 27,955 kilograms (6.6% of total harvest) in Barrow; 1,273 kilograms (0.8% of total harvest) in Wainwright; and 18,182 kilograms (10.1% of total harvest) in Point Hope (see Table III-15). The nearshore area of the Chukchi Sea--particularly

the fish-overwintering areas in and near the major river estuaries in Peard Bay (Barrow and Wainwright subsistence-use area), Kasegaluk Lagoon (Point Lay subsistence-use area), and Ledyard Bay--would be the most sensitive to the effects of the proposal, with MODERATE biological effects expected on chum and pink salmon smolts, arctic cod, and capelins if a spill occurred during the open-water (summer) season, and on rainbow smelt if a spill occurred during the winter (Sec. IV.B.4). No subsistence fishing occurs in Ledyard Bay. Wainwright residents harvest chum and pink salmon, arctic cod, and rainbow smelt along the coast and along the lower portions of the Kuk Lagoon; and they harvest rainbow smelt, arctic cod, and capelins in the Peard Bay area (Point Lay residents reportedly do not harvest any of these species in Kasegaluk Lagoon [see Sec. III.C.2]).

In the remainder of the Sale 109 area (all areas except Peard Bay, Kasegaluk Lagoon, and Ledyard Bay), MINOR biological effects are expected on fish (see Sec. IV.B.4). The low combined probability (less than 0.5%) of an oil spill occurring in these areas outside of Peard Bay (see Sec. IV.B.4) indicates that it is unlikely that an oil spill would affect the subsistence harvest of fish in these areas. For this reason--and because of the diversity of fish harvested (capelin, char, cod, grayling, salmon, sculpin, trout, ling cod, rainbow smelt, Bering and least ciscoes, flounder, saffron cod, Pacific herring, and tomcod) and the large harvest areas (fish are harvested along most of the Chukchi Sea coast near the communities and along all major rivers [see Sec. III.C.2 and Fig. III-26])--NEGLIGIBLE effects on subsistence harvests are expected in Point Lay and Point Hope. However, the combined probability of an oil spill occurring and contacting the Peard Bay area within 10 days is 56 percent during the summer. If a large oil spill occurred and contacted the Peard Bay area, effects on fish-subsistence harvests could be MINOR--not only because of the biological consequences (see Sec. IV.B.4), but also because of a fear of tainting (Elanna, 1980; Luton, 1985). As with other subsistence resources, fishes that were oiled likely would be rendered inedible or perceived as such and consequently would be unharvestable. However, even if fish in the Peard Bay area were oiled, fishing is conducted in a wide area (see Fig. III-26) and the overall harvest levels would not be affected. Barrow residents harvest marine fish from Peard Bay to Pitt Point; peak harvest periods occur from September through October, although fishing occurs all summer and fall. In addition to chum and pink salmon, arctic cod, rainbow smelt, and capelin (which could experience MODERATE biological effects), Wainwright residents harvest arctic char, Bering cisco, and sculpin along the coast and along the lower portions of the Kuk Lagoon, and Bering and least ciscoes and grayling in the Kuk River system. Although the most important fish harvest occurs from September through November, fish are also harvested during the summer months. The variety of fish harvested, the number of different areas for harvesting fish, and the longer season for harvesting fish would enable Wainwright residents to harvest other subsistence fishes--or the same fish in other areas--if an oil spill contacted the Peard Bay area. Effects from oil spills associated with Sale 109 on the Barrow and Wainwright fish-subsistence harvest are expected to be MINOR.

Noise and traffic disturbance are expected to have insignificant effects on subsistence-fish stocks (see Sec. IV.B.4). Disturbance from seismic activity associated with Sale 109 would occur more than 5 kilometers (3 miles) from subsistence-fishing areas, and boat noise would have only transitory effects on fish. While some access problems may arise due to the placement of onshore facilities at Point Belcher, harvest pressures are not expected to increase significantly. Effects on subsistence fishing from noise and traffic disturbance and construction activities associated with Sale 109 are expected to be NEGLIGIBLE.

Onshore-pipeline oil spills could contaminate at least one of the approximately 10 major rivers (Graphic No. 3; Table IV-1) that would be crossed by the projected 640-kilometer pipeline from Point Belcher to the TAP. Of these rivers, Atqasuk and Barrow residents fish the Meade River; Nuiqsut residents fish the Colville River; and Barrow residents fish the Chipp River, into which the Ikpikpuk River drains. Atqasuk residents also fish in the Usuktuk River, which--although not a major river--would also be crossed by the pipeline. During the 30-year life of the project, a total of 188 spills of less than 239 barrels each are projected (Table II-1). There is a 29-percent chance that at least one major pipeline spill of 239 barrels or greater (average spill size of 1,500 barrels) would contaminate one of the major rivers. The probability of contamination is greater for the Colville River, since the pipeline would cross its branches four times. Smaller spills would be even more likely to occur in or near the rivers, since many more small spills are projected to occur (121 spills of an average size of 6 barrels and 45 spills of an average size of 98 barrels). Since approximately 40 percent of the area is wetlands, including streams (USDOI, BLM, NPR-A, 1983), there also would be a chance that contamination could spread from a stream to a major river, thus increasing the possibility of a major spill affecting a river. Although a spill from the pipeline would occur upstream 80 to 161 kilometers away from primary fish-harvest areas, the oil would move downstream into primary subsistence-harvest areas. A spill would have MAJOR biological effects on the fish populations in the river where it occurred (see Sec. IV.B.4), thus affecting fishing in the entire river. A MAJOR biological effect would indicate that fish in the affected river would be unavailable for subsistence harvests for more than a year.

Barrow's fish harvest is composed of fish from rivers, deep lakes, and the ocean; the community is not dependent on the fish in the Meade or Ikpikpuk Rivers. Atqasuk residents harvest fish primarily from the Meade River (Braund, 1987, oral comm.; Burnham, 1987, oral comm.) but also from the Usuktuk and Nigisaktuvik Rivers (Craig, 1987). While an oil spill in a river could cause the fish to be unavailable in that river for more than 1 year--a MAJOR effect on the subsistence harvest, Atqasuk and Barrow residents could fish in other streams, rivers, lakes, and--in Barrow--the ocean if an oil spill occurred in a major river. Thus, while there may be considerable hardship, soiling of fishing equipment, and the need to move fish camps to other rivers, fish would not be totally unavailable to all Barrow and Atqasuk residents. Thus, while an onshore oil spill could cause MAJOR effects on the Barrow and Atqasuk fish harvests, a MODERATE effect is more likely. Although fish in the Meade River would be locally unavailable for more than a year, other fish would be available to Barrow residents. The situation is slightly different in Nuiqsut because Nuiqsut residents fish primarily in the Colville River Delta; Nuiqsut is too far from other major fishing sources to harvest fish elsewhere. In addition, during October and November fish is sometimes the only source of fresh meat. If fish were unavailable for more than 1 year in the Meade or Colville Rivers, this would result in a MAJOR effect on Nuiqsut's subsistence harvest of fish.

(5) Seals: Bearded and hair seals comprise between 7 and 24 percent of the total subsistence-resource harvests for the communities in the Sale 109 area (Sec. III.C.2 [Table III-15]; see Fig. III-24B for harvest areas). Bearded seals comprise 2.9 percent (150 seals) of Barrow's total harvest; 12.3 percent (250 seals) of Wainwright's; 8.9 percent (200 seals) of Point Hope's; no information on seals is available for the other communities. Hair seals comprise 4.3 percent (955 seals) of Barrow's total harvest; 4.4 percent (375 seals) of Wainwright's; and 14.8 percent (1,400 seals) of Point Hope's total harvest (see Table III-15). Section IV.B.6 concludes that MINOR biological effects are anticipated as a result of Sale 109 and that an oil spill could cause some contamination of seals, loss of the subsistence and economic value of contaminated seal hides, and loss of some of one season's young pups in affected areas. Even if only a small number of seals were heavily affected by an oil spill in the area, seals that were oiled would likely be rendered inedible or perceived as such and consequently would be unharvestable. Oil-spill effects are most likely to occur in the Barrow, Wainwright, and Point Lay seal-harvesting areas. The seal harvest occurs over a longer period of time (harvests are possible during the entire year [see Sec. III.C.2]) than harvests of other subsistence resources. However, although the potential effects on seals from an oil spill associated with Sale 109 might cause harvesters to hunt longer or take extra trips, these effects should not cause more than MINOR effects on the Barrow, Wainwright, and Point Lay seal harvests, with a possible reduction in harvests during a portion of the seal-hunting season; but seals would not become unavailable during the year.

Seals are somewhat susceptible to noise and disturbance from aircraft and vessel traffic. Industrial activity associated with Sale 109 is not expected to result in distributional changes in seal populations (Sec. IV.B.6). Disturbance from aircraft or vessels could cause short-term, localized effects on seals and some short-term disruption to the seal harvest; however, this would not affect annual harvest levels, and seals would not become unavailable during the year. MINOR effects on seal harvests due to noise and traffic disturbance are expected in Barrow's, Wainwright's, and Point Lay's subsistence-harvest areas.

Construction of a shorebase at, and an offshore pipeline to, Point Belcher might disturb the hunting of ringed, spotted, and bearded seals by Barrow and Wainwright residents. Point Belcher lies several kilometers from Peard Bay, an important area for harvesting spotted seals. Ringed and bearded seals also are harvested at Point Belcher and along the coast. A landfall at Point Belcher would concentrate noise and traffic disturbance in this harvest area.

If construction occurred during peak harvest periods (June and July), the harvests of bearded and ringed seals could be affected in the Wainwright subsistence area. However, the long seal-harvest period would enable residents to harvest seals during other times of the year. MINOR effects on Barrow's and Wainwright's seal harvests can be expected as a result of Sale 109-related construction activities in the Peard Bay subsistence-harvest area. The absence of construction activities in Point Lay's and Point Hope's subsistence-harvest areas would result in NEGLIGIBLE effects on those areas.

(6) Walruses: Walruses are most important in Wainwright, where this resource comprises an estimated 18.5 percent (86 walruses) of the

total annual subsistence harvest (estimated 20-year average) (Table III-15; see Fig. III-25 for harvest areas). In Barrow and Point Hope, walruses are less important (4.6% [55 walruses] for Barrow and 2.9% [15 walruses] for Point Hope of the total annual subsistence harvest [see Table III-15]); no data are available for Point Lay or Atqasuk. Atqasuk harvests walrus (and all other marine mammals) in conjunction with Barrow, thus any effects on Barrow's walrus harvest would also apply to Atqasuk. Section IV.B.6 concludes that MINOR biological effects on walruses are expected as a result of oil spills associated with Sale 109. Although oil spills could cause some contamination of walruses and the loss of some of one season's young in affected areas, walruses are not expected to be affected by oil spills to any great extent. However, walruses that were oiled likely would be rendered inedible or perceived as such and consequently would be unharvestable. Barrow's, Wainwright's, and Point Lay's walrus-harvest areas--particularly the Peard Bay area--are most sensitive to oil spills due to the higher probability (76% in Wainwright, 56% in Peard Bay, and 24% in Point Lay) of oil spills contacting the areas. Peard Bay is used by Barrow and--on the southern side of Point Franklin--Wainwright residents to harvest walrus (Fig. III-25). Walrus hunting is concentrated in each community's subsistence-resource area during the open-water months, primarily from late May and early June through the end of August. An oil spill that contaminated the annual walrus harvest of Barrow, Atqasuk, Wainwright, or Point Lay would cause walruses to become locally unavailable for no more than 1 year, resulting in MODERATE effects. Similar effects on the walrus harvest would also occur in Point Hope; however, the low probability of an oil spill occurring in the Point Hope area indicates that NEGLIGIBLE effects can be expected in this subsistence-harvest area.

Noise and traffic disturbance generally do not affect walrus-distribution patterns (Sec. IV.B.6); however, noise and disturbance from aircraft can have localized, short-term effects that would cause some disruption to the harvest but would not cause walruses to become unavailable. MINOR effects on the walrus harvests due to noise and traffic are expected in the Barrow, Atqasuk, Wainwright, and Point Lay subsistence-harvest areas, with NEGLIGIBLE effects expected in Point Hope. However, the construction of an offshore pipeline to, and a landfall at, Point Belcher would concentrate noise and traffic disturbance in this subsistence-harvest area and might temporarily disturb Wainwright walrus hunting for one season. Noise and disturbance of this level in this subsistence-harvest-concentration area during the Barrow, Atqasuk, and Wainwright walrus hunts could cause walruses to become unavailable for no more than 1 year, resulting in MODERATE effects from construction activities associated with Sale 109 on walrus hunting in the Barrow, Atqasuk, and Wainwright subsistence-harvest areas.

(7) Birds: Waterfowl are considered an important subsistence resource--not because of the quantity of meat harvested [Table III-15]; see Fig. III-27 for harvest areas) or the time spent hunting them (see Sec. III.C.2)--but because of their dietary importance during spring and summer and because they are a preferred food. Waterfowl comprise less than 3 percent of the total annual subsistence harvest over 20 years (0.9% or 3,636 kg of meat in Barrow; 0.3% or 545 kg of meat in Wainwright; 3.2% or 5,682 kg of meat in Point Hope; no data are available for other villages [Table III-15]).

According to Section IV.B.5, if an oil spill occurred during breakup or the open-water period--the seasons when bird hunting takes place--it would likely have immediate effects on birds. Eiders and oldsquaw (both subsistence species) would be most likely to suffer direct mortality; brant and other waterfowl could be harmed indirectly through contamination of salt marshes. The important bird-habitat areas that are also used for subsistence-bird harvests are Icy Cape, south Kasegaluk Lagoon, Cape Lisburne, and Cape Thompson. Wainwright and Point Lay residents use Icy Cape for bird hunting; Point Lay residents use south Kasegaluk Lagoon; and Point Hope residents use Capes Lisburne and Thompson. The combined probabilities of one or more spills occurring and contacting any of these areas within 10 days in summer is low: the highest is at Cape Lisburne, with a 3-percent probability; and the lowest is at Cape Thompson, with a less-than-0.5-percent probability. These low probabilities indicate that the subsistence-bird harvests in Wainwright, Point Lay, and Point Hope are unlikely to be affected by an oil spill. In addition, since most eider hunting occurs on the oceans and along the coasts during 2 spring months, and most brant hunting occurs along the coasts during 2 fall months, the probability that an oil spill would affect subsistence-bird hunting--even if oil contacted these bird-habitat areas--is lower than the probability of contact for that resource area. On the other hand, because of the short hunting season, oil contact could reduce the harvest levels of birds for an entire season. If an oil spill occurred and contacted the Wainwright, Point Lay, and Point Hope bird-hunting areas, birds would become unavailable for no more than a year, and the effects would be MODERATE; however, the low probability of an oil spill occurring and contacting these areas indicates that the effects on birds would be MINOR. Barrow's bird-hunting areas would not be affected by an oil spill; thus, effects would be NEGLIGIBLE. An onshore-pipeline oil spill from the pipeline near Point Belcher to the TAP would contaminate tundra vegetation and freshwater ponds. Oil-spill cleanup at the spill site would frighten waterfowl and shorebirds away from the spill site, although only a small number of birds may be affected. Onshore oil spills are expected to have MINOR biological effects on marine and coastal birds (see Sec. IV.B.4 for the analysis). Effects would be localized and are not expected to significantly contaminate or alter bird wetland or tundra habitats on the North Slope. While there would be some effect on birds, it is not expected to cause an effect on the subsistence harvest of birds--thus resulting in a NEGLIGIBLE effect.

The noise caused by construction of both offshore and onshore oil facilities may disturb waterfowl-feeding and -nesting activities. Construction of offshore pipelines also may disrupt waterfowl-food sources but is likely to result in only local and temporary effects. Such low-level biological effects would be too brief to have significant effects on bird harvesting by the communities in the Sale 109 area. Effects on all bird harvests in the Sale 109 area from noise and traffic disturbance and construction activities are expected to be NEGLIGIBLE.

(8) Polar Bears: Polar bears contribute less than 1 percent to the total annual subsistence harvest for community residents near the Sale 109 area (0.4% or 7 bears in Barrow; 1.0% or 7 bears in Wainwright; 1.3% or 10 bears in Point Hope; 0.1% or 1 bear in Nuiqsut; no data are available for other communities [see Table III-15 and Sec. III.C.2]). Section IV.B.6 concludes that oil spills could cause some contamination of seals (polar bear prey), loss of the subsistence and economic values of polar bear

hides, and loss of some of one season's young in affected areas. Prey contamination also could cause some mortality in the polar bear population. Thirty to forty bears could be directly killed by an oil spill (see Sec. IV.B.6). Such effects are most likely to occur in Barrow's, Wainwright's, and Point Lay's polar bear-harvest areas but could affect bears available to any of the coastal communities. The polar bear harvest occurs year-round; and while the effects that may occur on polar bears from an oil spill associated with Sale 109 might cause residents to hunt longer or take extra trips, these effects would not reduce harvests for an entire year. Effects of oil spills related to Sale 109 on Barrow's, Wainwright's, and Point Lay's polar bear harvest are expected to be MINOR; however, the low probability (less than 0.5%) of an oil spill occurring and contacting the Point Hope subsistence-resource area indicates that effects on Point Hope polar bear harvests due to oil spills would be NEGLIGIBLE.

Polar bears could experience short-term, localized aircraft-noise disturbance effects that would cause some disruption in the polar bear harvest but would not affect annual harvest levels. MINOR effects due to noise and traffic disturbance and construction activities can be expected on polar bear harvests in Barrow and Wainwright. Point Lay and Point Hope harvests are so distant from construction activities and aircraft noise and traffic that effects are expected to be NEGLIGIBLE. Overall effects on polar bear harvests in the Sale 109 area due to noise and traffic disturbance and construction activities are expected to be MINOR in Barrow, Wainwright, and Point Lay, and NEGLIGIBLE in Point Hope.

c. Effects on Subsistence Resources by Community:

The following discussion summarizes the preceding section by community.

(1) Barrow: A portion of Barrow's subsistence-harvest area lies within the Sale 109 area. Barrow residents use the Peard Bay area to some extent for harvesting marine resources. The higher probability (56%) of an oil spill occurring and contacting the Peard Bay area, and noise and traffic disturbance as well as construction activities associated with the Point Belcher shorebase, could cause some effects on Barrow's subsistence harvests.

The bowhead whale is the most preferred meat as well as the most culturally important subsistence resource in Barrow (and in Wainwright, Point Hope, and Nuiqsut). The low probability (less than 0.5%) of an oil spill occurring and contacting the Barrow bowhead-harvest area indicates that NEGLIGIBLE effects due to oil spills on the bowhead harvest are expected. Noise and traffic would not affect Barrow bowhead whaling because drilling units, production platforms, vessels, and icebreakers would not be in the vicinity of the Barrow bowhead-harvest areas. Construction activities in Peard Bay are too distant from the bowhead-harvest area to cause more than NEGLIGIBLE effects. The overall effect on Barrow's bowhead-subsistence harvest as a result of activities associated with the proposal is expected to be NEGLIGIBLE.

Barrow's beluga-harvest area extends only to the northeastern edge of the Peard Bay area, too distant for noise and traffic or construction activities to affect beluga whaling on more than a short-term, temporary basis. Noise and traffic disturbance would be expected to cause some effects but would not cause the harvest to become unavailable (MINOR effects). The overall effect on Barrow's beluga-subsistence harvest as a result of activities associated with the proposal is expected to be MINOR.

Caribou provide the largest source of meat in all communities close to the Sale 109 area. The low probability of an oil spill contacting the Barrow subsistence-harvest area would cause NEGLIGIBLE effects on caribou. Noise and traffic along the Sale 109 pipeline corridor would disturb caribou and could cause some temporary delays in caribou-movement patterns that could affect the harvest; however, the annual harvest would not be reduced. Effects on the caribou harvest due to noise and traffic disturbance are expected to be MINOR. Caribou may temporarily avoid the pipeline-construction area, which would cause MINOR effects on the caribou harvest for the duration of the construction. The overall effect on Barrow's caribou-subsistence harvest as a result of activities associated with the proposal is expected to be MINOR.

Bearded and hair seals are harvested by Barrow residents as far south as the Peard Bay area--an area of high probability for oil spills. Even though seals may be contaminated by an oil spill, the harvest would not become unavailable because seal harvests occur throughout the year; thus, only a portion of the harvest might be reduced, resulting in MINOR effects. In contrast, walruses are harvested during a very short period from early June through late August; and a reduction of the harvest during this period would result in a reduction of the entire harvest. Consequently, the walrus-subsistence harvest could experience MODERATE effects from oil contamination during that period. Seals and walruses could be affected by noise and traffic disturbance from aircraft that results in only short-term, localized effects. Both seals and walruses are also likely to be disturbed by the high concentration of activity associated with construction of the pipeline landfall at Point Belcher. This would produce MINOR effects on seals--again because of the longer hunting season--and MODERATE effects on walruses due to the shorter hunting season. Overall, effects on Barrow's seal-subsistence harvest would be MINOR, with MODERATE effects on the walrus-subsistence harvest.

Oil offshore is not expected to affect fishing in the Barrow subsistence-harvest area, with the exception of the Peard Bay area. However, even if fish in the Peard Bay area were oiled, fishing is conducted in a wide area and the overall harvest would not be affected. Effects on fish harvests due to oil spills are expected to be MINOR. Other effects due to noise and traffic disturbance and construction activities would be NEGLIGIBLE because these activities do not substantially affect fish. Onshore oil spills from the pipeline near Point Belcher would have MODERATE effects on Barrow's fish-subsistence harvest. The overall effect of the proposal on Barrow's fish-subsistence harvests would be MODERATE.

Oil is not expected to cause more than NEGLIGIBLE effects on Barrow's bird harvest due to the low probability (less than 0.5%) of an oil spill occurring and contacting Barrow's bird-harvest areas. Although birds may be affected by noise and traffic disturbance and construction activities, these effects would be too widely dispersed to have significant effects on a community's bird harvest in the sale area. The effect of the proposal on Barrow's bird-subsistence harvest is expected to be NEGLIGIBLE.

Polar bear harvests in the Barrow subsistence-harvest area could be reduced by oil spills that contaminated the polar bears or their main food source--seals. Since polar bears are hunted year-round, these effects would not reduce harvests for an entire year. The effect of the proposal on Barrow's polar bear-subsistence harvest is expected to be MINOR.

Conclusion (Effect on Barrow): The effect of proposed Sale 109 on Barrow's subsistence-harvest patterns is expected to be MODERATE.

(2) Wainwright: A pipeline landfall and shorebase for Sale 109 is expected to be located at Point Belcher, which is in the vicinity of Peard Bay. Peard Bay is an important subsistence-harvest area to Wainwright for all marine resources except the bowhead whale, which is harvested off Point Belcher. Oil spills, concentration of noise and traffic disturbance, and construction activities in the Peard Bay area are expected to cause more effects on the marine and terrestrial subsistence harvests in Wainwright than in other communities. Oil spills in the Wainwright subsistence-harvest area (76% chance of an oil spill occurring and contacting; see previous discussion in Sec. IV.B.10.a) would cause MODERATE effects on the bowhead whale harvest because bowhead whaling activities are localized and occur within a short time period. An oil spill would force hunters to move to a new location and thus shorten the whaling season. The harvest of whales--generally only one or two animals--could be reduced. Noise and traffic disturbance from icebreakers, support vessels, or platforms in or near the bowhead whaling area could cause bowhead whales to move into the pack ice and become unavailable to hunters, resulting in MODERATE effects on bowhead whaling. In a year when poor weather and ice conditions shortened the whaling season, such an occurrence could cause the harvest to be reduced. Construction activities associated with the landfall and shorebase at Point Belcher also could cause MAJOR effects by disrupting the bowhead whale harvest for more than 1 year and making harvesting of a bowhead more difficult, thus potentially eliminating the harvest of bowheads (only 1 or 2 are typically harvested in Wainwright). As a result of MAJOR effects from construction activities in the Point Belcher area, the overall effect of the proposal on Wainwright's bowhead whale-subsistence harvest is expected to be MAJOR.

Only a small portion of the beluga whale population is likely to be affected by an oil spill in the Wainwright beluga-subsistence-harvest area. Consequently, the subsistence-harvest level would not be affected, although there may be some MINOR effects. The longer period of time during which belugas are available ensures that the beluga-harvest season would not be eliminated. Noise from platforms, vessels, or icebreakers could cause short-term effects but should not cause harvest levels to be reduced (MINOR effects). Construction activities at Point Belcher would also include noise and traffic in Peard Bay--an important area for beluga whale hunting. Belugas are particularly sensitive to noise, which could affect their presence in Peard Bay and cause belugas to become unavailable for a year (MODERATE effects). As a result of MODERATE effects from construction activities, the overall effect of the proposal on Wainwright's beluga-subsistence harvest is expected to be MODERATE.

A portion of the caribou herd hunted by Wainwright grazes along the barrier islands and shallow coastal lands. Although some of these caribou could ingest oil, not all of these caribou would be affected. The caribou harvest may experience MINOR effects from an oil spill. Effects from noise and traffic disturbance and pipeline-construction activities are expected to be MINOR on the Wainwright caribou harvest, as on Barrow's. The overall effect of the proposal on Wainwright's caribou-subsistence harvest would be MINOR.

As in Barrow, oil spills and construction activities would cause MINOR effects on the Wainwright seal harvest and MODERATE effects on the walrus harvest. Even though seals may be contaminated by an oil spill, the harvest would not become unavailable because seal harvests occur throughout the year; thus, only a portion of the harvest might be reduced, resulting in MINOR effects. In contrast, walruses are harvested during a very short period in the summer; and an oil spill that occurred during the peak harvest could cause walruses to become unavailable for 1 year or less, producing MODERATE effects. NEGLIGIBLE effects would occur from noise and traffic disturbance on both seals and walruses. The overall effect of oil spills is expected to be MINOR on Wainwright's seal-subsistence harvest and MODERATE on the walrus-subsistence harvest.

Oil spills in the Peard Bay area and the Kugrua River could affect Wainwright's fish harvests; however, the ability to fish in other areas could enable residents to make up for some of the loss. Annual fish harvests could be affected by oil spills; but fish would not become locally unavailable, causing MINOR effects. As in Barrow, fish are not susceptible to disturbances from noise, traffic, and construction activities; and these activities are expected to cause NEGLIGIBLE effects on Wainwright's fish harvests. The overall effect of the proposal on Wainwright's fish-subsistence harvest is expected to be MINOR.

If an oil spill occurred and contacted the Wainwright bird-subsistence-harvest area, the effects could cause a reduction in the annual harvest because the bird-hunting season is quite short. Since the probability of such an event occurring is so low (1%), effects from oil spills are expected to be MINOR. As in Barrow, noise and traffic disturbance and construction activities are expected to cause NEGLIGIBLE effects on Wainwright's bird harvests. The overall effect of the proposal on Wainwright's bird-subsistence harvest is expected to be MINOR.

Wainwright's polar bear harvest could also be reduced by oil spills through contamination of polar bears and their main food source--seals. Polar bears may also experience short-term, localized effects from aircraft disturbance. Since polar bears are hunted year-round, these effects would not reduce harvests for an entire year. The overall effect of the proposal on Wainwright's polar bear-subsistence harvest is expected to be MINOR.

Conclusion (Effect on Wainwright): The effect of proposed Sale 109 on Wainwright's subsistence-harvest patterns is expected to be MAJOR.

(3) Point Lay: A large part of Point Lay's marine-subsistence-harvest area lies within the Sale 109 area (the remainder lies shoreward of the Federal/State 3-geographical-mile line). Point Lay's subsistence-harvest area is expected to be more susceptible to effects from oil spills than either Point Hope's or Barrow's. Noise and traffic in the vicinity may also affect some species. However, the Point Lay area is far

enough away from Point Belcher that it would not experience effects from and traffic disturbance or construction activities in the Point Belcher/Pe Bay area.

Point Lay residents do not harvest bowhead whales; however, the beluga whale--their most important marine resource--holds the most cultural significance since it is the only species that is hunted through a communal effort. Belugas are harvested in a short period of time. Although belugas may avoid areas where oil is present and thus are not likely to be affected by oil spills, the whales are likely to be rendered inedible or perceived as such if contacted by oil. Oil-spill-cleanup efforts could also hinder the harvest. For this reason, an oil spill that occurred and contacted the beluga-harvest area could cause MODERATE effects on the harvest by making belugas locally unavailable for a portion of the harvest period. If noise and traffic disturbed the harvest during this short period, the beluga harvest could be reduced, thus causing MODERATE effects. The overall effect of the proposal on the Point Lay beluga-subsistence harvest would be MODERATE.

Point Lay residents also harvest some caribou from the Western Arctic herd, as do residents in Wainwright, Barrow, Atqasuk, and Nuiqsut. As in Wainwright, the effects from oil spills on Point Lay's caribou harvest would be MINOR. The effects of noise and traffic disturbance and construction activities are expected to be NEGLIGIBLE because of the distance of the Point Lay caribou-subsistence-harvest area from the Sale 109 pipeline corridor. The overall effect of the proposal on Point Lay's caribou-subsistence harvest is expected to be MINOR.

As in Barrow and Wainwright, oil spills in the Point Lay subsistence-harvest area are expected to cause MINOR effects on the Point Lay seal harvest and MODERATE effects on the walrus harvest. Even though some seals may be contaminated by an oil spill, the harvest would not become unavailable because seal harvests occur throughout the year; thus, only a portion of the harvest might be reduced, resulting in MINOR effects. In contrast, walruses are harvested during a very short period in the summer; and an oil spill that occurred during the peak harvest could cause walruses to be unavailable for 1 year or less, resulting in MODERATE effects. Noise and traffic disturbance are expected to cause MINOR effects on both resources. Construction activities are expected to cause NEGLIGIBLE effects because of the distance from Point Lay to Peard Bay. The overall effect of the proposal is expected to be MINOR on Point Lay's seal-subsistence harvest and MODERATE on the walrus-subsistence harvest.

Oil spills are expected to cause MINOR effects on fish in the Point Lay subsistence-harvest areas; however, the diversity of fish harvested, the large area where fishing is possible, and the low probability of an oil spill occurring and contacting the area indicate an expectation of NEGLIGIBLE effects on fish harvests due to oil spills. Fish are not susceptible to disturbances from noise and traffic disturbance or construction activities. The overall effect of the proposal on Point Lay's fish-subsistence harvest is expected to be NEGLIGIBLE.

If an oil spill occurred and contacted the Point Lay bird-subsistence-harvest area, MODERATE effects could occur; however, the probability of such a spill occurring and contacting this area is very low (less than 0.5%), and effects consequently would be reduced to MINOR. The overall effect of noise and traffic disturbance and construction activities associated with the proposal on the bird-subsistence harvest in Point Lay is expected to be NEGLIGIBLE.

Point Lay's polar bear harvests could be reduced through oil-spill contamination of their main food source--seals. Polar bears also may experience short-term, localized effects from aircraft disturbance. Even though the harvest could be affected, these effects would not reduce harvests for an entire year because polar bears are hunted year-round. The overall effect of the proposal on the Point Lay polar bear-subsistence harvest is expected to be MINOR.

Conclusion (Effect on Point Lay): The effect of proposed Sale 109 on Point Lay's subsistence-harvest patterns is expected to be MODERATE.

(4) Point Hope: A large part of Point Hope's marine-subsistence-harvest area lies within the Sale 109 area (the remainder lies shoreward of the Federal/State 3-geographical-mile line). However, Point Hope subsistence harvests are not as likely to experience as many effects as Wainwright and Point Lay because of its distance from the Point Belcher/Peard Bay area, where most of the noise and traffic disturbance and construction activities would occur, and because of the low combined probability (less than 0.5%) of an oil spill occurring and contacting the area. Oil spills would have NEGLIGIBLE effects on the harvest of all Point Hope subsistence resources, with the exception of migratory birds. Noise and traffic disturbance would have NEGLIGIBLE effects on all harvests except those of bowhead and beluga whales. Construction activities would also have NEGLIGIBLE effects on all Point Hope harvests.

The bowhead harvest is numerically so small (usually 1 bowhead) that any effect that limited the harvest of even one whale could eliminate the harvest. Noise from icebreakers or other vessels could produce such an effect. As in Wainwright, Point Hope's bowhead whale harvest could become locally unavailable for a portion of the season or the entire season as a result of noise disturbance from icebreakers or other vessels. This could produce MODERATE effects on the bowhead whale harvest and would cause an overall MODERATE effect on Point Hope's bowhead whale-subsistence harvest. Similar disturbance effects on beluga harvests could also be expected; however, the longer beluga-harvest period would reduce the overall effect of the proposal on Point Hope's beluga-subsistence harvests to MINOR.

Point Hope residents harvest caribou from the Western Arctic herd--the herd that could be affected by noise and traffic disturbance and construction activities associated with the onshore pipeline corridor; but these effects would not occur in the Point Hope caribou-hunting area. Consequently, the overall effect of the proposal on the Point Hope caribou-subsistence harvest is expected to be NEGLIGIBLE.

The overall effects of the proposal on Point Hope's seal and walrus harvests are expected to be NEGLIGIBLE because of the low probability of an oil spill occurring and the MINOR biological effects expected from noise and traffic disturbance.

NEGLIGIBLE effects on subsistence-fish harvests are expected in Point Hope. The risk of an oil spill occurring and contacting the area is very low and fish are not susceptible to noise and traffic disturbance. The probability of an oil spill occurring and contacting the Point Hope bird-subsistence-harvest area is very low (less than 0.5%), and effects from oil spills are expected to be MINOR. Bird harvests are expected to experience NEGLIGIBLE effects from noise and traffic disturbance and construction activities. The overall effect of the proposal on Point Hope's bird-subsistence harvest would be NEGLIGIBLE.

Oil spills would have NEGLIGIBLE effects on seals (the polar bear's main food source) and consequently NEGLIGIBLE effects on polar bears. Because Point Hope is distant from anticipated noise and traffic disturbance and construction activities, these activities would be either nonexistent or short-term and temporary, resulting in NEGLIGIBLE effects on Point Hope's polar bear-subsistence harvest. The overall effect of the proposal on the Point Hope polar bear-subsistence harvest would be NEGLIGIBLE.

<u>Conclusion (Effect on Point Hope)</u>: The effect of proposed Sale 109 on Point Hope's subsistence-harvest patterns is expected to be MODERATE.

(5) <u>Atqasuk</u>: The residents of Atqasuk, an interior community, harvest marine resources only in conjunction with Barrow's harvests; therefore, any effects on Barrow's marine-resource harvests would also affect Atqasuk's (see discussion on Barrow [Sec. IV.B.10.c(1)]). MINOR effects are expected on all marine-mammal harvests in Barrow except for MODERATE effects expected on walrus harvests as a result of oil spills and construction activities in the Peard Bay area. Caribou is the only subsistence resource that could be affected by noise and traffic disturbance related to the Sale 109 pipeline corridor. These effects from traffic along the pipeline-support road would occur throughout its existence; however, the biological effects on caribou would be MINOR and characterized by temporary disturbance of caribou and short-term delays in caribou movements across the pipeline corridor. The pipeline would not cross major calving areas of the Western Arctic herd. The pipeline would create a physical barrier to subsistence access to caribou, but this should not be a major problem because pipelines are constructed to allow passage of caribou (see Secs. IV.B.8 and IV.B.10.b[3] for further discussion). During construction of the pipeline, movements of the caribou could be temporarily blocked and could slow down crossings; but successful crossings would still occur. While the subsistence harvest of caribou may be affected, caribou would not become locally unavailable at anytime, resulting in MINOR effects. MODERATE effects on Atqasuk's subsistence harvest of fish are expected due to oil spills in the Meade River from the onshore pipeline. All other Atqasuk subsistence harvests are expected to experience NEGLIGIBLE effects from this sale.

<u>Conclusion (Effect on Atqasuk)</u>: The effect of proposed Sale 109 on Atqasuk's subsistence-harvest patterns is expected to be MODERATE.

(6) <u>Nuiqsut</u>: Nuiqsut's subsistence-harvest area lies outside of the Sale 109 area; however, the onshore-pipeline corridor from Point Belcher to the TAP would pass through some of Nuiqsut's caribou-harvest area and over the Colville River, which is crucial to Nuiqsut's fish harvest. These caribou may be affected by noise and traffic disturbance and construction activities associated with the pipeline; thus, the Nuiqsut

caribou harvest could experience MINOR effects from these activities. Oil spills from Sale 109 would not affect the caribou harvest because Nuiqsut is too distant from the sale area. MAJOR effects are expected on Nuiqsut's fish harvest due to oil spills in the Colville River from the onshore pipeline from Point Belcher to the TAP. A MAJOR effect on the fish harvest in Nuiqsut is expected to result in an overall MAJOR effect on Nuiqsut's subsistence-harvest pattern.

Conclusion (Effect on Nuiqsut): The effect of proposed Sale 109 on Nuiqsut's subsistence-harvest patterns is expected to be MAJOR.

CONCLUSION (Effect on Subsistence-Harvest Patterns): The effect of Sale 109 on subsistence-harvest patterns is expected to be MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

CUMULATIVE EFFECTS: Cumulative effects include effects of the proposal and other ongoing or planned projects on the North Slope and in the western Canadian arctic. (For a complete list of these ongoing and planned projects, their scenarios and timetables, and the resource estimates involved, see Sec. IV.A, Table IV-2, and Appendix G.) The probability of any or all of the ongoing and planned offshore and onshore projects reaching the development stage is unknown; however, the following discussion assumes that all of these projects would reach the development and production stages.

The effects of these projects on subsistence may occur because of oil spills, noise and traffic disturbance, or disturbance from construction activities associated with the pipelines and the shorebase facility. Noise and traffic disturbance might come from seismic activities, the building or installation and operation of drilling facilities, supply efforts, or the tankering of oil from the Canadian arctic.

Cumulative Effects of Oil Spills: There is no difference in the number of oil spills estimated under the proposal or the cumulative case (7), and the probabilities of an oil spill of 1,000 barrels or greater occurring and contacting any subsistence-harvest area within 10 days are very similar (81% and 84%, respectively). In addition, oil spills associated with the Sale 109 area would tend to move westward away from the coast. Spills occurring under the cumulative case from Beaufort Sea leases or Canadian tankering would move westward--north of the sale area--and would not contact the Sale 109 subsistence-harvest areas. Since the number of oil spills is the same under the cumulative case as under the proposal, oil-spill effects would be the same as for the proposal. In Sale 97--which affects Nuiqsut, Barrow, and Wainwright--MODERATE effects are expected from oil spills.

Overall cumulative effects on subsistence-harvest patterns in the Sale 109 area as a result of oil spills are expected to be MODERATE, the same as for the proposal.

Cumulative Effects of Noise and Traffic Disturbance: Geophysical (seismic) exploration would increase somewhat under the cumulative case, but it is not expected to greatly affect the size of regional biological populations of species used for subsistence purposes. Noise and traffic disturbance from offshore facilities also may affect marine-subsistence activities. In the cumulative case, the increased amount of oil-related traffic makes it likely that subsistence-harvest activities could be occasionally disrupted by boat and air traffic. Since most marine-hunting activities occur within a wide area of open water, such interruptions typically may cause boat crews to hunt longer or take extra trips but may not reduce the overall harvests of marine mammals or seabirds. In addition, because of their short and ice-condition-dependent seasons, bowhead whale harvests are more likely to be affected by noise and traffic disturbance than are other forms of marine mammal hunting (other than beluga whaling), as discussed for the proposal. Since the bowhead whale harvest in all communities except for Barrow tends to be quite small (1 or 2 whales per year), disturbance from noise from drilling units, ice-breakers, and other vessels could cause this small harvest to become locally unavailable for the entire season, resulting in MODERATE effects. Such activities already may have occasionally affected subsistence hunting. For example, Kaktovik whalers contend that their 1985 fall-whaling season was adversely affected by vessels related to oil development operating in open-water areas. Effects on bowhead whaling due to noise and traffic disturbance are most likely to be MODERATE in Wainwright and Point Hope.

As discussed under the proposal, beluga whales appear to be sensitive to noise and traffic disturbance and may avoid areas of heavy industrial activities such as are currently found in the Canadian Arctic. Effects from noise and disturbance on the beluga whale harvest could be increased under the cumulative case. Increased air traffic and exploratory activities east of Point Barrow and near Peard Bay could cause beluga whales to become locally unavailable for a period of time, resulting in MODERATE effects on the beluga harvest. At Wainwright and Barrow, cumulative-case effects to subsistence harvests of beluga whales are expected to be MAJOR in Sale 97, thus this would increase effects from noise and traffic disturbance from MODERATE to MAJOR under the cumulative case. Other subsistence resources are expected to experience MINOR or NEGLIGIBLE effects as a result of increases in noise and traffic disturbance under the cumulative case. Overall cumulative effects on subsistence-harvest patterns in the Sale 109 area as a result of noise and traffic disturbance are expected to be MAJOR.

<u>Cumulative Effects of Construction Activities</u>: The cumulative-case effects due to construction activities on Wainwright's bowhead whale harvest would remain MAJOR--the same as for the proposal--because of the Sale 109 offshore-pipeline landfall and shorebase facility at Point Belcher. Effects on Wainwright's beluga whale harvest would remain MINOR, the same as for the proposal. Short-term effects from the construction of Sale 109 onshore support facilities and a pipeline corridor could cause short-term disruptions to caribou and seabird hunting, resulting in MODERATE effects on caribou and seabird harvests. The construction of an onshore pipeline from Point Belcher to the TAP may cause MODERATE effects on Wainwright's caribou harvest.

Pipelines and their support roads may affect caribou harvests over the long term. Cumulative oil and gas activities of proposed Sale 109 and other offshore and onshore projects would subject caribou herds on their summer ranges and calving ranges throughout the North Slope to a variety of oil-development projects. Cumulative disturbance of caribou from pipelines/roads and associated road traffic are likely to cause MINOR, or short-term, biological disturbances on caribou. At present, cumulative oil development in the Prudhoe Bay-Kuparuk industrial complex has caused minor displacement of caribou from a small portion of the calving range, with no apparent effect on herd abundance or overall distribution. The cumulative displacement of cow/calf groups from additional parts of the calving range because of the development of additional oil fields in the Prudhoe Bay-Kuparuk area and in the NPR-A and ANWR, and because of Canadian oil development, could represent a MODERATE biological displacement of caribou from available calving habitat and have a MODERATE effect on the overall distribution of caribou. These biological effects could cause caribou to become locally unavailable to subsistence hunters for a period of time each year, resulting in MODERATE effects on the subsistence harvest of caribou by the communities of Barrow, Wainwright, Atqasuk, and Nuiqsut.

Overall cumulative effects on subsistence-harvest patterns in the Sale 109 area as a result of construction activities are expected to be MAJOR.

<u>Summary</u>: The cumulative effects of oil spills on Barrow's walrus harvests would remain MODERATE, as for the proposal. The cumulative effects of noise and traffic disturbance on Barrow's bowhead and beluga whale harvests are expected to be MAJOR. Under the cumulative case, the effects of construction activities and noise and traffic disturbance are expected to cause MODERATE effects on Barrow's caribou harvests. Effects of an oil spill on Barrow's seal and fish harvests would remain the same as for the proposal--MINOR. The overall cumulative effect on Barrow's subsistence-harvest patterns is expected to be MAJOR.

Effects on Wainwright's subsistence-harvest levels of bowhead whales are likely to be MAJOR due to the Sale 109 pipeline landfall and shorebase at Point Belcher and noise associated with construction activities in Peard Bay. These activities in the Peard Bay area are also likely to cause MODERATE effects on Wainwright's beluga whale, walrus, and caribou harvests, while effects on fish and birds would be NEGLIGIBLE. Cumulative effects from oil spills and noise and traffic disturbance on Wainwright's seal harvests are expected to remain MINOR, as for the proposal. The overall cumulative effect on Wainwright's subsistence-harvest patterns is expected to be MAJOR.

Cumulative effects from Federal lease sales of oil spills and noise and traffic disturbance on Point Lay's beluga whale harvest are expected to be MODERATE. Effects from oil spills on Point Lay's walrus and bird harvests would remain MODERATE, as for the proposal. Oil spills and noise and traffic disturbance would cause MINOR effects on Point Lay's caribou and seal harvests. Cumulative effects on Point Lay's fish harvests would be NEGLIGIBLE. However, effects on Point Lay subsistence harvests are expected to be MAJOR if State lease sales in the Chukchi Sea are reinstated on the State's 5-year lease-sale schedule. Thus, the overall cumulative effect on Point Lay's subsistence-harvest patterns is expected to increase to MAJOR.

Effects would not increase in the cumulative case for Point Hope's subsistence-harvest patterns because of the absence of activity in the area other than from Sale 109 and possible State lease sales. Cumulative effects of oil spills on Point Hope's subsistence-harvest patterns are expected to be NEGLIGIBLE. Effects on Point Hope's bowhead whale harvest are expected to be MODERATE. Effects on Point Hope's beluga and bird harvests would remain MINOR, as for the proposal. Effects on other subsistence harvests in the area are expected to be NEGLIGIBLE. Effects on Point Hope's subsistence harvests are expected to be MINOR for State lease sales in the Chukchi Sea. The overall cumulative effect on Point Hope's subsistence-harvest patterns is expected to be MODERATE.

Effects on Atqasuk's walrus harvest (done in conjuction with Barrow) would be the same as for the proposal--MODERATE. Other effects on Atqasuk's as well as Nuiqsut's subsistence harvests would remain the same as for the proposal--with the exception of MODERATE effects on the caribou harvests as a result of construction of and an increase in the presence of pipelines, roads, and associated vehicle traffic, and MAJOR effects on Nuiqsut's and Atqasuk's subsistence harvest of fish. MAJOR effects are expected on Atqasuk's and Nuiqsut's subsistence harvests from State and Federal leases in the Beaufort Sea, the NPR-A, and possible development of the ANWR. The overall cumulative effects on Atqasuk's and Nuiqsut's subsistence-harvest patterns are expected to be MAJOR.

Conclusion: Cumulative effects on subsistence-harvest patterns are expected to be MAJOR in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut, and MODERATE in Point Hope.

11. Effect on Sociocultural Systems: This discussion is concerned with those communities that could be affected by Chukchi Sea Sale 109. Under the scenario for this sale (see Sec. II.A.2), the Sale 109 communities that potentially could host petroleum-industry offshore-support facilities include Barrow and Wainwright as air-support bases. Wainwright is also the community closest to the enclave at Point Belcher, the location for the offshore-pipeline landfall and shorebase facilities. The sociocultural systems of Point Lay, Point Hope, and Atqasuk are also analyzed primarily because MAJOR and MODERATE effects on the subsistence harvests of these communities are expected as a result of Sale 109. Nuiqsut is included in this analysis because of its close ties with Barrow and its proximity to the Sale 109 onshore-pipeline corridor. This analysis does not include the "other communities" described in Section IV.B.10.c.7 because there will be no additional industrial activities (see Sec. IV.A.1), population growth or employment (see Sec. IV.B.9), or effects on subsistence-harvest patterns (see Sec. IV.B.10) in these communities.

The primary aspects of the sociocultural system covered in this analysis are (1) social organization and (2) cultural values, as described in Section III.C.3. For the purpose of effects assessment, it is assumed that effects on social organization and cultural values could be brought about at the community level--predominantly by industrial activities, increased population, and increased employment or effects on subsistence-harvest patterns associated with the sale. Potential effects are evaluated relative to the primary tendency of introduced social forces to support or disrupt existing systems of organization, and relative to the duration of such behavior.

a. Introduction:

(1) Parameters of This Analysis: An analysis of the social organization of a society involves examining how people are divided into social groups and networks. Social groups are generally based on kinship and marriage systems, as well as nonbiological alliance groups formed by such characteristics as age, sex, ethnicity, and community. Kinship relations and

nonbiological alliances serve to extend and ensure cooperation within the society. Social organization could be affected by an influx of new population that causes growth in the community and/or change in the organization of social groups and networks. Disruption of the subsistence cycle could also change the way these groups are organized. Activities such as the sharing of subsistence foods are profoundly important to the maintenance of family ties, kinship networks, and a sense of community well-being (see Sec. III.C.3). In rural Alaskan-Native communities, task groups associated with subsistence harvests are important in defining social roles and kinship relations. The individuals one cooperates with help define kin ties; the distribution of specific tasks reflects and reinforces the roles of husbands, wives, grandparents, children, friends, etc. (see Sec. III.C.3). Disruption of the subsistence cycle also could undercut the system of traditional leadership and threaten the community's stability. It might also create a disruption of family ties, kinship networks, and the community's sense of well-being, which would damage the social bonds that hold the community together. Any serious disruption of sharing networks could appear in a community as a threat to the way of life itself and could set off an array of emotions--fear, anger, frustration, and a sense of loss and helplessness. Perceived threats to subsistence activity and its psychological importance in these sharing networks is an important source of the anxieties about oil development.

An analysis of cultural values looks at values shared by most members of a social group. These values are shared conceptions of what is desirable. They are ideals which the members of some social group accept, explicitly or implicitly. Forces powerful enough to change the basic values of an entire society include a seriously disturbing change in the physical conditions of life--a fundamental cultural change imposed or induced by external forces, e.g., when an incoming group induces acculturation of the residing group; or when a series of fundamental technological inventions change the physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly or suddenly and dramatically (Lantis, 1959). Cultural values in the sale area include strong ties to Native foods, the environment and its wildlife, the family, the virtues of sharing the proceeds of the hunt, and independence from the outside (see Sec. III.C.3). A serious disruption of subsistence-harvest patterns could alter these cultural values. For the system of sharing to operate properly, some households must be able to produce--rather consistently--a surplus of subsistence goods. It is more difficult for a household to produce a surplus than to adequately satisfy its own needs. For this reason, sharing, and the supply of subsistence foods in the sharing network, may be more sensitive to harvest disruptions than the consumption of these foods by active producers.

(2) Effect Agents: This section discusses the agents associated with Sale 109 that could affect the sociocultural systems in communities in the sale area (described in Sec. III.C.3): industrial activities, changes in population and employment, and effects on subsistence-harvest patterns.

(a) Industrial Activities: During the exploration phase (see Sec. II.A.2.a), Barrow and Wainwright would be used as air-support bases. Personnel and air freight would be transferred to helicopters at either airport. One helicopter trip per day per platform is assumed for exploration (see Table II-1); four to six helicopters would service the Sale 109 area. The existing facilities at

Barrow and Wainwright are adequate to handle the projected needs during exploration. During the development and production phase, air support would gradually shift to the shorebase facility at Point Belcher. The Barrow and Wainwright airports and facilities would continue to provide alternatives in case of emergencies and also would enable the shift from existing to new infrastructure to occur more gradually, but in sufficient time to prevent overtaxing the infrastructure in those communities (see Sec. II.A.2.b). Point Belcher is the location of the enclave for the proposed shorebase facilities for the offshore-pipeline landfall and the onshore pipeline to the TAP. The enclave would be approximately 20 to 25 kilometers from Wainwright. During development, a road would be constructed between Wainwright and Point Belcher to facilitate the shift between the support base at Wainwright and the shorebase at Point Belcher, which would have all necessary facilities. During production, two supply boats and one helicopter per platform would be used. In the peak year (1998), ten workboats and five helicopters would be used in the sale area. Point Lay, Point Hope, Atqasuk, and Nuiqsut are too far from the proposed industrial activities for their sociocultural systems to be affected by these activities.

(b) Population and Employment: Sale 109 is projected to affect the population of the North Slope Borough through two types of effects on employment in the region: (1) more petroleum-industry-related jobs as a consequence of Sale 109 exploration, development, and production activities and (2) more NSB-funded jobs as a result of higher NSB operating revenues and expenditures (see Sec. IV.B.9.a). Employment projections as a consequence of Sale 109 are provided in Section IV.B.9.b. Throughout the production phase, total employment would average about 2,200 jobs, of which about 300 would be onshore. All of these jobs would be filled by commuters who would be present at the work sites approximately half of the days in any year. Most workers are expected to permanently reside outside of the North Slope. Sale 109 is projected to increase resident employment by 10 percent or more above the declining existing-condition projections between 1997 and 2010. In 1997 and 1998, respectively, employment would be 17 and 22 percent above existing-condition projections. The employment effect over the existing-condition projections would reach 20 percent by 2005 and 30 percent by 2008 (see Sec. IV.B.9.b).

The effect on the population in the North Slope from increased employment opportunities would partially offset expected declines in other job opportunities and, therefore, delay expected out-migration. Sale 109 is projected to increase the North Slope Borough population by less than 10 percent above the existing-condition level until 2005. By 2008, the effect would be over 20 percent greater. The population of the North Slope Borough is not expected to decline as a consequence of the sale because of the increased employment opportunities. The Native proportion of the population is not expected to change (86%), and Native employment is expected to improve as a consequence of Sale 109 (see Fig. IV-27). Barrow is most likely to benefit from sale-related and sale-induced employment increases. It is expected that Wainwright's proximity to the shorebase at Point Belcher would encourage more Wainwright residents to apply for sale-related jobs (see Sec. IV.B.9).

Point Lay, Point Hope, Atqasuk, and Nuiqsut are not expected to experience much of an increase in sale-related employment, although there may be some degree of sale-induced employment. These changes in employment are not expected to be significant and would not cause effects on the sociocultural systems of these communities in addition to those already experienced under the NSB CIP.

(c) Effects on Subsistence-Harvest Patterns: Subsistence is important to the Inupiat sociocultural system (see Sec. III.C.3 for a detailed description). Overall, MAJOR effects are expected on subsistence-harvest patterns in the Sale 109 area as a result of effects on Wainwright's bowhead whale harvest and effects on Nuiqsut's fish harvest. MODERATE effects are expected in Barrow and Atqasuk as a result of effects on walrus and fish harvests; MODERATE effects are expected in Point Lay and Point Hope as a result of effects on beluga whale and bowhead whale harvests, respectively.

b. Effect on Barrow, Wainwright, Point Lay, Point Hope, Atqasuk, and Nuiqsut: This section discusses the effect of the proposal on the communities whose sociocultural systems may be affected by Sale 109. The relatively homogenous nature of these communities--they are all predominantly Inupiat--indicates that changes would be similar in the communities. The exception to this may be Barrow, which is larger, has a larger percentage of non-Natives, and has already experienced more change than the other, smaller North Slope communities (see Sec. III.C.3). This section analyzes effects of industrial activities, population and employment, and subsistence-harvest patterns on North Slope social organization, cultural values, and other issues. This discussion focuses on the North Slope as a whole, with a discussion of each community where necessary.

(1) Social Organization: The social organization of Sale 109 communities includes typical features of Inupiat culture: kinship networks that organize much of a community's subsistence-production and -consumption levels, informally derived systems of respect and authority, strong extended families--although not always living in the same household--and stratification between families focused on success at subsistence endeavors, and access to subsistence technology (see Sec. III.C.3). These non-Western elements of social organization could be altered to become less oriented toward the family and exhibited in a breakdown of kinship networks as a result of OCS-induced social conditions in Barrow and Wainwright. Increased air traffic during exploration is unlikely to have a large effect on the community of Wainwright. Air-traffic delays could potentially strand workers in Wainwright for many hours or days; however, this increase in non-Natives in the community would not be more than the increased number of non-Native workers present in Wainwright during the peak of the CIP construction years in the 1980's. Other OCS industrial activities (Point Belcher shorebase facility and pipeline) would occur close to Barrow and Wainwright but not within the communities, and the changes in population and employment would not be more excessive than those the communities have already experienced.

In Barrow, there has been a decrease in the Inupiat population from 91 percent to 61 percent from 1970 to 1985 and an increase in the non-Native, non-Caucasian population (see Sec. III.C.3), as well as an increase in high-paying jobs during the peak of CIP-project construction (see Sec. IV.B.9). Beginning in the early 1980's, there has been an increased number of "strangers" present in Wainwright--usually construction workers working on new buildings for the community. The difference between Barrow and Wainwright is that Barrow's non-Native population is permanent (see Sec. III.C.3). This trend would continue in both communities with Sale 109. However, while disruptions would occur to Barrow's and Wainwright's social organization as a result of increases in temporary or permanent population growth and increases in population, these disruptions would not be significantly higher than those already occurring as a result of NSB CIP development; and it is not likely that Barrow's and Wainwright's social organization would be displaced.

The construction of a road between Wainwright and the shorebase at Point Belcher (a distance of 20-25 km) could cause disruptions to Wainwright's social organization due to an increase of social interaction between Wainwright residents and oil industry workers. Other instances of increased interaction would occur if local residents are employed in oil industry jobs. While some oil industry workers could exhibit a respect and understanding of Inupiat culture, others could come equipped with prejudices too ingrained to be modified by experience. Some of the interactions of oil workers with the local Inupiat population are likely to be unpleasant and could lead to a growth in racial tension. In addition, the presence of the oil workers could be stressful in a community as small as Wainwright (population 507 in 1985), while in Barrow the higher population (3,075 in 1985) and larger proportion of non-Natives (39%) is more likely to absorb this additional effect. Social interaction of oil industry workers and Wainwright and Barrow residents would be long-term, but there would not be a tendency toward displacement of their social organizations. Point Lay, Point Hope, Atqasuk, and Nuiqsut are not expected to experience any of these effects since they are not located close to sale-related industrial activities and thus would experience insignificant, indirect population and employment growth.

Subsistence is important to Inupiat social organization through sharing, task groups, crew structure, and strengthening social bonds. Effects on Barrow's, Wainwright's, Point Hope's, Atqasuk's, and Nuiqsut's subsistence-harvest patterns are expected to be MAJOR. MAJOR effects are expected on bowhead whale harvests and MODERATE effects on Wainwright's walrus and beluga whale harvests. MAJOR effects are expected on Nuiqsut's fish harvest. Effects on Point Lay's subsistence-harvest patterns are expected to be MODERATE (see Sec. IV.B.10). Subsistence is a naturally cyclical activity. It is expected that harvests would vary from year to year, sometimes substantially. It is precisely for this reason that numerous species are hunted in order to compensate for a reduced harvest of any resource in any one year. However, multiyear disruptions to even one resource--particularly one as important as the bowhead whale--or multiyear disruptions to more than one subsistence resource could disrupt sharing networks and subsistence task groups. Crew structures, particularly bowhead whale-hunting crews, could be disrupted, resulting in ramifications in the social organization through loss of status and kinship ties. Effects on sharing networks and subsistence task groups could cause a breakdown in family ties and the community's sense of well-being as well as damage linkages between communities. Tensions and anxieties caused by the disruptions could occur at high levels (see Sec. IV.11.b[3]).

Other tensions could be caused by OCS activities perceived as a threat to subsistence resources, especially if oil industry activities are visibly evident and North Slope residents in the Sale 109 area do not perceive OCS development as a benefit to the Inupiat people. In Wainwright, a most likely number of two or three spills is estimated to contact the Wainwright subsistence-harvest area. No other subsistence-harvest areas are anticipated to have more than one spill contact. Wainwright is the only community that might have multiyear, multiresource disruptions. If the harvest of more than one species were unavailable in one year, or if one or more species became unavailable for a few consecutive years (as in Wainwright), there could be a tendency for additional stress on the sociocultural system--with possible tendencies toward disruption of the sharing networks and task groups, which also would disrupt the social organization (as well as disrupt cultural values [see discussion below]). This disruption could be long-term; however, it would not lead to a displacement of existing institutions, resulting in a MODERATE effect on sociocultural systems. MODERATE effects on social organization are expected in Wainwright. Disruptions in Barrow, Point Lay, Point Hope, and Atqasuk also would be short-term and would not have a tendency toward displacement of existing sociocultural institutions. MINOR effects are expected in Barrow, Point Lay, Point Hope, and Atqasuk; and NEGLIGIBLE effects are expected in Nuiqsut.

(2) Cultural Values: Cultural values and orientations (as described in Sec. III.C.3) can be affected by changes in the population, social organization and demographic conditions, economy, and alterations to the subsistence cycle. Of these, the only changes expected in Barrow and Wainwright are in the social organization (see discussion above) and the subsistence cycle (see Sec. IV.B.10 and discussion above). Only the subsistence-harvest patterns of Point Lay, Point Hope, and Atqasuk are expected to be affected by the proposed sale. NEGLIGIBLE effects are expected on Nuiqsut's subsistence-harvest patterns; consequently no effects on cultural value are anticipated.

A trend toward displacement of the social organization could lead to a decreased emphasis on the importance of the family, cooperation, sharing, and subsistence as a livelihood, with an increased emphasis on individualism, wage-labor, and entrepreneurialism. Interaction with oil industry workers could result in introduction of new values and ideas, as well as increased racial tensions and an increased availability of drugs and alcohol. Tensions could be created and could result in increased incidents of socially maladaptive behavior and family stress, potentially straining traditional Inupiat institutions for maintaining social stability and cultural continuity (see Sec. IV.11.b.[3]). Cultural values and orientations can change slowly or suddenly (Lantis, 1959). Long-term change depends on the relative weakening of traditional stabilizing institutions through prolonged stress and disruption effects, which could be expected to occur under the scenario for the proposed lease sale. These changes are already occurring to some degree on the North Slope as a result of onshore oil and gas development, increased employment, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructures, increased presence of non-Natives, increased travel outside of the North Slope, and the introduction of television.

Although the degrees of intensity of these changes are not yet documented nor are they easily quantifiable, it appears that these changes are trends that could increase rapidly with more intensive development as a result of this lease sale. However, in Barrow, many of these changes have already occurred to a much greater extent than in the remainder of the smaller North Slope communities. Additional effects as a result of the proposal would not be felt in Barrow to the same extent as they would in the smaller communities.

Subsistence is considered the core value and a central feature of Inupiat cultural values (see Sec. III.C.3). While a year-long disruption to only one subsistence resource would not be likely to cause long-term, chronic disruption of the sociocultural system with a displacement of existing systems, multiyear disruptions throughout the 30-year life of the project as well as disruptions of more than one resource would be more likely to begin affecting cultural values, with the potential for long-term sociocultural change and a tendency toward the displacement of existing institutions. When a group's identity is formed around being able to hunt--particularly to hunt the bowhead whale--and this hunt is not possible or not successful due to oil industry activity, a considerable amount of social stress, tension, and anxiety are likely to occur. It would also be expected that the inability to hunt would cause a disintegration of subsistence task groups, a tendency to replace sharing networks, and consequently a decrease in the importance of subsistence as a cultural value. Wainwright is the most likely community to experience such effects, since MAJOR or MODERATE effects are expected on the harvests of three of its primary subsistence resources--bowhead and beluga whales and walruses. It is likely that one or more of these harvests would be affected at least once during the life of the project because of the high probability on an oil spill occurring and contacting the Wainwright subsistence area (77%, see Sec. IV.B.10), and because two to three oil spills are expected to contact the Wainwright subsistence-harvest area. Other subsistence-harvest areas are anticipated to have no more than one oil spill contact in each area.

MODERATE effects are expected on two of Point Lay's subsistence resources--beluga whales and walruses; the beluga is the most important subsistence resource for Point Lay. However, if beluga whales and walruses were not available for 1 year, this disruption would be short-term and would not displace Point Lay's cultural values. In Barrow, Point Hope, and Atqasuk, MODERATE effects are expected on only one subsistence resource--walruses in Barrow and Atqasuk and bowhead whales in Point Hope. Effects also would be short-term and would not be likely to cause a tendency toward the disruption of existing cultural values.

MODERATE effects on cultural values are expected in Wainwright; MINOR effects are expected in Barrow, Point Lay, Point Hope, and Atqasuk; and NEGLIGIBLE effects are expected in Nuiqsut.

(3) <u>Other Issues</u>: Increases in social problems--rising rates of alcoholism, drug and alcohol abuse, domestic violence, wife and child abuse, rape, homicide, and suicide (as described in Sec. III.C.3.d) are also issues of concern to this analysis of sociocultural systems.

Additional problems could arise from the road between Wainwright and the shorebase at Point Belcher and from the increased presence of oil workers in the community and Wainwright residents working in the oil industry. This situation has the potential for creating new access to alcohol and drugs. Although the oil industry generally strictly forbids consumption of alcohol and drugs when workers are in camp, many such events frequently occur in Prudhoe Bay and Kuparuk (Armstrong, 1985, oral comm.). In Prudhoe Bay it is often the service industries that have not complied in enforcing the ban on alcohol. The increased availability of drugs and alcohol in Wainwright as a result of the increased traffic through the airport, visitors in town, and shorebase workers associating with local residents could be disruptive to the social well-being in the community. A similar situation has occurred in Nuiqsut, which is within 56 kilometers of Kuparuk and 105 kilometers of Prudhoe Bay. Although not accessible by road year-round, Nuiqsut is connected to the Prudhoe Bay/Kuparuk industrial complex by a winter road and by air. There is some indication of an increase in social problems (consumption of alcohol and drugs, sexual abuse, domestic violence) in Nuiqsut at a rate higher than in other North Slope communities (Armstrong, 1985, oral comm.). Although there may be additional reasons for differences in social problems in Nuiqsut, it is clear that the proximity to industrial enclaves is enabling the residents easier access to drugs and alcohol, thereby affecting the social health of the community--an effect that could also occur in Wainwright as a result of this lease sale. Any effects on social health would have ramifications in the social organization and possibly result in a breakdown in cultural values due to dissension in the family unit, weakening in kinship networks, and disintegration of the Inupiat value system.

The Effects of Stress on Sociocultural Systems: Effects on sociocultural systems are often evidenced in rising rates of mental illness, substance abuse, and violence. This has proven true for Alaskan Natives who have been faced since the 1950's with increasing acculturative pressures. The rates of these occurrences far exceed those of other American populations such as Alaskan non-Natives, American Natives, and other American minority groups (Kraus and Buffler, 1979). While such behaviors are individual acts, the rates at which they occur vary among different groups and through time. These changing rates are recognized as the results of a complex interaction of interpersonal, social, and cultural factors (Kraus and Buffler, 1979; see also, Kiev, 1964; Murphy, 1965; Inkeles, 1973). As a community grows, the rates of all types of mental illness appear to increase because rates of mental illness are higher ". . . in larger rural Native towns than in the more traditional Native villages" (Foulks and Katz, 1973; Kraus and Buffler, 1979). Native communities help buffer the individual by providing a sense of continuity and control.

People live with recognized role expectations, values, beliefs, and lifestyles. Bethel is an Alaskan example of a village that experienced these acculturative pressures rather early, as seen in its violent-death-rate increase in the 1930's (Anderson and Eells, 1935). Similarly, others found that a notable increase in mortality due to these causes in non-Native Fairbanks parallels the pipeline work (Klausner and Foulks, 1982). Increased social mobility may isolate individuals from kinsmen and supportive social situations (Stillner and Stillner, 1974). The growth of smaller communities into larger ones may have a similar effect.

Psychic stress leads to social pathologies; such problems may result from people being socialized for a lifestyle that no longer exists (Brower, 1980; see also Kiev, 1964, 1972; Chance, 1966; Milan, 1964; Murphy, 1965). New routes to success, created by development, may contradict the more traditional patterns of reciprocity and egalitarianism and lead to social conflict and feelings of guilt (Hippler, 1969). Conversely, people may identify with new goals that are inaccessible or for which they lack skills. This leads to lowered self-esteem and increased anger and frustration (Chance, 1965, 1966; Chance, Rin, and Chu, 1966; Kiev, 1964; Murphy, 1965). Problems of self-image are critical to the development or nondevelopment of social pathologies

(Chance, 1966). The substitution of one set of nominative behaviors for another may disrupt the standard set of expectations, predictions, and responses used to understand social settings. This too leads to lowered self-esteem and increased frustration (Erasmus, 1961; Kiev, 1964).

The nature and direction of change may not be clear or understood, or change may accelerate and "overload" the existing sociocultural system (Murphy, 1965). Such a situation decreases the sense of control and increases perceptions of an external threat as well as psychic stress. A sense of control is particularly important for adjustment (Chance, 1966), just as a sense of an uncontrolled, external threat is particularly detrimental (Kiev, 1964; Murphy, 1965).

Several salient points in the evaluation of possible sociocultural effects of oil-related developments due to this lease sale should be made. First, change itself--even though induced primarily by forces outside the communities--does not necessarily cause the levels of psychic stress that lead to pathology (for a general discussion, see Inkeles, 1973). Second, and related to the first point, not all sociocultural change (directly or indirectly related to oil development) may be negative. Higher levels of employment, better health programs, and improved public services must be viewed as possible positive sociocultural effects from oil development on the North Slope. Employment of the underemployed resident Inupiat in oil industry operations could assist in filling the economic vacuum created by decreasing North Slope revenues. Income from oil industry employment could improve living conditions, although major dependence on a nonrenewable-resource-based economy could cause long-term social costs at the time of resource depletion. Third, rapid and wide-ranging sociocultural effects are significant, not only because a way of life is altered but also because these alterations can come with high social costs. These costs include growing alienation; increasing rates of mental illness, suicide, homicide, and accidental death; growing disruption of family and social life; and substance abuse. Fourth, what makes sociological change disruptive ". . . is the manner in which changes occur" (Murphy, 1965). Fifth, the conditions that make sociocultural change stressful must be viewed as ongoing. If the stressful conditions alter, the society can make successful adjustments to the changes that have occurred; and the rates of violence, suicide, and substance abuse will drop.

Wainwright is the only community in the North Slope region that is expected to experience additional changes in social health and well-being as a result of this lease sale above those effects already being experienced as a result of the NSB CIP and indirect effects from current oil development. These effects on Wainwright's social health would be long-term and would have direct consequences on the sociocultural system but would not have a tendency toward displacement of existing institutions. MODERATE effects as a result of effects on "other issues" are expected in Wainwright; MINOR effects are expected in Barrow, Point Lay, Point Hope, and Atqasuk; and NEGLIGIBLE effects are expected in Nuiqsut.

<u>SUMMARY</u>: Effects on the sociocultural systems of communities in the Sale 109 area would occur as a result of industrial activities, changes in population and employment, and effects on subsistence-harvest patterns. These effect agents would affect the social organization, cultural values, and social health of the communities in the Sale 109 area. Barrow and Wainwright are the

communities that are most likely to be affected by Sale 109 due to their proximity to the shorebase at Point Belcher and their use as air-support bases. Sale-related increases in population and employment predicted for the Sale 109 area are expected to occur primarily in Barrow and Wainwright. In addition, Wainwright is expected to experience MAJOR and MODERATE effects on three primary subsistence-harvest patterns. Although Barrow would be in proximity to industrial activities, would have increases in population and employment, and thus would have MODERATE effects on one subsistence-harvest resource--walruses, these changes should not be more significant than those changes that have already been felt in Barrow, particularly from 1975 to 1985. Barrow is a much larger community that is more heterogenous than others on the North Slope, and it could withstand some degree of increased population and employment opportunities. MINOR effects are expected on Barrow's sociocultural system as a result of the proposal.

Wainwright would be closer to the shorebase (only 20-25 km), and a road would be built between Wainwright and the shorebase. Wainwright's population would not experience significant increases; however, more of Wainwright's residents than Point Lay's, Point Hope's, Atqasuk's, or Nuiqsut's residents are expected to seek employment at the shorebase due to its proximity to the community. In addition, Wainwright is a small, relatively homogenous community that would not absorb the presence of non-Natives as well as Barrow would. Interactions with non-Natives, increased non-Native population, and leaving the community to work in the industrial enclave could lead to a breakdown of kinship networks as well as increase social stress in the community. A disruption of the social organization could lead to a decreased emphasis on the importance of the family, cooperation, and sharing. Multiyear, multiresource disruptions of Wainwright's subsistence-harvest patterns--particularly of the bowhead whale, which is an important species to the Inupiat culture--could disrupt sharing networks, subsistence task groups, and crew structures and could cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being and could damage sharing linkages with other communities. Other effects might be a decreasing emphasis on subsistence as a livelihood, with an increased emphasis on wage employment, individualism, and entreprenuerialism. Wainwright also may experience an increase in social problems due to the increased presence of oil workers in the community and a road connecting Wainwright to the shorebase--both of these factors enabling easier access to drugs and alcohol and affecting the social health of the community. Effects on the sociocultural system, such as increased drug and alcohol abuse, breakdown in family ties, and weakening of social well-being, would lead to additional stresses on the health and social services available to Wainwright. These effects described above would be long-term; and there could be a tendency for additional stress on the sociocultural system but without tendencies toward displacement, resulting in MODERATE effects on Wainwright's sociocultural system.

Point Lay, Point Hope, Atqasuk, and Nuiqsut are too distant from onshore industrial activities to be directly affected by this lease sale and are not expected to experience direct population and employment increases as a result of this lease sale. These communities may experience some indirect rises in population and increases in employment, but they are not expected to be significant. MODERATE effects are expected on two primary subsistence-harvest patterns in Point Lay, while MODERATE effects are expected on only one subsistence-harvest pattern in Point Hope and Atqasuk. MINOR effects are expected on Nuiqsut's subsistence-harvest patterns. MINOR effects are expected on Point Lay's, Point Hope's, and Atqasuk's sociocultural systems, and NEGLIGIBLE effects are expected on Nuiqsut's sociocultural system.

CONCLUSION (Effect on Sociocultural Systems): The effect of proposed Sale 109 on sociocultural systems is expected to be MODERATE.

CUMULATIVE EFFECTS (Effect on Sociocultural Systems): Cumulative effects on sociocultural systems are assessed as the aggregate result of effects associated with this lease sale in combination with other activities or projects identified in Section IV.A. Barrow is identified as a major air-support base for other projects and is the regional center for the North Slope. The Beaufort Sea Sale 97 scenario identifies Point Belcher as the location for an enclave near Wainwright and for an onshore pipeline to the TAP.

Projects and activities in the cumulative case include projected offshore development from Beaufort Sea Sale 97 and the Diapir Field Lease Offering (Sale 87); onshore oil development in Prudhoe Bay and other fields; and the Red Dog Mine project. In the cumulative case, MAJOR effects of displacement of sociocultural systems are described in the Diapir Field Lease Offering (Sale 87) and Beaufort Sea (Sale 97) FEIS's (USDOI, MMS, 1984a, 1987a) for communities in those lease-sale areas (Barrow, Wainwright, and Nuiqsut are the only communities affected by activities in those sale areas that also would be affected by Sale 109).

Cumulative Effect on Social Organization: In the cumulative case, effects on social organization would be the result of effects of industrial activities, changes in population and employment, and effects on subsistence-harvest patterns. These effects would be similar to those described for the proposal; however, the level of effects would be increased due to the intensity of activity in the cumulative case. Additional air traffic and growth in the number of non-Natives in the North Slope would increase the interaction between Natives and non-Natives and could cause additional stress between these groups. Increases in population growth and employment would be long-term in the cumulative case and would cause disruptions to (1) the kinship networks that organize the Inupiat communities' subsistence-production and consumption levels, (2) extended families, and (3) informally derived systems of respect and authority (primarily respect of elders and other leaders in the community). MAJOR cumulative effects on subsistence-harvest patterns (which also would be long-term in the cumulative case) would affect the Inupiat social organization through disruptions to their kinship ties, sharing networks, task groups, crew structures, and other social bonds. Effects on sharing networks and subsistence task groups could cause a breakdown in family ties and the communities' well-being as well as tensions and anxieties leading to high levels of social discord. In the cumulative case, these disruptions to the social organization would be long-term and would cause displacement of the existing social organization.

Cumulative Effect on Cultural Values: Effects on cultural values in the cumulative case would be the result of effects of industrial activities, changes in population and employment, and effects on subsistence-harvest patterns. These effects would be similar to those described for the proposal;

however, the level of effects would be higher due to the intensity of activity in the cumulative case. MAJOR effects on the social organization in the cumulative case would lead to a decreased emphasis on the importance of the family, cooperation, sharing, and subsistence as a livelihood, and an increased emphasis on individualism, wage labor, and entreprenuerialism. Increased interaction with oil industry workers in the cumulative case would result in increased stress and strain on traditional Inupiat institutions. In the cumulative case, MAJOR long term effects are expected to affect subsistence-harvest patterns. Chronic, long-term disruptions of subsistence-harvest patterns would affect subsistence task groups, have a tendency to displace sharing networks, and consequently cause a decrease in the importance of subsistence as a cultural value.

Cumulative Effect on Other Issues: In the cumulative case, increases in social problems--rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide--are also issues of concern. The NSB is already experiencing problems in the social health and well-being of its communities; however, additional development--including offshore oil development--on the North Slope would lead to further disruptions of their social health and well-being. These long-term effects would cause a displacement of existing sociocultural institutions.

Cumulative effects of sociocultural systems would be MAJOR in Barrow and Wainwright because MAJOR effects are expected from Sale 97 (Barrow and Wainwright) and the Diapir Field Lease Sale (Barrow only), in addition to the MODERATE (Wainwright) and MINOR (Barrow) effects described under the proposal. MINOR effects are expected in Point Lay, Point Hope, and Atqasuk under the proposal. These effects would increase slightly in the cumulative case for Point Hope due to effects from the Red Dog Mine project; however, the effect would remain MINOR. Point Lay and Atqasuk would not be directly affected by other development on the North Slope and would not experience more than MINOR effects as a result of effects from the proposal.

Conclusion: Cumulative effects on sociocultural systems in the Sale 109 area are expected to be MAJOR.

12. Effect on Archaeological Resources: There are two major categories of prehistoric and historic archaeological resources identified in the Sale 109 area: offshore resources (seaward from the 3-geographical-mile line) and onshore resources (inland and seaward to the 3-geographical-mile line). Therefore, the effect of Sale 109 on these resources is discussed in terms of (1) offshore resources (prehistoric) and shipwrecks (historic) and (2) onshore resources (prehistoric and historic). Archaeological resources in the sale area could be affected by offshore exploration on the lease, construction of onshore support facilities, construction of offshore pipelines to shore, recreational visits by OCS-related employees (employed directly and indirectly) to archaeological-resource sites, development, production of oil, and other oil-related activities such as oil-spill cleanup.

a. Effect on Offshore Resources: A condition essential to assessing offshore effects is the probability that a prehistoric resource exists (see Appendix E, MMS Archaeological Analysis, Fig. 4). This analysis concludes that the only zones in the Sale 109 area that might not have been extensively ice-gouged and also would have enough sediment cover to preserve a prehistoric site are Zones A, B, and C north of 72°N. latitude in the Chukchi Basin, and Zone A south of 69°N. latitude in Hope Basin (Appendix E, Fig. 4). According to this report, none of these zones show present-day evidence of ice gouging nor do they show any significant landforms upon which a prehistoric site could have been situated. New information released by the Alaska OCS Region shows landforms that may have contained prehistoric resources around a pleistocene lake between 69°N. and 71°N. latitude and 165°W. and 170°W. longitude (shown in Appendix E, Fig. 12) and west of Point Hope. Such landforms probably would have been ice-gouged, resulting in a small chance for site survival. Activities such as platform installation and pipeline installation would therefore, by definition, have MINOR effects if only one resource existed in this area of the lease sale.

Because of the extensive ice gouging, sparse sediment cover, and lack of landforms in other parts of the sale area, it is not likely that any prehistoric offshore sites exist there today. Overall, the effects of the proposal on offshore prehistoric resources are expected to be NEGLIGIBLE.

In addition to prehistoric resources, there also is a high likelihood that historic shipwrecks exist in the deeper waters offshore of Point Belcher, where about 40 ships went down in the 1800's (Tornfelt, 1982, 1987 [In Press]) (Appendix E, Shipwreck-Update Analysis, Tables E-1 and E-2; Figs. III-34 and III-35). This likelihood that shipwrecks exist is further enhanced because historical objects are not subjected to as many years of ice gouging as prehistoric objects. Therefore, the likelihood of survival is greater and the chance of disturbance to shipwrecks is greater. Activities associated with exploration platforms, production platforms, and pipelines near Point Belcher, where about 28 ships went down in 1871, could have a MAJOR effect. However, surveys conducted during site planning for oil development could reveal archaeological evidence of ships that would otherwise be further ground up by ice. Such evidence would reduce the effects on shipwrecks.

b. Effect on Onshore Resources: One of the important onshore archaeological sites near the sale area is the Shipwreck City Historic Site (see Fig. III-34). Over 40 ships were wrecked somewhere offshore of Point Belcher in September 1871 and September 1876 and the 1,219 survivors of the wrecks on September 7, 1871 (including families of crew members) spent the night at the location onshore that is now referred to as the Shipwreck City Historic Site (State of Alaska, DNR, 1986). Construction and maintenance activities associated with the offshore pipelines and facilities projected for the proposal (Table II-1) would disturb these resources and their ground context. Such disturbance is caused by plowing, digging, and dirt removal during construction and later during maintenance. Other onshore resources are likely to be disturbed by activities, pipelines, and facilities that are constructed onshore. OCS employees who visit archaeological sites may inadvertently disturb these sites and could cause MODERATE disturbance to onshore resources. Oil spills could indirectly affect archaeological resources when bulldozers, trucks, and other heavy equipment are moved to the oil-spill-cleanup area on the strand from an airport in the vicinity of the spill. Equipment transported over archaeological sites during cleanup could cause MODERATE effects on sites located in OSRA Land Segments 14 through 24 (Fig. IV-1). Concentration areas for bowhead whales, beluga whales, seals, fishes, and migratory birds and the archaeological sites of the communities of Point Hope and Wainwright are also likely places of prehistoric-human habitation because of their location near food and freshwater (Kotani and Workman, 1980). The probabilities of an oil spill striking these targets are all below 5 percent (see Table IV-15). The effects of the proposal on the Ipiutak Historic Site are expected to be MINOR due to the site's location at the boundary of the Sale 109 area. The effects of the proposal on the Cape Krusenstern National Monument and the Bering Land Bridge National Preserve are expected to be MINOR due to their locations outside of the area of activity related to Sale 109.

CONCLUSION (Effect on Archaeological Resources): The effect of the proposal on offshore and onshore archaeological resources and shipwrecks is expected to be MINOR.

CUMULATIVE EFFECTS: The cumulative effects of other private, State, and Federal projects, together with the effects of the proposal, would result in a likely chance of interaction with archaeological resources. These cumulative industrial activities and activities resulting from oil spills are discussed in the following paragraphs.

State of Alaska Oil and Gas Leasing: The State of Alaska's 5-year leasing schedule has included--and may include over the life of the Sale 109 proposal--lease areas where potential exploration and development could affect the archaeological sites shown in Figures III-34 and III-35. These areas are at Point Belcher, south of Point Lay, and inland (Graphic No. 3). These proposed activities (Table IV-2) would have to be consistent with legislative mandates presently in effect that ensure protection of archaeological resources (i.e., the Coastal Zone Management Act and the Alaska Historic Preservation Act).

Any construction activities on wetlands or navigable waters will require Federal permits in accordance with Section 10 of the Rivers and Harbors Act of 1899 or Section 404 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977. Archaeological-clearance surveys must be completed prior to commencement of such activities, thereby ensuring adequate protection through the U.S. Army Corps of Engineers permitting process.

Arctic Slope Regional Corporation Oil and Gas Leasing: The full extent and nature of activities proposed under this project are not completely known; however, several land-selection areas along the river where many sites are located would be affected by mineral activity if it occurred. It is assumed that any possible petroleum exploration and/or development would generate potential onshore effects on archaeological resources similar to those discussed under NPR-A. It is important to note that these activities would be conducted on privately owned land. No oil discoveries have been made to date (Table IV-2). The North Slope Borough's Land Management Regulations (Title 19) set policy and provide protection for archaeological resources. Due to low-level exploratory activity, the effects of the leasing activities on archaeological resources would be MINOR.

Future Federal Oil and Gas Leasing: Potential effects on unknown offshore sites could result with respect to future proposed OCS lease sales. With respect to onshore sites where non-Federal land could be involved, the Coastal Zone Management Act and the Alaska Historic Preservation Act would ensure adequate protection of archaeological resources. Since activity in the Beaufort Sea has recently slowed, future activities would produce MINOR effects.

Table IV-15
Shipwreck and Archaeological Sites Relative to OSRA Segments in the Sale 109 Area

OSRA Seg. No. 1/	No. of Ship-wrecks	No. of Arch. Sites	OSRA Prob. Pro-posal, Winter 2/	Cum. OSRA Prob. Winter 2/	Descriptive Name	Summary of Effects (Proposal)	Summary of Effects (Cumulative)
Type I	Segments 3/						
22	26	5	n 6/	n	Wainwright	Minor	Moderate
23	10	6	n	n	Pt. Belcher	Minor	Moderate
25	2	6	n	n	Barrow	Minor	Moderate
Type II	Segments 4/						
17	0	6	3	3	Cape Sabine	Minor	Minor
21	1	23	n	n	Pt. Lay	Minor	Minor
24	4	5	n	n	S.W. of Barrow	Minor	Minor
Type III	Segments 5/						
15	0	3	n	n	Cape Lisburne	Minor	Negligible
26	0	2	n	n	E. of Barrow	Minor	Minor

Source: Tornfelt, 1987 (In Press).

1/ See Figure IV-1 for geographic location of OSRA segments.
2/ Combined probabilities are for spills of 1,000 barrels or greater (Appendix A).
3/ A Type I segment includes a number of archaeological sites and shipwrecks both above the mean number of archaeological sites and shipwrecks. (The mean number of archaeological sites is 4; the mean number of shipwrecks is 1).
4/ A Type II segment includes a number of archaeological sites above the mean number of archaeological sites and a number below the mean number of shipwrecks.
5/ A Type III segment includes a number of shipwrecks above the mean number of shipwrecks and a number below the mean number of archaeological sites.

Note: "n" denotes a less than 0.5-percent chance.

Canadian Oil and Gas Activities: The U.S. area adjacent to the possible Canadian tanker routes contains archaeological sites. There is the possibility of adverse effects if a tanker oil spill occurred and cleanup activities necessitated people and equipment crossing lands containing archaeological sites to get to contaminated areas. Effects on the archaeological resources of the Chukchi Sea and shore would be MINOR.

Conclusion: Overall cumulative effects of the above projects and the proposal on archaeological resources are expected to be MINOR.

13. Effect on Land Use Plans and Coastal Management Programs: Onshore activities and some offshore activities resulting from Sale 109 would be subject to the North Slope Borough (NSB) Comprehensive Plan and Land Management Regulations and the Alaska Coastal Management Program (ACMP). The Land Management Regulations are being applied to all activities occurring on private and State lands. Activities that would take place in these areas are portions of the onshore pipeline/corridor east of the NPR-A, the offshore pipeline within State waters, and the road between Point Belcher and Wainwright. The support base near Point Belcher probably would be located within the boundaries of the NPR-A. However, if the shorebase were constructed south of Point Belcher on lands held by the Wainwright Village Corporation, it would be subject to the NSB Land Management Regulations. Any development that occurred within the coastal boundaries of the ACMP or affected the uses of the coastal zone would be subject to the policies of the ACMP. This includes even those activities that also would be subject to the Land Management Regulations. Activities that would be assessed for consistency with the ACMP would be the shorebase, the offshore pipeline, and those portions of the onshore pipeline/corridor within approximately 40 kilometers of the coast. The policies of each of these management programs are assessed in the following section for potential conflicts between the policies and the potential effects identified in Sections IV.B.1 through IV.B.12. The first part assesses the NSB Land Management Regulations and the second, the policies of the ACMP.

a. North Slope Borough Comprehensive Plan and Land Management Regulations: Two permit processes are available under the Land Management Regulations. One process makes use of conditional-use permits. This method permits activities on a case-by-case basis and is useful for small-scale or unique requests. The second process is more applicable to large-scale development; through this process, a master plan is created for all activities that are part of a development. All components are assessed together and approved via the approval of the master plan. Activities or developments approved in this manner become a use-by-right. Decisions on permits for these activities must be issued within 5 business days of the submission of the application (NSB, Title 19 [NSB] 19.50.033).

Few land management permits should be required during exploration because most onshore support would be based in existing facilities at Barrow and Wainwright. Any permits that are requested probably would be conditional-use permits for individual activities. This would change during development, when a master plan would be submitted because of the numerous projects that would be undertaken to develop the facilities and related infrastructure necessary to produce the oil resource and transport it to market. Onshore and nearshore developments are assumed to occur near Point Belcher and continue east to TAP Pump Station No. 2.

The shorebase area currently is used only for subsistence purposes and is classified in the Conservation District. Limited development can occur within this district as long as it qualifies for a conditional-use permit. Development assumed for Sale 109 probably is too extensive to be considered piecemeal (NSB 19.40.350). As a result, a rezone from the Conservation District to a Resource Development District would be requested and a master plan prepared.

As noted in the description, policies in the Land Management Regulations fall into several categories. First, Mandatory Policies must be complied with unless the policy is not applicable or the NSB grants a variance. Mandatory Policies would prohibit the shorebase and pipeline corridor to the TAP if the developments depleted any subsistence resource to a level below the needs of residents (NSB 19.80.021[A]), precluded subsistence-user access to a subsistence resource (NSB 19.80.021[E]), or significantly interfered with bowhead whaling at Point Belcher (NSB 19.80.021[G]). Subsistence resources are not expected to experience significant losses. However, both projects would alter land now used for subsistence purposes and generate activities that could lead to MAJOR effects on subsistence. If effects on subsistence or subsistence resources were evident but less serious, the activities would not automatically conflict with NSB policies, provided that developers have used their best efforts to comply with the Best-Efforts Policies and there is no feasible and prudent alternative to the proposed compliance (NSB 19.80.030 and 19.80.031[A], [B], and [R]). For example, access could be enhanced if a road between the community and the shorebase were constructed that facilitated subsistence access to Peard Bay or Point Belcher. Indeed, the transportation assumptions used for the proposal may conform more closely to NSB policies than other potential routes or modes of transportation. For example, a shorter pipeline route between Point Belcher and the TAP constructed farther north across the lake district would cut across Barrow's primary subsistence area. Although the pipeline corridor hypothesized for the proposal also would affect subsistence activities, the route conforms with the policies that require transportation and utility facilities to minimize such interference and avoid the most sensitive areas (e.g., NSB 19.80.040[B]). For example, the route avoids those portions of the Ikpikpuk and Colville Rivers identified as most sensitive by the NPR-A Task Force (USDOI, BLM, NPR-A Task Force, 1978). Support for all offshore development in the Chukchi Sea is assumed to occur from one support base. Land requirements should be minimal (25-30 hectares). Because pipelines are assumed for hydrocarbon transportation, treatment facilities are assumed to be on the platform; and the need for oil-storage facilities is limited. As a result, support facilities should conform to the requirements that they be as compact as possible and shared to the maximum extent possible (NSB 19.80.032[B]). The proposed pipeline corridor also is expected to conform with this policy.

Best-Efforts and Minimization-of-Negative-Impacts Policies would require that the pipeline be properly located, designed, and maintained with respect to subsistence resources and their habitats (NSB 19.80.032[A]); that disruptions of migratory patterns and other major movements of wildlife be minimized (NSB 19.80.031[I]); and that, where above ground, the pipeline would be elevated a minimum of 5 feet except where it intersects a road or caribou ramp (NSB

19.80.040[C]). Conformance with these policies should be possible because effects on caribou migration as a result of this proposal are not expected to exceed MINOR. Finally, the landfall site for the pipeline would need to be sited, designed, and constructed to minimize damage from oceanic storms, waves, ice gouging and override, and shore erosion (NSB 19.80.040[D]).

The airfield at Point Belcher and any helipads built along the pipeline corridor must be constructed to minimize their effects upon significant waterfowl-migration routes, -breeding grounds, and -nesting areas (NSB 19.80.040[A]). Because loss of waterfowl habitat is not expected to be significant (Sec. IV.B.5), conformance with this policy is expected to be possible.

Limited marine support facilities that would be associated with the shorebase would be located in a "sensitive area" (NSB 19.80.031[E]); however, they would qualify as an exception since there is no potential alternative. The shorebase probably would be constructed inland of these restricted areas in order to provide adequate protection from geological hazards (NSB 19.80.040[D]).

Most required features of the NSB Land Use Regulations could be achieved by the major developments assumed in the Sale 109 scenario. For example, requirements for maintaining the natural permafrost insulation of existing soil and vegetation (NSB 19.80.032[C]) and for consolidating transportation facilities for resource development and extraction to the maximum extent possible (NSB 19.80.032[G]) also would be beneficial to the developer.

In conducting reviews for other development projects in the NSB that have some features comparable to those anticipated for the pipeline corridor, the NSB has established special conditions to assure conformance with several land use policies. Policies cited by the NSB during these reviews include: Mandatory Policies related to deposition of toxic materials and untreated solid wastes, and emissions; Best-Efforts Policies related to subsistence resources, sensitive areas, pollution, habitat disturbance, and permafrost; and Minimization-of-Negative-Impacts Policies related to habitat changes and disturbance (NSB 19.80.021[D]; 19.80.025[C]; 19.80.031[A], [E], [O], [Q], and [R]; 19.80.032[C]; and 19.80.040[B]). It is likely that special conditions to ensure conformance with these policies also would be attached to developments and activities resulting from Sale 109.

Several development features are recognized by the NSB as beneficial impacts and are awarded special consideration. The development would be considered more favorably if the pipeline and accompanying facilities were coordinated with NPR-A activities to permit joint siting and use (NSB 19.80.050[A]) and accommodated free cross-migration of caribou (NSB 19.80.050[B]). Hiring practices and tax advantages also could enhance the project (NSB 19.80.050[F], [G], [H], [K], and [O]). Two features assumed in the Sale 109 scenario would be viewed favorably. First, the proximity of the development to Wainwright may encourage more Wainwright residents to apply for sale-related jobs (Sec. IV.B.9). Second, the project probably would provide an excess of tax revenues over demand for expenditures (Sec. IV.B.9).

b. Coastal Management Programs: Coastal management policies apply to all activities that occur within the coastal boundaries of the Borough or that directly affect the use of the coastal zone. Activities within the coastal zone would include the shorebase, the offshore pipeline within 3 statute miles of the coast, the landfall site for the pipeline, and portions of the onshorepipeline system assumed for Sale 109. In addition, the State reviews all exploration and development and production plans to certify that activities that could affect the use of the coastal zone are consistent with the ACMP.

Standards of the ACMP are related to the scenario and to potential effects identified throughout Section IV of this EIS. Because approval of the NSB CMP was denied by the U.S. Department of Commerce (USDOC), the NSB policies adopted by the Coastal Policy Council are not used in this analysis.

This analysis is not a consistency determination pursuant to the Coastal Zone Management Act of 1972, as amended, 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 policy is to ensure that onshore developments or activities that can be placed inland do not displace activities dependent upon locations along limited shoreline areas. The only OCS developments or activities hypothesized in the scenario that would require a shoreline location are the landfall sites for the pipeline, barges, and support vessels, and, possibly, limited marine support facilities within Peard Bay. Other developments are expected to be located either inland or offshore. No conflicts with this policy are inherent in the scenario.

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]). All offshore and much of the onshore development hypothesized in the scenario would be subject to COE regulations. Developments assumed in the scenario that would require COE permits include dredging and the possible burial of offshore pipelines, emplacement of a bottom-founded structure offshore, construction of the shorebase, and construction of a pipeline/road system to the TAP Pump Station No. 2. None of these projects is necessarily allowed or disallowed under the provisions of the COE regulations. Site-specific environmental changes pursuant to such development would be assessed, as they were for the Endicott and Lisburne projects, and permitted depending on the attendant effects. Potential effects noted elsewhere in Section IV.B would be subject to close analysis once the details of the development were established.

(2) Geophysical-Hazard Areas (6 AAC 80.050): State policies require 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.

A variety of hazards are evident in the lease-sale area. Sea ice is the principal physical hazard to the development of the oil resources in the sale area. However, drilling and completing wells in the arctic is possible with existing technology (Sec. IV.A.3). Superstructure icing would be a greater risk to work boats and service vessels than to the drilling units. Although this could occur from June through November, it is most likely to occur during September and October. Since the conditions that cause superstructure icing are known, planning to minimize the risks and protect against loss of life is possible.

Development assumed for the proposal would cover extensive areas of permafrost. Although only portions of the pipeline from the platforms to the TAP would cross offshore areas and streams included within the coastal boundary, development along the entire route would be subject to the same problems with offshore hazards, permafrost, and aufeis. These hazards would constrain pipeline routes and be a source of constant concern to both those developing the field and those reviewing the development. Current and emerging technologies are considered adequate to meet the demands (Sec. IV.A.3). Potential conflicts with this policy can be resolved. Since the geophysical hazards of greatest concern have been identified, measures that will minimize property damage and protect against loss of life are possible.

(3) Energy Facilities (6 AAC 80.070): The State standard includes 16 policies for siting energy-related facilities. Because of the unique terrain, ownership patterns, and land use patterns of the NSB, not all 16 policies are applicable. The following discussion includes the policies considered most relevant for this lease sale.

ACMP policies 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]). The shorebase at Point Belcher and the pipeline to the TAP may not be compatible with existing uses. In fact, a base at Point Belcher would be a major shift in land use that could affect both subsistence resources and access to subsistence resources. Therefore, prior to construction, these adverse social effects must be minimized.

Other ACMP policies require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability (6 AAC 80.070[3] and [13]). Development assumed for this sale could create severe conflicts with these policies. The proposed landfall and shorebase would be located near Peard Bay, a biologically productive area used extensively by gray whales, some beluga whales, seals, walruses, fishes, and marine and coastal birds. Bowhead whales use the lead system in proximity to Point Belcher in the spring. However, the analyses in Sections IV.B.3 through IV.B.8 indicate that the effects of oil spills and construction in this area would not exceed MINOR (which means that effects of the activity affect a specific group of individuals of a population in a localized area and/or over a short time period [one generation or less]). Effects on benthic organisms, however, could be MAJOR if species are restricted in their distribution to Peard Bay. Therefore, the potential for conflict with these elements of the energy-facility-siting standard is present, especially if dredging activity occurs in Peard Bay and leads to long-term changes in distribution.

Facilities must be designed to permit free passage and movement of fish and wildlife with due consideration for historic migratory patterns (6 AAC 80.070

[12]). As is evidenced by the Endicott project, this policy does not preclude causeways or berms; but it does require careful consideration of the effects on circulation and fish populations before approval can be obtained. No causeway is hypothesized for this development; however, berms may be used to bring pipelines ashore. Although a berm would be less extensive than a causeway, a berm would raise similar issues. Information gathered from studies undertaken in conjunction with the Endicott project, and for the proposed Lisburne causeway, may also prove useful for the Chukchi Sea. Offshore pipelines should pose no barriers to migrating fish and wildlife.

Construction associated with energy-related facilities resulting from Sale 109 also must comply with siting policies that apply to all types of development. These more general policies are discussed under Habitats (Sec. IV.B.13.b(7)) and Air, Land, and Water Quality (Sec. IV.B.13.b(8)).

(4) Transportation and Utilities (6 AAC 80.080): The State standard requires that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. The pipeline corridor is assumed to cross the shore and continue to the east; no pipeline construction parallel to the shore is anticipated. The road between Point Belcher and Wainwright would parallel the coast. However, constraints imposed by natural forces along the coast make it likely that the road would be sited inland from the shoreline. As a result, no conflict with this policy is inherent in the scenario.

(5) Mining and Mineral Processing (6 AAC 80.110): ACMP standards require that mining and mineral processing be compatible with the other standards, adjacent uses and activities, State and national needs, and district programs (6 AAC 80.110[a]). Sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits when no feasible and prudent noncoastal alternative is available to meet the public need (6 AAC 80.110[b]).

Extraction of sand and gravel is a major concern on the North Slope and development from Sale 109 would require a major commitment of gravel. Gravel would be needed to construct the berm to bring the pipeline onshore, develop the shorebase and airfield at Point Belcher, and construct the pipeline and associated road and helipads to TAP Pump Station No. 2. Gravel sources are extremely limited for most of the area.

The ACMP policies for gravel extraction would apply to the onshore pipeline from the Chukchi Sea coast to the TAP because the nearshore area as well as several river crossings are either within the coastal boundary or could have a direct effect on uses in the coastal zone. Given the national importance of developing oil reserves within the U.S., these developments would conform to the first criterion for exemptions--that there be a significant public need for the development. Although industry's preferences for gravel sources and the CMP policy may diverge on occasion from those that are deemed consistent with the CMP policy, conflict is not inherent in the scenario.

(6) Subsistence (6 AAC 80.120): State standards guarantee opportunities for subsistence use of coastal areas and resources. Subsistence uses of coastal resources and maintenance of subsistence way of life are primary concerns of the residents throughout the NSB. The prevalence

of subsistence use of land in the NSB is evident in the NSB Land Management Regulations, in which all lands outside the Village, Barrow, and Resource Development Districts are designated as a Conservation District. The intent of that designation is to conserve the natural ecosystem needed to support subsistence (NSB 19.40.041).

Potential conflicts with this policy are assessed with respect to the effects of the proposal on Inupiat subsistence (Sec. IV.B.10). Development along the Chukchi Sea coast could affect the entire marine-subsistence-resource areas of Wainwright, Point Lay, and Point Hope, as well as a substantial portion of Barrow's area. Subsistence could be affected by oil fouling and noise and traffic disturbance that could affect the resources or lead to shifts in the migration patterns of subsistence resources and loss of access. During years when offshore whaling is severely constrained by ice conditions, the movements of whaling vessels may be affected by the presence of vessels associated with development of this lease-sale area. MAJOR effects on the Wainwright bowhead whale hunt are possible. MODERATE effects on subsistence use of offshore resources would be possible in the three other coastal communities (Barrow, Point Lay, and Point Hope). At least MINOR effects are expected on the Nuiqsut and Atqasuk caribou harvests. Potential oil spills from the onshore pipeline could have a MODERATE effect on subsistence fishing in Barrow and Atqasuk. MAJOR effects are expected in Nuiqsut, where residents fish almost exclusively from the Colville River.

Wainwright would be the community most affected. Not only would resources be affected, but access to those resources possibly could be affected if provisions were not made for continued use of Point Belcher as a launching site or for the protection of the cultural landmarks used by Wainwright residents during their bowhead whale hunt. Such levels of effects are likely to create MAJOR conflicts with the subsistence policy.

(7) Habitats (6 AAC 80.130): The ACMP standard for habitats requires that all habitats in the coastal zone "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]). Habitats of particular relevance for this analysis include the offshore; rocky islands and seacliffs; barrier islands and lagoons; wetlands; rivers, lakes and streams; and uplands.

In addition to the requirement that the habitat be managed to maintain the features that enable it to support living resources, the offshore habitat is designated a fisheries conservation zone (6 AAC 80.130[c][1]). In the arctic, marine mammals are an important resource using the offshore habitat; as a result, effects on marine mammals as a consequence of events occurring in the offshore environment are assessed under this habitat. MINOR effects on fish could occur in the offshore habitat. MODERATE effects on some anadromous fishes and MINOR effects on marine mammals are possible in the unlikely event that an oil spill occurred in a sensitive area--such as in nearshore waters, in the lead system off Barrow, or in the drifting pack ice west and north of Icy Cape--at a time when resources are present. Another special offshore feature is the kelp bed. If a large or continuous spill occurred in the immediate vicinity of a kelp bed, MODERATE effects are possible. These effects would not preclude offshore development, assuming that the developer has undertaken all feasible and prudent steps to maximize conformance.

Rocky-island and seacliff habitat is represented by Capes Lisburne, Lewis, and Thompson. This habitat standard requires that these areas be managed to avoid harassment of wildlife, destruction of important habitat, and introduction of competing or destructive species and predators (6 AAC 80.130[c][4]). No new species or predators are likely as a result of Sale 109. Concerns focus on the potential for disturbance and oil spills to affect the birds that use these areas. Because most activity assumed with the sale would occur north of the seacliff habitat, effects are not expected to exceed MINOR. As a result, little conflict is anticipated with this element of the habitat policy.

Lagoon habitats are managed to assure that sediment and water conditions are maintained so that neither infilling of lagoons nor erosion of barrier islands occurs. Activities that might decrease the use of the barrier islands by coastal species, including polar bears and nesting birds, are discouraged (6 AAC 80.130[c][5]). Use of Peard Bay for marine support could cause a conflict with this policy if dredging of the bay led to erosion or subsidence of the islands, spit, or mainland, or to changes in benthic-invertebrate distribution or abundance. Kasegaluk Lagoon, identified in the NSB CMP as an Area Meriting Special Attention (AMSA), is one of the most important sensitive habitats along the Chukchi Sea coast. No OCS-related activity is anticipated in Kasegaluk Lagoon as a result of Sale 109. However, planned and accidental activities could lead to a decrease in the use of the lagoon by important coastal species and conflict with the CMP policy. Of particular concern would be disturbance of birds that nest offshore of the lagoon and beluga whales and seals as they move to and from the lagoon. Although the potential for oil to affect the lagoon is small, MODERATE effects on salmon, rainbow smelt, arctic char, and capelin could result if spawning-year individuals, aggregated multiyear assemblages, or a year-class of young were affected by a spill in nearshore waters. Conclusions reached in Sections IV.B.4 through IV.B.6 indicate that MINOR effects are possible in this habitat. This level of effects would not preclude development, assuming that all feasible and prudent steps have been taken to avoid the identified adverse effects.

Much of the upland habitat in the NSB has been classified by the COE as wetlands. Therefore, onshore development would need to be designed and constructed to avoid adverse effects on the natural-drainage patterns, destruction of important habitat, and discharge of toxic substances (6 AAC 80.130[c][3]). In Section IV.B.5, the amount of North Slope tundra habitat that would be used by development for this sale is considered insignificant to the bird populations and the caribou herds of the North Slope.

Pipelines and roadways would transect wetland habitat both along the shore and farther inland. As a result, the potential for an oil spill is present. Removal of contaminated soil and vegetation resulting from an oil spill, or even heavy foot traffic during the cleanup operation, could cause scars in the landscape and affect the ecosystem. However, newer cleanup techniques, such as low-pressure hosing combined with clipping of oiled vegetation, provide both ecologically and technologically sound means of cleaning some of these wetland areas (Sec. IV.A.2). As a result, wetland and upland habitats should be protected, assuming that all feasible and prudent steps have been taken to minimize potential adverse effects. Restrictions on storing toxic substances are covered more completely under the ACMP standard for Air, Land, and Water Quality (Sec. IV.B.13.b(8)).

Rivers, lakes, and streams are managed to protect natural vegetation, water quality, important fish or wildlife habitat, and natural water flow (6 AAC 80.130[c][7]). The probability that oil spilled offshore would enter the stream and affect riverine habitat during summer and winter is low. During breakup, large volumes discharging from the river systems would retard or prevent significant amounts of oil moving upstream. However, rainbow smelt would be vulnerable in late winter, when adults aggregate off the mouths of spawning rivers. River habitat also might be affected if an oil spill occurred along the upland-pipeline route, especially where it crosses streams and rivers. A large spill that contacted a major river is likely to have a MODERATE effect on fishes. A MAJOR effect on fishes is possible if the Colville River is contaminated. On the other hand, special care is needed to protect the integrity of the pipeline and road system from environmental conditions associated with river and stream habitats, such as aufeis and subsidence. All feasible and prudent steps are likely to be required to protect the river, lake, and stream habitats.

These habitats also could be affected by construction activities and gravel extraction. Uplands and abandoned stream channels are the most likely sources of gravel. Although gravel extraction is regulated under specific policies described earlier in the discussion of mining (Sec. IV.B.13.b(5)) gravel-extraction activities also would need to be conducted in a manner consistent with this policy to ensure that the riverine habitat and fish resources are protected.

(8) <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 (6 AAC 80.140).

Water quality can be affected by oil spills, deliberate discharges (e.g., drilling muds and cuttings, formation waters, and sanitary waste), and dredging and gravel operations. An accidental oil spill is very likely to occur. Seven spills of 1,000 barrels or more are estimated as likely to occur as a result of this lease sale. More chronic, smaller spills also are assumed. Although decomposition and weathering processes for oil are much slower in the arctic OCS than in temperate OCS waters, hydrocarbon contamination is very unlikely to cause regional, long-term degradation of water quality below State and Federal standards (Sec. IV.B.2). Chronic, small spills might have a MINOR effect on water quality (Sec. IV.B.2). However, either a spill of 100,000 barrels or more or a winter spill where the oil is frozen into the ice pack could cause MODERATE effects on water quality and conflict with the ACMP standard.

Water quality also could be affected by deliberate discharges. Discharges of muds, cuttings, and drilling fluids are regulated closely; therefore, NEGLIGIBLE effects are expected (Sec. IV.B.2). During production, the discharge of formation waters into the sea could have local, long-term MINOR effects. However, if formation waters can be reinjected rather than released, effects again would be NEGLIGIBLE (Sec. IV.B.2).

Effects on water quality from dredging for the pipeline and constructing a berm at the shoreline are expected to be short-term and local and to fall within State and Federal standards (Sec. IV.B.2).

Air quality also must conform with Federal and State standards (6 AAC 80.140). The analysis in Section IV.B.1 indicates that--using Best Available Control Technology--MINOR degradation of air quality could result from normal offshore operations because exemption levels for nitrogen-oxide and volatile-organic-compound emissions could be exceeded. Air-quality modeling would be required if similar results were indicated when site-specific information is presented in exploration plans or development and production plans. Accidental emissions from blowouts, spills, or in situ burning could have a MINOR effect on air quality.

(9) Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): The ACMP 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 (6 AAC 80.150). Many areas along the coast have been identified as culturally important sites (Wickersham and Flavin, 1983).

Development along the Chukchi Sea coast is assumed to be centered near Point Belcher. The shorebase is not expected to be extensive; however, there are numerous historic sites around Point Belcher. Historically, Point Belcher has been used as the launching site for subsistence whaling and still is used by present-day whalers who rely on cultural landmarks located there (Luton, 1985, oral comm.). Prehistoric-human habitation of Point Belcher is likely because of its proximity to food and water. Point Belcher also was used by the survivors of a major disaster in 1871; the Shipwreck City Historic Site has been identified onshore.

Extraordinary care would need to be exercised in placing even minimal facilities near Point Belcher. Prehistoric sites are possible, and some cultural and historic sites have been identified. Numerous shipwrecks could be affected by the offshore pipeline. Although extensive pipeline surveys could be instrumental in locating any of the remains, some modification in pipeline routes and siting onshore may be required to avoid damaging important sites.

SUMMARY: Major changes in land use would result from development associated with Sale 109. Because no industrial development currently exists along the Chukchi Sea coast, the shorebase and 640-kilometer onshore pipeline would be placed in areas currently used only for subsistence hunting. The location of the shorebase and landfall at Point Belcher could be highly incompatible with existing uses there because it could significantly interfere with the subsistence hunting of bowhead whales. This also would lead to conflicts with at least two NSB Land Management Regulations and the CMP. Second, Point Belcher has traditionally been the launching site for whaling, and the potential also exists for conflicts with the cultural resources of the area and conflict with policies designed to protect these resources. While the assumed pipeline/road system could be constructed to conform to most NSB land use and CMP policies, access of Wainwright residents to the North American road system and vice versa via the pipeline/road to the Dalton Highway may generate additional problems and benefits that would need to be assessed if the road became public. Potential conflicts with the standards for geophysical-hazard areas, lagoon and river habitats, and water quality also would need to be resolved. Changes of this magnitude could lead to a conflict with the NSB Land Management Regulations and the ACMP.

CONCLUSION (Effect on Land Use Plans and Coastal Management Programs): MAJOR conflicts with land use, the NSB Land Management Regulations, and the Alaska Coastal Management Program are expected to occur as a result of activities associated with proposed Sale 109.

CUMULATIVE EFFECTS:

Land Use Plans: The NSB has approved a master plan for the Endicott project and development permits for activities in the NSB contingent upon conditions to mitigate potential adverse effects and foster beneficial effects. If future developments lead to greater levels of adverse effects on onshore resources, more stringent conditions may be imposed to mitigate conflicts with Best-Efforts Policies and Mandatory Policies. Ultimately, the NSB may prohibit development on lands subject to its jurisdiction.

For example, if the potential effects of a development led to a decline in subsistence resources below the level needed by residents or precluded user access to the subsistence resources, Mandatory Policies would not be met (NSB 19.80.021[A] and [E]). Variances can be granted by the NSB Planning Commission if (1) the development implements the spirit, but not the letter, of the Mandatory Policy, and (2) enforcement either works undue hardship without a concomitant public purpose or requires designs out of character with the surroundings that are not justified by a concomitant public purpose (NSB 19.60.061).

Effects resulting from the Red Dog Mine, Canadian oil development, or development on Federal lands could lead from the outset in certain instances to imposing stringent conditions for development to conform with Mandatory Policies. This could occur because migrating resources are subject to effects of developments outside the jurisdiction of the NSB as well as within the Borough, and negative effects could reach higher levels in spite of the land management policies used for projects subject to NSB regulation. Multiple road networks could magnify effects on caribou and conflict with NSB regulations for transportation and pipeline construction (NSB 19.80.031[I]). Multiple causeways likewise could magnify the effects on coastal resources and processes and conflict with the land management relations that require that such adverse effects be minimized (NSB 19.80.040[B]).

In most instances, conflict with the land management policies would be MODERATE. However, MAJOR conflicts could result if development outside the jurisdiction of the NSB combined adversely with development inside the Borough or significantly stressed the subsistence pursuits of the residents.

Coastal Zone Management: Activities included in the cumulative analysis may magnify effects or generate types of effects different from those of the proposal. These differences are the focus of this analysis.

Energy Facilities (6 AAC 80.070) and Transportation and Utilities (6 AAC 80.080): Along the Chukchi Sea coast, negative effects on land use identified in the proposal are accentuated in the cumulative case. The likelihood of development increases; the magnitude of potential developments is greater; and the nearshore locations of possible State lease sales along the Chukchi Sea coast include more sensitive habitats. As a result, development is more likely to affect environmentally sensitive areas such as Kasegaluk Lagoon and conflict with ACMP policies 6 AAC 80.070(b)(1), (2), (3), and (13).

Along the Beaufort Sea coast, free passage of fish becomes a major concern in the cumulative case because additional causeways may be constructed. ACMP standard 6 AAC 80.070(b)(12) requires that causeways "allow for the free passage and movement of fish and wildlife with due consideration for historic migration patterns." In the past, industry has insisted that causeways were critical elements in their development plans and the breaches initially requested by government agencies were too extensive. Studies now underway should help the NSB and Federal and State agencies make informed decisions on causeways. However, given this past experience, conflicts with ACMP Standard 6 AAC 80.070(b)(12) are likely.

The effects of pipelines and roads are magnified in the cumulative case. The Red Dog Mine will have a road between the De Long Mountains and the Chukchi Sea. Oil development would lead to an extensive network of pipelines and associated roads extending east from Pump Station No. 1 to the Canadian border, west from Pump Station No. 1 along the Beaufort Sea, west from Pump Station No. 2 to the Chukchi Sea, and south from Pump Station No. 1 to Valdez. If these networks bisected important calving areas, effects could be greater and could increase the potential for conflict with ACMP Standards 6 AAC 80.070(b)(1), (2), and (13).

Subsistence (6 AAC 80.120): Under the proposal, the effect of Sale 109 on subsistence-harvest patterns is likely to be MAJOR in Wainwright and Nuiqsut and MODERATE in Point Lay, Point Hope, and Atqasuk. In the cumulative case, effects are expected to be MAJOR in all the communities but Point Hope, where they would remain MODERATE. These increased levels of effect reflect the increased probability that tidal areas and shorelines would be oiled during the open-water season when subsistence hunters are using the area. Loss of both subsistence resources and access to these resources could persist for an entire season. In addition, onshore construction and facilities and offshore vessel traffic could affect hunter access in more areas along the coast--either precluding access or making hunters travel farther and hunt longer. Finally, additional causeways are probable in the cumulative case and may alter the availability of subsistence fishes, the most reliable and one of the larger sources of subsistence foods. As a result, activities in the cumulative case are likely to create greater conflict with the subsistence standard.

Habitats (6 AAC 80.130): All habitats noted as at-risk from the proposal (offshore; barrier islands and lagoons; wetlands; rocky islands and seacliffs; and rivers, lakes, and streams) are more likely to be affected adversely in the cumulative case and, therefore, to be in conflict with ACMP standards 6 AAC 80.130(c)(1), (3), (4), (5), and (7).

Offshore, increased risks of oil spills and more traffic would raise potential levels of effects for some marine mammals, including bowhead and gray whales, and for special features such as the kelp beds in the Chukchi Sea. Causeways extending offshore in the Beaufort Sea could increase risks to anadromous fishes to MAJOR.

Development of State leases included in the cumulative case would increase the likelihood that barrier islands and lagoons would be affected. For example, both Kasegaluk Lagoon and Peard Bay may be included within the boundaries of State lease sales if these sales along the Chukchi Sea coast are reinstated in the State's 5-year lease schedule. Along the Beaufort Sea coast, Smith Bay, Camden Bay, and Beaufort Lagoon are included on the State lease-sale schedule. Activities in these areas could be more disruptive because these habitats are more sensitive and their proximity to shore makes them more likely to be developed, given a limited quantity of oil.

Tundra wetlands would be subject to significantly greater infilling. Development from Sale 97 is considered an add-on to extensive development that precedes it. Oil development also could occur in the NPR-A and the coastal plain of the ANWR. Coal development is possible at Cape Beaufort and hardrock mining in the De Long Mountains. Adverse effects on tundra and wetland-nesting, -feeding, and -staging areas could lead to MODERATE to MAJOR adverse effects on marine and coastal birds and conflict with the standard for wetland habitat. Upland habitat used by caribou would be subjected to greater development. Avoidance by caribou cows with calves of these areas with high levels of road and air traffic could lead to MODERATE effects on caribou distribution or abundance. This could lead to conflict with upland habitat.

Pipeline and road crossings and gravel extraction would increase in riverine areas that are used extensively by anadromous fishes. The potential for onshore oil spills would be greater. This could lead to greater conflict with the riverine-habitat policy.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): Numerous sites along the NSB coast have been identified as culturally important sites. Because of the vast areal extent susceptible to development in the cumulative case, opportunities for culturally important areas to be violated are increased significantly.

Summary: Potential policy conflicts would be more frequent and pervasive in the cumulative case. Effects in the NSB could be compounded by those in the Northwest Arctic Borough and Canada. Along the Beaufort Sea coast, there is greater potential than there is along the Chukchi Sea coast for oil spills to affect coastal areas and for causeways to be constructed. Along the Chukchi Sea coast, areas most sensitive to development may be included in future State lease sales if these sales are reinstated in the State's 5-year lease schedule. Inland, development on the coastal plain of the ANWR may be permitted by Congress and may occur near Teshekpuk Lake; both areas contain sensitive habitat.

Policies that are most likely to conflict with potential development include those for energy-facility siting, transportation and utilities, habitat, subsistence, air and water quality, and cultural resources. Conflicts would arise from the siting and construction of shorebases, pipelines and associated roads, and support activities.

Effects of oil spills would create a conflict with subsistence, several habitat policies, and the water-quality standard. However, the specific conflicts would only be known following a spill.

Conclusion: Potential conflicts of developments included in the cumulative case with land use and land and coastal management regulations are likely to remain MAJOR, the same as for the proposal.

C. Alternative II - No Lease Sale

The cancellation of the proposed lease sale could reduce future OCS oil production, prolong the need for imported oil, and add to a national need to develop alternative-energy sources. Appendix H of this EIS identifies alternative-energy resources and describes their environmental risks and current and projected uses. Briefly, the following energy actions or sources might be used as substitutes: energy conservation; conventional oil and gas supplies; coal; nuclear power-fission; nuclear power-fusion; oil shale; tar sands; hydroelectric power; solar energy; oil imports, natural-gas-pipeline imports, and liquefied-natural-gas imports; geothermal energy; other energy sources; or a combination of alternatives. It should be noted that some of these actions are not feasible at this time and may not be during the estimated life of this production area. Table II-6 shows the amount of energy needed from other sources to replace anticipated oil production from the proposal. The effects on resources, as described in the proposal (Alternative I), would not occur and are indicated below.

1. Effect on Air Quality: There would be no degradation of onshore air quality as a result of this alternative. In the cumulative case, air pollution from the Federal OCS would be reduced by at least 98 percent. Possible nearshore State leasing would not have the potential to exceed onshore air-quality standards--the MMS estimates that negligible oil resources are present on State offshore lands. In addition, the State requires that Best Available Control Technologies (BACT) be used regardless of whether ambient or incremental Federal standards would be exceeded. In the cumulative case, NEGLIGIBLE degradation of onshore air quality is expected with respect to standards. NEGLIGIBLE effects on onshore air quality also are expected for other considerations.

2. Effect on Water Quality: There would be no degradation of water quality as a result of this alternative. The remaining cumulative case in the Chukchi Sea without Sale 109 would have almost no oil spillage. There would likely not be sufficient oil found in the Chukchi Sea portion of proposed Sale 97 to promote development without Sale 109. Therefore, no cumulative OCS construction or production would occur under this alternative; and no degradation of water quality in the Sale 109 area would occur. The cumulative case without Sale 109 is expected to result in NEGLIGIBLE degradation of water quality.

3. Effect on Lower-Trophic-Level Organisms: There would be no adverse effects on marine plants and invertebrates as a result of this alternative. However, under the cumulative case, which includes Canadian tankering and possible State-oil-lease sales in the Chukchi Sea, higher-order effects (MODERATE from drilling discharges and MAJOR from construction activities) are possible for kelp-bed communities from activities associated with possible State leases in nearshore waters. The most likely effect on marine plants and invertebrates under this alternative is expected to be MINOR.

4. Effect on Fishes: There would be no adverse effects on fishes as a result of this alternative. This proposal would eliminate potential effects from oil spills, drilling discharges, and construction activities associated with the proposal. However, cumulative effects could derive from Federal onshore leases, possible State leases in nearshore waters, and vessel

traffic from other projects. Activities on the NPR-A and possible State sales along Kasegaluk Lagoon and from Icy Cape almost to Barrow are the most likely additional activities to have an effect on fishes. Since negligible resources are predicted in nearshore State waters, effects on fishes from oil spills associated with those activities are not expected to exceed MINOR. Onshore oil spills from pipelines associated with the NPR-A are likely to have a MODERATE effect on fishes. A MAJOR effect is possible if the Colville River were contaminated. In general, when all existing and proposed projects are considered, cumulative effects on fishes are likely to be MODERATE.

5. Effect on Marine and Coastal Birds: There would be no adverse effects in the Chukchi Sea or associated coastal areas as a result of this alternative. This alternative would eliminate the potential oil-spill and offshore noise and disturbance effects on marine and coastal birds, particularly effects on the over 150,000 seabirds at Cape Lisburne. However, the potential cumulative effects of oil spills associated with vessel traffic from other projects, and habitat and disturbance effects from the NPR-A and possible State onshore oil development, are still expected to have MODERATE effects on some birds such as murres, snow geese, and Pacific brant.

6. Effect on Pinnipeds, Polar Bears, and Beluga Whales: There would be no adverse effects in the Chukchi Sea or associated coastal areas as a result of this alternative. This alternative would eliminate most of the potential cumulative effects of oil spills and noise disturbance on the marine mammals in the northern Chukchi Sea, most notably oil-spill risks and potential effects on walruses, ice seals, and polar bears occurring along the pack-ice front north and west of Icy Cape and in the migration corridor offshore between Point Hope and Point Barrow. However, potential cumulative effects of oil spills and noise disturbance on these marine mammals from vessel traffic associated with the Prudhoe Bay Sea Lift and the Red Dog Mine Project are still expected to be MINOR.

7. Effect on Endangered and Threatened Species: There would be no adverse effects on endangered and threatened species as a result of this alternative. Cumulative effects are expected to be the same as for the proposal for fin and humpback whales because so few of these whales inhabit the sale area. This alternative would significantly reduce effects on gray whales that summer in the Chukchi Sea--especially cow/calf pairs. This alternative would not expose the whales to any additional OCS activities. Bowhead whales would also benefit from a total elimination of OCS activities associated with Sale 109 by not being exposed to potential oil spills and noise disturbance associated with exploration and development and production activities that could adversely affect the population. Bowhead whales are expected to be exposed to OCS activities in the Navarin and Norton Basins, and the Alaskan and Canadian Beaufort Sea. Gray whales may be exposed to OCS activities in the North Aleutian, St. George, Navarin, and Norton Basins, and the Beaufort Sea. As a result of contact with these activities, cumulative effects are expected to be MINOR on gray and bowhead whales and NEGLIGIBLE on fin and humpback whales. Cumulative effects on arctic peregrine falcons are expected to be NEGLIGIBLE because no onshore-pipeline construction would occur in the nesting area.

8. Effect on Caribou: There would be no adverse effects on caribou as a result of this alternative. Disturbance and habitat effects

associated with cumulative onshore development, particularly vehicle-traffic disturbance during construction of the 640-kilometer pipeline/support road associated with the proposal, on caribou of the Western Arctic herd would be eliminated under this alternative. However, ground-vehicle traffic and habitat alterations associated with oil development on the NPR-A and other projects on the North Slope are still expected to have MODERATE cumulative effects on caribou.

9. Effect on the Economy of the North Slope Borough: Under this alternative, the effects of proposed Sale 109 described in Section IV.B.9 would not occur. In the absence of the proposed sale, NSB revenues and employment in the North Slope region would be as projected in Section III.C.1. In the cumulative case, NSB revenues and employment in the North Slope region would increase, but not nearly as much as they would under the proposal. The effect of this alternative is expected to be MINOR.

10. Effect on Subsistence-Harvest Patterns: This alternative would eliminate adverse effects on subsistence-harvest patterns in the six North Slope communities considered in this EIS. However, in the cumulative case, effects on subsistence-harvest patterns in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut are expected to be MAJOR due to the ongoing presence of barges, vessels, and other traffic in the sale area from possible State leases in the Chukchi Sea, and development in the Beaufort Sea and on the coastal plain of the ANWR, and if there is further development in NPR-A. MINOR cumulative effects are expected in Point Hope because of the distance of Point Hope from possible State lease sales.

11. Effect on Sociocultural Systems: There would be no adverse effect on sociocultural systems under Alternative II. This alternative would decrease employment and population in Barrow and Wainwright, with slight decreases in indirect employment in other communities in the Sale 109 area; however, these decreases would not adversely affect the Inupiat sociocultural system. In the cumulative case, effects on the sociocultural systems in the North Slope region are expected to be MAJOR if development occurred in the Beaufort Sea and on the coastal plain of the ANWR, and if further development occurred in the NPR-A.

12. Effect on Archaeological Resources: There would be no effect on archaeological resources as a result of this alternative. There would be fewer cumulative effects under Alternative II since there would be no Sale 109 activity, and the activities of other projects and industries would remain the same. Therefore, the cumulative effects on archaeological resources are expected to be reduced from MINOR under the proposal to NEGLIGIBLE under this alternative.

13. Effect on Land Use Plans and Coastal Management Programs: Eliminating this sale would remove the potential for producing oil from the Chukchi Sea OCS. In turn, the shorebase and supporting transportation network would be deferred to the cumulative case, thereby eliminating the causes for MAJOR conflicts--between development and existing land use, the NSB Land Management Regulations, and the Alaska Coastal Management Program--that are expected to occur under the proposal. In the cumulative case, MAJOR conflicts are still expected to ensue if development occurred on State and Federal leases in the Beaufort and Chukchi Seas, in the NPR-A, and on the coastal plain of the ANWR (if permitted by Congress).

D. Alternative III - Delay the Sale

Under this alternative, the proposed lease sale would be delayed for a period of 2 years. Delaying the sale could provide additional time for ongoing research to acquire data that might be used in assessing effects that petroleum exploration, development and production, and transportation might have on the environment. Although additional information would be useful, the MMS considers the existing data base adequate to analyze the consequences of petroleum-related activities in the Sale 109 area. Table IV-16 identifies potential studies that could be conducted during the 2-year delay, based on the 1986 and 1987 proposed studies lists for the Alaska Regional Studies Program. Additional studies are being proposed for 1988. The following sections assess the effects of this alternative.

1. Effect on Air Quality: The air-pollutant emissions associated with this alternative would be essentially the same as those discussed for the proposal (Sec. IV.B.1). However, the 2-year delay would allow sufficient time for adaptation of MMS and EPA air-quality models to the Sale 109 area. Modeling would remove the need to make some of the extreme-case assumptions about the effects of air pollutants. It is anticipated that modeling of nitrogen-oxide concentrations would demonstrate that pollutants would be blown farther offshore, resulting in modeled concentrations at the shoreline that would not exceed ambient or incremental Federal standards or the DOI significance levels; the effect level is expected to remain MINOR.

CONCLUSION: The expected effect of Alternative III on air quality is MINOR with regard to standards, the same as for the proposal. The effect on air quality with regard to other considerations also is expected to be MINOR.

Cumulative Effects: Delay of the sale would postpone the Sale 109 portion of the cumulative case. More information would be available regarding location of oil prospects in State waters, and the analysis would be able to more accurately estimate effects of cumulative pollutant emissions on air quality. The improved predictability could reduce the need for extreme-case assumptions regarding air quality; but the anticipated effect of the cumulative case under this alternative is still expected to be MINOR with respect to standards, the same as for the proposal. The effect on air quality with regard to other considerations also is expected to be MINOR.

2. Effect on Water Quality: Effects associated with this alternative would be essentially the same as those discussed for the proposal (Sec. IV.B.2). In particular, oil spillage is estimated as proportionate to the number of wells in exploration and to the quantity of oil produced and transported; timing and rate of production do not affect the spillage estimate. No breakthroughs in ability to clean up oil spills at sea--which would guarantee that spilled oil would not affect water quality--are anticipated in the next 2 years.

CONCLUSION: Alternative III is expected to delay potential effects of the proposal on water quality, causing a MODERATE effect, the same as for the proposal.

Cumulative Effects: Delay of the sale would postpone some of the cumulative effects, but because most cumulative effects are caused by oil spills, deliberate discharges, and construction activities associated with the proposed action, the delay would not spread cumulative effects over a longer time period. In particular, short-term contamination of winter ice from spills is still expected to occur over long distances--a MODERATE effect on water quality.

3. Effect on Lower-Trophic-Level Organisms: Effects associated with this alternative are expected to be qualitatively the same as those discussed for the proposal (Sec. IV.B.3). However, the magnitude of the effects would vary depending on the population status of potentially affected or more vulnerable species (e.g., kelp-bed species) at the end of the delay or upon the initiation of activities.

CONCLUSION: Under Alternative III, the effect on lower-trophic-level organisms is expected to be MINOR, the same as for the proposal.

Cumulative Effects: Delaying the sale would postpone some of the potential cumulative effects of oil spills, release of drilling fluids, and construction activities on lower-trophic-level organisms. MODERATE effects on kelp-bed communities would be possible if they were contacted by oil or if drilling discharges and construction activities occurred too close to the communities. MAJOR effects are possible for these communities if construction activities were sited within the communities. However, the level of effect on marine plants and invertebrates is not expected to be different than that for the proposal--MINOR.

4. Effect on Fishes: Effects associated with this alternative would essentially be the same as those discussed for the proposal (Sec. IV.B.4). Delaying the sale would provide additional time for research to acquire data useful in improving the accuracy and precision of the analysis relative to fish resources.

CONCLUSION: Alternative III would delay the effects of the proposal on fish resources; however, the proposal is likely to have a MODERATE effect on fish resources at a later date.

Cumulative Effects: Delay of the sale would postpone some of the cumulative effects since most of those effects are associated with the proposal. The oil-spill risk is the greatest threat to fish resources; however, projects other than Sale 109 could contribute to this risk. The cumulative effect of Alternative III on fish resources is expected to be the same as for the proposal--MODERATE.

5. Effect on Marine and Coastal Birds: Effects associated with this alternative would be essentially the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.5). The magnitude of effects could vary, depending on the population status of affected bird species at the time the delay would terminate or when the undesirable effects would occur. For example, the Pacific brant population is currently at a low level (133,000--about a 20% decline). If this population continues to decline further in the next 2 years, the effect of Sale 109--as presently estimated (MINOR)--could be an underestimate of the level of effect. However, if the brant population recovers to its former level (160,000) during the next 2 years, the effect could be an overestimate of the actual effect of the

Table IV-16
Studies Pertinent to the
Chukchi Sea Area That
May be Conducted During a 2-Year
Delay of Sale

Year	Study Title
1986-87	Circulation Model and Oil-Spill-Risk Analysis (ongoing)
1987	Quantification of the Relative Magnitude of Noise Associated with Oil and Gas Exploration and Development Compared with Other Sources of Potential Acoustic Disturbance to Marine Mammal Habitats in Alaska (ongoing)
1987-88	Monitoring Seabird Populations Near Offshore Activity (ongoing)
1987-88	Normal Behavior of Davis Strait Bowhead Whales: A Control Group for the Western Arctic Stock
1987-88	Aerial Surveys of Endangered Whales in the Northern Bering, Chukchi, and Beaufort Seas (ongoing)
1987	Application of Satellite-Linked Methods of Large Cetacean Tagging and Tracking Capabilities in Offshore Lease Areas (ongoing)
1985-87	Coastline and Surf-Zone Oil-Spill-Smear Model (ongoing)
1986-87-88	Quality Assurance (ongoing)
1986	Simulation Modeling of the Effects of Oil Spills on the Population Dynamics of Key Marine Mammal Species
1985-87	Ice Freezeup and Breakup: Sediment-Oil-Ice Interaction (ongoing)
1986-87-88	Remote-Sensing-Data Acquisition (ongoing)
1986-87	Monitoring Relationships of Ringed Seal Distribution, Abundance and Reproductive Success to Habitat Characteristics and Industrial Activities (ongoing study providing additional results annually)
1986-87	Marine-Meteorology Update (ongoing)
1986	Behavior Responses of Feeding Gray Whales in the Coastal Waters of Alaska
1986-88	Wage and Salary Employment Data for Individual Communities
1986	Rural Village Economics and Subsistence
1986-87-88	Arctic Ocean-Buoy Programs (ongoing)
1986-87	Beaufort Sea Mesoscale Circulation (ongoing)
1986-88	Arctic-Fish Habitats and Sensitivities (ongoing)
1986-88	Social-Indicators Monitoring
1987	Point Lay Case Study
1983-85	Environmental Characterization and Biological Utilization of Peard Bay
1986	Primary Productivity and Nutrient Dynamics in the Chukchi Sea
1986-87	Chukchi Shelf Benthic (ongoing)
1986-87-88	Bering Strait/Hope Basin Ecosystem and Habitat Utilization (ongoing)
1986-87	Bering Strait Circulation (Part of Beaufort Sea Mesoscale Circulation Study)

Table IV-16
Studies Pertinent to the
Chukchi Sea Area That
May be Conducted During a 2-Year
Delay of Sale
(continued)

Year	Study Title
1987-88	Effects of Oil on Settling, Recruitment, and Survival of Amphipods: Important Prey of Whales
1987-88	Acquisition and Curation of Alaska Marine Mammal Tissue in Determining Levels of Containments Associated with Offshore Oil and Gas Development (ongoing)
1987	Literature Analysis of the Probable Effects of Oil and Gas Exploration and Development on Major Haulout Concentrations of Bering Sea Pinnipeds (ongoing)
1988	Effects of Icebreaker and Other Oil and Gas Industrial Noise on Migrating Beluga Whales
1988	Effects of Dispersants and Dispersed Oil on Salmon
1987	Arctic Information Transfer Meeting
1988	Performance Analysis, Compatibility and Simulation Testing of Alaskan OCS Oil Weathering and Transport-Related Models
1988	Shoreline-Segment Characteristics Handbook for Smear-Model Application
1988	Bowhead Whale Book
1988	Acquisition of Water-Quality Information in Conjunction with Other Alaska OCS Studies
1987-88	Synthesis and Information-Update Meetings and Report Publication (ongoing)

Source: MMS, Alaska OCS Region.

proposal. Delay of the sale would provide additional time for ongoing research to acquire data useful in improving the accuracy and precision of effects prediction relative to marine and coastal birds.

CONCLUSION: Alternative III would delay potential effects of the proposal on marine and coastal birds; however, the proposal is expected to have MINOR effects on marine and coastal birds at a later date.

Cumulative Effects: Delay of the sale would postpone most of the potential cumulative oil-spill, noise-disturbance, and habitat effects on marine and coastal birds in the northern Chukchi Sea, most notably some oil-spill risks and effects on seabirds off Cape Lisburne and possible effects on shorebirds and waterfowl populations that feed and stage in Kasegaluk Lagoon. However, potential effects from other projects on marine and coastal birds in the Bering Strait area are expected to be the same and would occur in the same timeframe as under the proposal. Overall cumulative effects on marine and coastal birds are expected to be MODERATE.

6. Effect on Pinnipeds, Polar Bears, and Beluga Whales: Effects associated with this alternative would be essentially the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.6). The magnitude of effects could vary, depending on the population status of affected species at the time the delay would terminate or when the undesirable effects would occur. Delay of the sale would provide additional time for ongoing research to acquire data useful in improving the accuracy and precision of effects prediction relative to these marine mammals.

CONCLUSION: Alternative III would delay effects of the proposal on pinnipeds, polar bears, and beluga whales; however, the proposal is expected to have MINOR effects on these marine mammals at a later date.

Cumulative Effects: Delay of the sale would postpone some of the potential cumulative effects of oil spills and noise and disturbance on marine mammals in the northern Chukchi Sea area, most notably some oil-spill risks and potential effects on walruses, ice seals, and polar bears occurring north and west of Icy Cape along the pack-ice front and in the migration corridor. However, potential oil-spill and disturbance effects from other projects on marine mammals in the Bering Strait area would be the same and would occur in the same timeframe as under the proposal. Overall cumulative effects on these marine mammals are expected to be MINOR.

7. Effect on Endangered and Threatened Species: Effects associated with Alternative III would be essentially the same as those discussed for the proposal (see Sec. IV.B.7). The magnitude of effects could vary, depending on the population status of the affected species at the time the delay would terminate or when undesirable effects would occur. Delay of the sale would provide additional time for ongoing research to gain data useful in improving the accuracy and precision of effects predictions.

CONCLUSION: Effects associated with Alternative III are expected to be the same as for the proposal--MINOR for gray and bowhead whales and arctic peregrine falcons, and NEGLIGIBLE for humpback and fin whales.

Cumulative Effects: Delaying the sale would postpone those effects associated with the proposal that could add to overall cumulative effects on endangered whales. Delaying the sale 2 years would allow time for populations to increase, resulting in a more fit population. A fitter population would be less stressed by effects from OCS activities than a nonfit population. A 2-year delay could result in additional calf production that would not be affected by additional human activities associated with the proposal. Endangered species can best recover in nonstressful environments. After the 2-year delay, cumulative effects are expected to be the same as for the proposal--MODERATE on gray and bowhead whales, NEGLIGIBLE on humpback and fin whales, and MINOR on arctic peregrine falcons.

8. Effect on Caribou: Effects associated with this alternative would be essentially the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.8). The magnitude of effects could vary, depending on the population status of the Western Arctic caribou herd at the time the delay would terminate or when the undesirable effects would occur. Delay of the sale would provide additional time for ongoing research to acquire data useful in improving the accuracy and precision of effects prediction relative to all the North Slope caribou herds.

CONCLUSION: Alternative III is expected to have MINOR effects on caribou at a later date.

Cumulative Effects: Delay of the sale would postpone much of the potential habitat-alteration and disturbance effects on the Western Arctic caribou herd--most notably disturbance and habitat effects from the 640-kilometer pipeline and support road that would cross the herd's summer range. However, cumulative disturbance of caribou from NPR-A development and other projects on the North Slope would be the same and might occur in the same timeframe as under the proposal. Overall cumulative effects on caribou of the Western Arctic herd are still expected to be MODERATE--the same as for the proposal.

9. Effect on the Economy of the North Slope Borough: If the sale is delayed, effects on NSB revenue and employment would be the same as for the proposal (Sec. IV.B.9), but delayed.

CONCLUSION: The effect of Alternative III on the economy of the NSB region is expected to be the same as for the proposal--NEGLIGIBLE.

Cumulative Effects: The cumulative effects of Alternative III on the economy of the NSB region are expected to be the same as for the proposal--MINOR.

10. Effect on Subsistence-Harvest Patterns: The effect of Alternative III on subsistence-harvest patterns would be the same as described for the proposal, only delayed (see Sec. IV.B.10). Delaying the sale could provide improved technology on oil-spill containment and cleanup and could reduce effects imposed by oil spills on these resources.

CONCLUSION: The effect of Alternative III on subsistence-harvest patterns is expected to be the same as for the proposal, only delayed--MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

Cumulative Effects: The cumulative effects on subsistence-harvest patterns are expected to be the same as for the proposal, except for a postponement of effects resulting from the proposal--MAJOR in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut, and MODERATE in Point Hope.

11. Effect on Sociocultural Systems: The effect of Alternative III on sociocultural systems is expected to be the same as described for the proposal--MAJOR--only delayed (see Sec. IV.B.11).

CONCLUSION: The effect of Alternative III on sociocultural systems is expected to be the same as for the proposal--MAJOR.

Cumulative Effects: Delay of the sale would postpone the effect of the sale on sociocultural systems. However, cumulative MAJOR effects on North Slope sociocultural systems from development in the Beaufort Sea and on the coastal plain of the ANWR and the NPR-A would still occur in the same time period. In the cumulative case, the effect of Alternative III on sociocultural systems in the Sale 109 area is expected to be the same as for the proposal--MAJOR.

12. Effect on Archaeological Resources: The effect of Alternative III on archaeological resources is expected to be the same as for the proposal, only delayed.

CONCLUSION: The effect of Alternative III on archaeological resources is expected to be the same as for the proposal--MINOR--but delayed.

Cumulative Effects: The cumulative effects of Alternative III on archaeological resources are expected to be the same as for the proposal--MINOR--but delayed.

13. Effect on Land Use Plans and Coastal Management Programs: Delaying the sale may alter the sequence of development with respect to other activities occurring on the North Slope; these effects are discussed in the cumulative case (Sec. IV.B.13). A delay also would provide those administering the land use program an opportunity to benefit from new studies enabling them to develop mitigating measures that would achieve desired results without being overly restrictive. However, this alternative would make no other substantive changes.

CONCLUSION: The effect of Alternative III with respect to land use, the NSB Land Management Regulations, and the Alaska Coastal Management Program is expected to remain MAJOR, the same as for the proposal.

Cumulative Effects: A delay might change the order in which development occurs. This may affect individual projects in the mid-Beaufort area, where projects are in proximity to existing development; and cumulative biological effects may make a difference in the conditions attached to a permit. This situation occurred when the causeway for the offshore Lisburne development was denied following the approval of the causeway for the Endicott project. Comparable situations could arise along the Chukchi Sea coast if development from State sales occurred first. However, the overall level of effects is expected to remain MAJOR, the same as for the proposal.

E. Alternative IV - Eastern Deferral Alternative: Alternative IV would defer 488 blocks, approximately 993,028 hectares, located along the Chukchi Sea coast from northeast of Peard Bay to south of Kasegaluk Lagoon in a band from 5 to 48 kilometers wide (see Fig. II-1). The MMS estimates the conditional mean-case resource estimate for Alternative IV to be 2.68 billion barrels of oil, the same as for the proposal. This estimate is a result of the very low probability assigned for the occurrence of hydrocarbons in the deferral area. However, because of the uncertainty involved in making resource estimates for frontier areas, there remains a very small probability that the deferral area contains hydrocarbons. Basic scenario assumptions are the same as for the proposal (see Sec. II.A).

1. Effect on Air Quality: The magnitude and rates of air-pollutant emissions would be identical to those for the proposal. The shoreline north of Naokok Pass would be more protected from offshore emissions because such emissions would be at least 29 kilometers offshore. However, exemption limits for nitrogen oxides and VOC could still be exceeded. Shoreline concentrations would be more likely to be higher south of Naokok Pass than north of the Pass because of potential development closer to shore.

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CONCLUSION: Under the Eastern Deferral Alternative, a MINOR effect on air quality is expected with regard to standards, the same as for the proposal. A MINOR effect on air quality also is expected with regard to other considerations.

Cumulative Effects: Although Alternative IV would provide some protection to the northern portion of the Chukchi Sea coast from OCS pollutants, nitrogen-oxide emissions from the OCS could still affect onshore air quality. State leasing nearshore and onshore, although currently not proposed, would also pose risk from pollutants--although the State automatically requires BACT for emission sources. The cumulative case with Alternative IV is expected to result in a MODERATE effect on air quality, the same as for the proposal.

2. Effect on Water Quality: Effects associated with this alternative would be essentially the same as those discussed for the proposal. Oil spillage is estimated as proportionate to the number of wells in exploration and to the quantity produced and transported; these parameters are not changed under this alternative. Most importantly, most spillage within the area suggested for deferral is not from platform spillage, but is attributable to spills from pipelines that cross the suggested deferral area. Winter spills would still occur under this alternative, causing short-term contamination of the ice pack over long distances. However, no deliberate discharges of muds, cuttings, or formation waters would occur within the deferred area.

CONCLUSION: Under the Eastern Deferral Alternative, a MODERATE effect is expected on water quality, the same as for the proposal.

Cumulative Effects: Most cumulative effects would be those resulting from Alternative IV--from oil spills, deliberate discharges, and construction activities. Winter oil spills are still expected to cause the greatest degradation of water quality by contaminating pack ice over long distances--a MODERATE effect on water quality. Overall, a MODERATE effect on water quality is expected from this alternative.

3. Effect on Lower-Trophic-Level Organisms: Alternative IV would delete the two known kelp-bed communities on either side of Peard Bay from the sale area. Effects on marine plants and invertebrates under this deferral alternative would be similar to those expected for the proposal, except that the potential for higher-order effects on the kelp-bed communities is reduced. Adverse effects on these organisms from drilling discharges and platform-construction activities would not occur in the deferred area. The removal of these activities reduces the potential for MODERATE or MAJOR effects on the kelp-bed communities.

This deferral alternative only negligibly affects the conditional probabilities that an oil spill occurring within the deferred area would contact Peard Bay or Kasegaluk Lagoon land segments during the open-water season, which is considered to be the more vulnerable period. Assuming that a spill occurred during the winter in the deferred area, there is a reduction in the probability (18% for Land Segment 23, bordering Peard Bay and near the kelp beds) that the spill would contact "land" over the entire winter season. A spill making contact would be striking either landfast or shorefast ice rather than land, so the probability of contact with organisms or sediments in nearshore zones would be very low. Combined oil-spill probabilities for important marine plant and invertebrate resources or habitats do not differ from those for the proposal because resource estimates are the same as for the proposal. Thus, potential oil-spill effects on marine plants and invertebrates of concern are only negligibly affected by this deferral alternative and are most likely to be MINOR--the same as for the proposal. However, removal of drilling discharges and platform-construction activities from the deferred area reduces the potential for MODERATE or MAJOR effects on the kelp-bed communities.

CONCLUSION: The effect of the Eastern Deferral Alternative on lower-trophic-level organisms is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MINOR.

4. Effect on Fishes: Since no exploratory activity would occur in the area deferred by Alternative IV, most incidents of seismic disturbance and drilling discharges would not occur in this area. The pipelines would still meet offshore of Point Belcher before coming onshore. The probability of pipeline oil spills throughout the deferral area is still present even though there would be no platforms. Construction of the subsea pipeline would still occur with the associated effects. No oil resources are estimated for the deferral area; therefore, the probabilities of a 1,000-barrel-or-greater oil spill occurring during the winter and contacting the nearshore, or occurring in the summer and contacting the nearshore within 10 days, are the same as for the proposal (66% and less than 0.5%, respectively). Kasegaluk Lagoon and Peard Bay also would have the same probabilities of oil spills with this alternative as with the proposal. A MINOR effect from offshore spills is expected to occur with this alternative; however, in the unlikely event of an unweathered oil spill contacting an estuarine area during the summer while pink or chum salmon smolts or concentrations of capelins are present, or during the late winter while rainbow smelt aggregations are near the mouths of spawning rivers, a MODERATE effect could occur. Potential spills from the projected onshore pipeline would not be affected by this deferral alternative.

Since the highest-order effects are likely to come from onshore-pipeline spills, the likely effect of the Eastern Deferral Alternative on fishes remains the same as for the proposal--MODERATE. Although unlikely, a MAJOR effect could occur if the Colville River were contaminated by a large oil spill.

Slight reduction in effects on fishes would result from elimination of drilling-fluid discharge and platform construction within the deferred area.

CONCLUSION: The effect of the Eastern Deferral Alternative on fishes is likely to be MODERATE, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MODERATE.

5. Effect on Marine and Coastal Birds: This alternative would defer exploration near Kasegaluk Lagoon and Peard Bay--important habitats of several thousand sea ducks, geese, and shorebirds. Combined oil-spill risk to bird populations and habitats are the same as for the proposal because the reduction in spill risks is a direct function of the estimated oil resources (no oil resources are estimated for the blocks being deferred). Under this alternative, the 400-kilometer offshore pipeline would still come onshore at Point Belcher, just south of Peard Bay; therefore, oil-spill risks to Peard Bay are still similar to the proposal assuming that a spill occurred near Peard Bay (Fig. IV-2, Launch Point 17). The slight, but significant, reduction in this conditional spill risk to Peard Bay may mean some reduction in oil-spill effects to Peard Bay bird populations and habitats under this alternative. However, spill risk to this habitat area and other coastal-bird-concentration areas is very low, even for a 30-day-old spill that would be highly weathered and dispersed, and would cause few bird deaths.

Potential disturbance of birds from air and boat traffic moving along the coast may be substantially reduced in the important Kasegaluk Lagoon and Peard Bay feeding, molting, and nesting habitats under Alternative IV because air and boat traffic would be traveling to and from platforms farther offshore and farther away from these coastal habitats. Potential disturbance of several thousand birds using Kasegaluk Lagoon and Peard Bay could be reduced from MINOR to NEGLIGIBLE since the 124 to 810 helicopter flights per month would move farther offshore to the four exploration drilling units and nine production platforms associated with this alternative as well as the proposal.

Potential oil-spill effects on birds and their habitats in the Kasegaluk Lagoon area and perhaps in the Peard Bay area could be reduced somewhat from those effects described under the proposal. Effects on birds from onshore and offshore construction would be about the same as for the proposal, with the same onshore-development scenarios taking place, the same number of platforms being used, and the same amount of pipeline being laid.

CONCLUSION: The effect of the Eastern Deferral Alternative on marine and coastal birds is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MODERATE.

6. Effect on Pinnipeds, Polar Bears, and Beluga Whales: This alternative would defer exploration near Kasegaluk Lagoon--an important seasonal habitat of several thousand seals and a few thousand beluga whales--and near Peard Bay--an important seasonal habitat of some ringed and spotted seals. Alternative IV significantly reduces conditional oil-spill risks to the marine mammal-migration corridor between Icy Cape and Point Barrow during the winter-spring and summer seasons, assuming that spills occur within or immediately adjacent to the corridor (Fig. IV-2, Launch Points 9-12, 23, and 34). Combined oil-spill risks to marine mammals and their habitats during the winter season are the same as for the proposal because no oil resources are estimated for the blocks deferred under this alternative.

The above conditional oil-spill risks indicate that potential oil-spill effects on marine mammals could be reduced somewhat for beluga whales and spotted seals that frequent Kasegaluk Lagoon and Peard Bay; and spill effects on migrating seals, walruses, and whales could be reduced slightly. However, the overall level of effect on over 100,000 seals and walruses along the pack-ice front is not likely to be reduced appreciably; therefore, MINOR oil-spill effects are as likely to occur under this alternative as under the proposal.

Noise and disturbance effects on marine mammals, particularly spotted seals and beluga whales, from air and boat traffic that may move along the coast could be reduced slightly under this alternative (although traffic levels of 124-810 flights/month are expected to be the same as for the proposal), because such air traffic is more likely to travel to and from drilling platforms farther offshore and farther away from the coast. However, aircraft and boat disturbance of walruses, seals, and whales could still occur in the migration corridor. Such disturbance is not likely to be significantly reduced with this alternative. Overall noise and disturbance effects are likely to be MINOR, the same as for the proposal.

Onshore and offshore construction effects on marine mammals through habitat alterations are likely to have the same MINOR effect as for the proposal, with the same onshore development occurring, the same number of platforms being installed, and the same amount of pipeline being laid. In summary, the overall oil-spill, disturbance, and habitat-alteration effects on spotted seals and beluga whales could be locally reduced near Peard Bay and Kasegaluk Lagoon; but the level of effect on pinnipeds, polar bears, and beluga whales is expected to be MINOR, the same as for the proposal.

CONCLUSION: The effect of the Eastern Deferral Alternative on pinnipeds, polar bears, and beluga whales is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MINOR.

7. Effect on Endangered and Threatened Species: This alternative would defer an area used by bowhead whales for spring and fall migration and by gray whales for summer feeding and migration. If spilled oil contacted a whale-habitat area, resulting effects would be as discussed under the proposal. Some bowhead whales (up to several hundred) or gray whales could

experience one or more of the following: skin contact and possible irritation, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, and the consumption of contaminated prey items. The most likely result of these factors would be temporary discomfort and reductions in feeding efficiency for affected individuals without substantial effects on the population. Localized areas of gray whale-feeding habitat also may be degraded. Since no oil is estimated for the blocks being deferred under this alternative, it is likely that no exploration or production rigs would be located in the deferred area. Oil spilled in this area would most likely be due to the transportation of oil, not the removal of oil from the ground. The risks from oil spills to endangered whales would therefore be the same as for the proposal.

Noise levels also would be the same as for the proposal, since all rigs/platforms would likely be located seaward of the deferral area. Whales would likely cease normal activities and move away from vessels traveling to or from rigs/platforms. If Wainwright is the air-support base, helicopter flights to drilling units and production platforms would bisect the deferral area where whales are most likely to occur. Whales overflown at low altitudes would quickly dive in response to the aircraft sound but should resume their normal behavior within minutes. Since a deferral would only prevent drilling in this area, the pipeline placement would still go to Point Belcher and on to TAP Pump Station No. 2. Whales would likely avoid areas within several kilometers of pipeline-construction activity and may abandon feeding areas near pipeline-construction activity as long as that activity persists. In the event that exploration or development and production activities would occur within the deferral area, endangered whales would likely avoid the near vicinity of these activities. Depending upon the location of the activity, this avoidance behavior may result in the delay or displacement of migrating bowheads or the displacement of gray whales from feeding areas. Deferral of the area would eliminate these potential effects on bowhead and gray whales within the deferral area. However, these species would be subject to the effects described for the proposal in the areas outside the deferral area. Therefore, deferral of this area is expected to have overall effects similar to those for the proposal on whales and arctic peregrine falcons.

CONCLUSION: The effect of the Eastern Deferral Alternative is expected to be MINOR on bowhead and gray whales and arctic peregrine falcons and NEGLIGIBLE on fin and humpback whales, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as for the proposal--MODERATE for bowhead and gray whales, NEGLIGIBLE for fin and humpback whales, and MINOR for arctic peregrine falcons.

8. Effect on Caribou: Alternative IV would defer oil exploration near Icy Cape and Peard Bay, coastal habitats that are sometimes used by caribou for insect relief. However, the oil-spill effects on caribou from this alternative are likely to be NEGLIGIBLE, the same as for the proposal. Under this alternative, onshore facilities--including the 640-kilometer onshore pipeline corridor--would be located at the same sites and follow the same onshore route as described for the proposal. Thus, onshore effects of this alternative on caribou would be the same as for the proposal--MINOR.

CONCLUSION: The effect of the Eastern Deferral Alternative on caribou is expected to be essentially the same as for the proposal--MINOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MODERATE.

9. Effect on the Economy of the North Slope Borough: The revenue and employment effects of the Eastern Deferral Alternative would be virtually identical to those of the proposal, because the resource estimate for this alternative is the same as the estimate for the proposal. Consequently, the resulting effects would be the same as for the proposal.

CONCLUSION: The effect of the Eastern Deferral Alternative on the NSB economy is expected to be the same as for the proposal--NEGLIGIBLE.

Cumulative Effects: The cumulative effects of this alternative on the economy of the North Slope region also are expected to be the same as for the proposal--NEGLIGIBLE.

10. Effect on Subsistence-Harvest Patterns: Alternative IV would remove from potential leasing Barrow's (and Atqasuk's) seal, walrus, fish, and bird subsistence-harvest areas, all of Wainwright's coastal harvest areas, and Point Lay's most critical subsistence-harvest area for all marine species--Kasegaluk Lagoon. Deferral of this area does not alter the risk of oil spills in the area, because the conditional resource estimate and the marginal probability of discovering oil remain the same. For this reason, effects due to offshore oil spills would remain about the same as for the proposal--MODERATE on Barrow, Wainwright, and Point Lay subsistence-harvest patterns. The transportation routes--a landfall at Point Belcher and a pipeline to the TAP--would also remain the same. Therefore, effects on subsistence harvests due to construction activities and facility sitings would remain the same as for the proposal. Disturbance from noise and traffic is the only causal agent that could be anticipated to change under this alternative.

This alternative would remove the possibility of exploration or production occurring within these hunting areas which would decrease the noise from boats, seismic and traffic disturbance, and the presence of platforms in the deferred area. The bowhead whale--hunted in Barrow, Wainwright, and Point Hope--is the species most likely to be affected by this action. As discussed for the proposal, although bowheads may avoid areas of high industrial activity, this is not likely to affect bowhead whaling in the Chukchi Sea region because the bowhead whaling season occurs during the spring migration through narrow ice leads at a time when exploration drilling units are not likely to be in place. Bottom-founded units could be in place year-round for exploration or production. Noise and disturbance from these units and from support vessels and icebreakers could interfere with bowhead whaling. Removal of this deferral area from the whale-harvest areas would decrease these effects. However, icebreakers could still be in the area and could cause disturbance to the whales and curtail or eliminate the whaling season. The same icebreaker interference would occur under this alternative and under the proposed action. Thus, MODERATE effects due to noise and traffic disturbance are expected to be the same under this alternative as for this proposal--MODERATE.

Noise and traffic disturbance in the Chukchi Sea would not affect caribou, which are only expected to be affected by oil spills that reach shore, onshore construction activities, facility sitings, and the pipeline corridor to the TAP. These effects are not anticipated to change under this alternative. Thus, caribou would experience the same effects from this alternative as for the proposal--MINOR.

Beluga whales can be susceptible to noise and traffic disturbance. The summer (open-water) months are the peak seasons for harvesting beluga whales in Barrow (and Atqasuk), Wainwright, Point Lay, and Point Hope. Beluga whales are the most important marine-subsistence resource for Point Lay. The beluga whaling season in Point Lay is conducted during a few weeks and under the proposal could be anticipated to experience MODERATE effects from noise and traffic disturbances. This alternative would eliminate exploration platforms, vessels, or icebreakers located near the open-water area used for beluga whaling, which would decrease the possibility of disruption of the beluga whaling season. Thus, this alternative would reduce the effects of noise and traffic disturbance on beluga whales in Point Lay from MODERATE for the proposal to MINOR. Effects from oil spills would continue to be MODERATE. For reasons discussed in the proposal, the effect on Barrow's (and Atqasuk's), Wainwright's, and Point Hope's beluga harvests would be MINOR, the same as for the proposal. Walruses, seals, and polar bears are susceptible to noise and disturbance from aircraft and would continue to experience MINOR effects from noise and vessel disturbance, the same as for the proposal.

Fish are not as susceptible to noise and traffic disturbance; and disturbance to bird harvests due to noise and traffic would be short-term, causing NEGLIGIBLE effects under this alternative. Effects from the projected onshore pipeline would not be altered by this deferral alternative. A spill would have MODERATE biological effects on the fish populations in the river where it occurred (see Sec. IV.B.4), thus affecting fishing in the entire river for more than one generation. Such a biological effect would indicate that fish in the affected river would be unavailable for subsistence harvests for more than a year--a MAJOR effect, the same as for the proposal. Barrow and Atqasuk residents harvest fish from a number of sources; thus, effects on Barrow and Atqasuk most likely would be MODERATE. Nuiqsut residents are dependent primarily on Colville River fish; thus, effects on Nuiqsut's fish harvests are expected to be MAJOR.

Although the overall level of effect on subsistence resources under this alternative would not be lower than the overall effect from the proposal, this alternative does show a reduction of effects. Effects from noise and traffic disturbance on bowhead whale harvests in Wainwright and on beluga whale harvests in Barrow, Wainwright, and Point Lay would be decreased with removal of this deferred area from the whale-harvest areas. Despite these reductions in effects, the projected pipeline from Point Belcher to the TAP would not be altered; thus, MAJOR effects on Wainwright's bowhead whale harvest from construction activities in Peard Bay and MAJOR effects on Nuiqsut's fish harvest from a pipeline oil spill would cause the overall level of effects from this alternative to be the same as for the proposal.

CONCLUSION: The effect of the Eastern Deferral Alternative on subsistence-harvest patterns is expected to be about the same as for the proposal--MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

Cumulative Effects: Alternative IV would not alter the risk of oil spills in the area, because the conditional resource estimate and the marginal probability of discovering oil would remain the same. Consequently, oil-spill effects in the cumulative case would not alter under this alternative and are expected to be the same as for the proposal--MODERATE.

While noise and traffic disturbance would be reduced under this alternative, there would still be substantial noise and traffic from other lease-sale activities in the cumulative case and there would continue to be some ice-breaker interference under this alternative. Thus, effects due to noise and traffic disturbance are expected to be the same under this alternative as for the proposal--MAJOR.

Effects from construction activities or the presence of the pipeline landfall and shorebase at Point Belcher would be the same under this alternative as for the proposal. Thus, in the cumulative case under this alternative the effects from construction activities are expected to be the same as for the proposal--MAJOR.

The overall cumulative effects of Alternative IV on subsistence-harvest patterns in the Sale 109 area are expected to be the same as for the proposal--MAJOR in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut, and MODERATE in Point Hope.

11. Effect on Sociocultural Systems: Alternative IV would not alter the onshore industrial activities and population and employment projections for this sale since the resource estimate for this alternative is the same as for the proposal, and the effect on subsistence-harvest patterns would be the same as for the proposal (see Sec. IV.E.10). Consequently, the effect of this alternative on sociocultural systems would be the same as for the proposal--MODERATE.

CONCLUSION: The effect of the Eastern Deferral Alternative on sociocultural systems is expected to be the same as for the proposal--MODERATE.

Cumulative Effects: Cumulative effects of Alternative IV on sociocultural systems also are expected to be the same as for the proposal--MAJOR.

12. Effect on Archaeological Resources: The area deferred by Alternative IV is estimated to contain no oil resources. Therefore, this deferral would not change the effects described for the proposal.

CONCLUSION: The effect of the Eastern Deferral Alternative on archaeological resources in the Sale 109 area is expected to be the same as for the proposal--MINOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as for the proposal--MINOR.

13. Effect on Land Use Plans and Coastal Management Programs: The driving forces behind the conclusion reached for land use and coastal managements programs under the proposal (MAJOR) were the effects on land use, habitats, subsistence, and cultural resources caused by the onshore facility, pipeline, and oil spills. Alternative IV mitigates some of the effects that Best Efforts Policies also try to reduce. For example, potential effects on the kelp beds are somewhat reduced under this alternative, as are effects on bird populations and marine mammals using Peard Bay and Kasegaluk Lagoon. Reductions were not adequate, however, to reduce the levels of effects on those resources. Moreover, the assumptions for the onshore facility, pipeline, and oil spills remain the same. As a result, the effects of this alternative are expected to be the same as for the proposal.

CONCLUSION: Potential conflicts between the effects of the Eastern Deferral Alternative and land use, the NSB Land Management Regulations, and the policies of the Alaska Coastal Management Program are expected to be the same as for the proposal--MAJOR.

Cumulative Effects: The limited changes in effects resulting from this alternative are not expected to change the conclusion for cumulative effects from that of the proposal; the conclusion is expected to remain MAJOR.

F. Alternative V - Southern Deferral Alternative: Alternative V would defer 289 blocks, approximately 624,291 hectares, located from 5 to 58 kilometers offshore around Point Hope and Cape Lisburne (see Fig. II-1). The MMS estimates the conditional mean-case-resource estimate for this alternative to be 2.68 billion barrels of oil, the same as for the proposal. This estimate is a result of the very low probability assigned for the occurrence of hydrocarbons in the deferral area. However, because of the uncertainty involved in making resource estimates for frontier areas, there remains a very small probability that the deferral area contains hydrocarbons. Basic scenario assumptions are the same as for the proposal (see Sec. II.A).

1. Effect on Air Quality: The magnitude and rates of air-pollutant emissions would be identical to those for the proposal. The shoreline west of about Cape Sabine would be more protected from offshore emissions because such emissions would be at least 29 kilometers offshore. Air quality would be more likely to be degraded immediately to the north of the proposed deferral area because exploration and development could occur 5 kilometers from shore.

CONCLUSION: The effect of the Southern Deferral Alternative on air quality is expected to be MINOR with respect to standards, the same as for the proposal. The effect on air quality with respect to other considerations also is expected to be MINOR.

Cumulative Effects: Although Alternative V would provide some protection from OCS pollutants to the southern portion of the Chukchi Sea coast, nitrogen-oxide emissions from the OCS could still exceed exemption criteria. State leasing nearshore, although currently not proposed, would not pose significant risk from pollutants. The cumulative case with Alternative V would still result in a MINOR effect on air quality with respect to standards, the same as for the proposal. The effect on air quality with respect to other considerations also is expected to be MINOR.

2. Effect on Water Quality: Effects associated with Alternative V would be essentially the same as those discussed for the proposal. Oil spillage is estimated as proportionate to the number of wells in exploration and to the quantity produced and transported; these parameters would not change with this alternative. However, this alternative would eliminate the possibility of a spill occurring within the area suggested for deferral. (The only pipelines in the area would be transporting oil produced in the potentially leased area). Winter spills would still occur elsewhere under this alternative, causing short-term contamination of the ice pack over long distances. Also, no deliberate discharges of drilling muds, cuttings, or formation waters would occur within the deferral area.

CONCLUSION: The effect of the Southern Deferral Alternative on water quality is expected to be MODERATE, the same as for the proposal.

Cumulative Effects: Most cumulative effects would be those resulting from Alternative V--from oil spills, deliberate discharges, and construction activities. No spills would occur within the deferred area of Alternative V or nearshore. However, winter oil spills elsewhere still are expected to cause the greatest degradation of water quality, contaminating pack ice over long distances and resulting in a MODERATE effect on water quality, the same as for the proposal. Overall, a MODERATE effect on water quality is expected from this alternative.

3. Effect on Lower-Trophic-Level Organisms: The dense planktonic community that occurs off of Cape Lisburne supports, indirectly, huge colonies of seabirds nesting nearby. Deferral of this area would eliminate pipeline and platform spills from occurring within the deferred area. However, the probability that an oil spill would occur and contact Seabird-Concentration Area I does not vary between the proposal and Alternative V because resource estimates are the same for both. There is a 3-percent probability that a spill of 1,000 barrels or greater would occur and contact this target within 10 days in the open-water season. Thus, the most likely oil-spill effects on marine plants and invertebrates under this alternative are judged to be the same as for the proposal--MINOR. Adverse effects from drilling discharges and platform-construction activities would not occur within the deferred area; but effects from these activities are still expected to be MINOR under this alternative.

CONCLUSION: The effect of the Southern Deferral Alternative on lower-trophic-level organisms is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MINOR.

4. Effect on Fishes: This alternative would defer leasing around the Cape Lisburne/Cape Thompson area, which includes the Kukpuk River. The amount of the oil resource within this alternative is negligible; therefore, the most likely number of 1,000-barrel-or-greater spills is seven, as for the proposal. The probability of a 1,000-barrel-or-greater oil spill contacting the nearshore zone of this area is 2 percent or less during the summer or winter. The Kukpuk River, a spawning river for pink salmon, has a less-than-0.5-percent chance of being hit by an oil spill under this alternative or under the proposal. No reduction in oil-spill risk occurs. A MINOR effect on fishes from offshore oil spills is most likely under this alternative. In the unlikely event that an unweathered oil spill contacts an estuarine area during the summer while pink or chum salmon smolts or concentrations of capelins are present, or during the late winter while rainbow smelt aggregations are near the mouths of spawning rivers, a MODERATE effect could occur. Potential spills from the projected onshore pipeline would not be affected by this deferral alternative. Since the highest-order effects are likely to come from onshore pipeline spills, the likely effect of the Southern Deferral Alternative on fishes remains the same as for the proposal, MODERATE. Although unlikely, a MAJOR effect could occur if the Colville River were contaminated by a large oil spill. Other exploration and production activities are expected to produce a MINOR effect, the same as for the proposal, although adverse effects from drilling discharges and platform-construction activities would not occur within the deferred area.

CONCLUSION: The effect of the Southern Deferral Alternative on fish resources is likely to be MODERATE, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as those discussed for the proposal--MODERATE.

5. Effect on Marine and Coastal Birds: Alternative V would defer exploration within 48 to 58 kilometers of the Capes Lisburne and Lewis seabird colonies, where over 150,000 birds nest. This alternative would significantly decrease the conditional oil-spill risks to Cape Lisburne seabird populations and the offshore-feeding habitat of the Capes Lisburne and Lewis colonies, assuming that one of the seven spills occurred in the deferred area and offshore feeding habitat under the proposal (Fig. IV-2, Launch Point 15). However, combined oil-spill risks to other important bird populations and habitats are the same as under the proposal because oil-resource estimates for this alternative are the same as for the proposal. Potential oil-spill effects on over 150,000 vulnerable seabirds in the Cape Lisburne area from potential platforms and pipelines within the deferred area could, in theory, be substantially reduced from the risk under the proposal. Thus, oil-spill effects on the Capes Lisburne and Lewis colonies could, in theory, be reduced from MINOR to NEGLIGIBLE, since none of the nine production platforms would be present in the area deferred under this alternative. However, MINOR oil-spill effects (loss of several hundred to a few thousand birds) on seabirds along the pack-ice front could still occur.

Noise and disturbance of Capes Lisburne and Lewis seabirds from the helicopter flights would be completely avoided under this alternative. Air and boat traffic would be less likely to pass near the Capes Lisburne and Lewis colonies when traveling to and from the drilling platforms. However, air traffic (124-810 flights/month during exploration and development) centered out of Barrow and Wainwright would have no need to pass near the colonies under the proposal or under this alternative; but several thousand birds that nest and feed at Kasegaluk Lagoon and Peard Bay could still be disturbed by some of this traffic. Therefore, noise and disturbance effects on marine and coastal birds are expected to be MINOR, the same as for the proposal. Effects on birds from onshore and offshore construction would be about the same as for the proposal because the same onshore- and offshore-pipeline and support facilities would occur under both the proposal and this alternative, and the same number of platforms (9) would be used. The absence of one drilling platform in the southern blocks would not significantly reduce construction effects on birds from those described under the proposal.

In summary, this alternative could reduce potential platform- and pipeline-oil-spill effects on the Capes Lisburne and Lewis seabird populations by eliminating oil-industry activities within about 58 kilometers of Cape Lisburne. However, potential oil-spill, disturbance, and habitat-alteration effects on thousands of birds using Kasegaluk Lagoon, Peard Bay, and the pack-ice front would not be reduced from those effects of the proposal.

CONCLUSION: The effect of the Southern Deferral Alternative on marine and coastal birds is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as discussed for the proposal--MODERATE.

6. Effect on Pinnipeds, Polar Bears, and Beluga Whales: This alternative would defer exploration within 48 to 58 kilometers of Cape Lisburne and within the southwestern half of Ledyard Bay--coastal and migration habitats of over 100,000 seals, walruses, and thousands of beluga whales and polar bears. Alternative V could reduce conditional oil-spill risks to

walruses and beluga whales occurring in the migration corridor between the Bering Strait and Icy Cape, assuming that oil spills occurred within the deferred area (Fig. IV-2, Launch Points 15 and 16). Combined oil-spill risks to over 100,000 walruses and seals, as well as polar bears frequenting the pack-ice front and the migration corridor, are the same as under the proposal since no oil is expected to be found in the deferred area. Combined oil-spill risks to these marine mammals and their habitats during the winter season are the same as under the proposal. Oil-spill effects on thousands of seals, walruses, beluga whales, and polar bears could, in theory, be reduced slightly when these animals frequent the ice-flaw zone or migration corridor between the Bering Strait and Icy Cape. However, overall oil-spill risks and potential effects are not likely to be appreciably reduced from the MINOR-effect level assessed under the proposal since these marine mammals could still be affected by oil spills contacting the migration corridor and pack-ice front north and west of Icy Cape.

Noise and disturbance of marine mammals from drilling, offshore-construction activity, and air traffic could be reduced in the Point Hope/Cape Sabine coastal and offshore habitats under this alternative. However, the number of platforms (9) and drillships (2-4) would be the same as for the proposal; and drillship and icebreaker traffic would still pass through the deferred area and disturb migrating marine mammals, regardless of whether blocks from Point Hope to Cape Sabine are leased. Marine mammal populations could still be disturbed by air and marine traffic while migrating north of Cape Sabine. Although noise and disturbance of seasonally hauled-out seals and walruses could be reduced somewhat in the Point Hope/Cape Sabine area, the overall level of disturbance is expected to be the same as for the proposal--MINOR.

In summary, the combined effects of oil spills, disturbance, and habitat changes on marine mammals could be reduced somewhat in the Point Hope/Cape Sabine coastal area. However, the overall level of effect on pinnipeds, polar bears, and beluga whales is likely to be MINOR, the same as for the proposal.

CONCLUSION: The effect of the Southern Deferral Alternative on pinnipeds, polar bears, and beluga whales is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as discussed for the proposal--MINOR.

7. Effect on Endangered and Threatened Species: The area deferred under Alternative V consists of an area around Cape Lisburne from 5 to a maximum of 48 kilometers offshore. The area is used by bowhead whales for spring migration and by gray whales for summer feeding and migration. If spilled oil contacted a whale-habitat area, resulting effects would be as discussed under the proposal. Some bowhead whales (up to several hundred) and gray whales could experience one or more of the following: skin contact and possible irritation, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, and the consumption of contaminated prey items. The most likely result of these factors would be temporary discomfort and reductions in feeding efficiency for affected individuals without substantial effects on the population. Localized areas of gray whale feeding habitat also may be degraded. No oil is estimated to occur in this area, so exploration or production activities are unlikely to occur here. Oil

spilled in this area would most likely be due to the transportation--not the production--of oil. Therefore, risks from oil spills to endangered species would be much the same as described for the proposal.

Endangered whales present in undeferred portions of the lease-sale area are expected to experience effects as described under the proposal. A low number of whales may be startled and may dive as a result of aircraft overflights once or twice per day. These individuals should resume normal activities within a few minutes of aircraft passage. A few whales may encounter vessels either transporting supplies to an offshore facility or moving ice away from drilling units. In most cases, whales will avoid vessel paths or avoid approaching within a few kilometers of vessels. Occasionally, vessels may move rapidly through groups of whales, resulting in group disruption and causing whales to flee rapidly. This may result in individual whales being disturbed for several hours but should not result in serious or long-lasting effects on individuals or the population. Overall, vessel activities may result in small deflections in individual migration paths, but they should not result in significant adverse effects on the species. Whales have shown conspicuous reaction to seismic-survey activity only when approached to within 5 to 7 kilometers. Because of the small amount of the relatively quiet, high-resolution seismic surveys expected to result from Sale 109, seismic activities are not expected to adversely affect whales. Stationary offshore noise sources appear less disturbing to whales than moving sources, and bowheads have been observed within a few kilometers of operating drillships and dredges. Bowheads would likely avoid approaching within a range of a few kilometers to over 10 kilometers of drilling units and production platforms. Exploratory-drilling units or production platforms located in spring leads used by migrating bowheads may result in a delay or deflection of the bowhead migration, and feeding gray whales would likely be displaced from the near vicinity of any exploratory-drilling units or production platforms.

As a result of this deferral, noise and habitat disturbance associated with the proposal--from drilling units, postlease geophysical surveys, artificial-island construction, and production platforms--to bowhead whales migrating through the deferred area during the spring and fall and to summer-feeding gray whales would be virtually eliminated because these activities would not occur within the deferred area. Aircraft disturbance may continue to a low degree, because support aircraft may fly over the deferred area from Barrow or Wainwright to offshore units in other portions of the sale area. Similarly, vessel disturbance to gray whales may occur at a low level as traffic enroute to offshore units may traverse the deferral area during the open-water months.

Adoption of the alternative would allow the bowhead migration to occur through the deferred area as it has in the past without the concern for whales diverting their migration paths away from noise sources. As a result, under this deferral few, if any, adverse effects on migrating bowhead whales or feeding gray whales would occur in the deferred area. However, outside the deferred area--which includes a majority of the sale area--oil-spill and noise effects on bowhead and gray whales would occur as described for the proposal. Consequently, the overall effects of the sale on bowhead and gray whales under the Southern Deferral Alternative would not be substantially reduced, and effect levels would remain the same as described for the proposal--MINOR.

CONCLUSION: The effect of the Southern Deferral Alternative is expected to be MINOR on gray and bowhead whales and arctic peregrine falcons and NEGLIGIBLE on fin and humpback whales, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as for the proposal--MODERATE on bowhead and gray whales, NEGLIGIBLE on fin and humpback whales, and MINOR on arctic peregrine falcons.

8. Effect on Caribou: Alternative V would defer oil exploration within coastal waters (within about 38-43 km from the coast) of the southwestern half of Ledyard Bay, the coast of which is occasionally used by caribou for insect relief. This alternative could reduce conditional oil-spill risks to and oil-spill effects on caribou of the Western Arctic herd, which may use coastal habitats near the Cape Sabine and Cape Beaufort areas along the coast of Ledyard Bay, assuming spills occurred near the coast under the proposal. However, oil-spill effects on caribou under this alternative are likely to be NEGLIGIBLE, the same as for the proposal. Onshore facilities, including the 640-kilometer onshore pipeline, would be located at the same sites and follow the same onshore route as described under the proposal. Thus, onshore effects of Alternative V on caribou would be the same as for the proposal.

CONCLUSION: The effect of the Southern Deferral Alternative on caribou is expected to be essentially the same as for the proposal--MINOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be essentially the same as discussed for the proposal--MODERATE.

9. Effect on the Economy of the North Slope Borough: The revenue and employment effects of Alternative V would be virtually identical to those of the proposal, because the resource estimate for this alternative is the same as for the proposal. Consequently, the resulting effect would be the same as for the proposal.

CONCLUSION: The effect of the Southern Deferral Alternative on the economy of the North Slope Borough is expected to be NEGLIGIBLE, the same as for the proposal.

Cumulative Effects: The cumulative effects of this alternative also are expected to be the same as those of the proposal--NEGLIGIBLE.

10. Effect on Subsistence-Harvest Patterns: This alternative would remove from potential leasing Point Hope's subsistence-harvest area. Bowhead and beluga whales, seals, walruses, fishes, birds, and polar bears are harvested in the deferred area by Point Hope residents. Effects from this alternative on the subsistence-harvest patterns of Barrow, Wainwright, Point Lay, Atqasuk, or Nuiqsut would be the same as for the proposal. Thus, the only subsistence-harvest area of concern under this alternative is Point Hope's. Deferring this area would not alter the risk of oil spills in the Point Hope subsistence-harvest area, since the conditional mean-resource estimate and marginal probability of discovering oil would remain the same as for the proposal; thus, effects due to offshore oil spills would remain the same as for the proposal--MODERATE in Barrow, Wainwright, and Point Lay.

Effects from construction activities associated with the landfall, shorebase facilities, and onshore pipeline to the TAP would remain the same under this alternative because the scenario is the same as for the proposal. However, platforms, drillships, and pipelines would be eliminated from this deferred area.

Only Point Hope's bowhead whale and migratory bird subsistence-harvest patterns would experience more than NEGLIGIBLE effects under the proposal. Since this alternative would not alter the probabilities for an oil spill and would decrease disturbances from noise and traffic, the NEGLIGIBLE effects on subsistence-harvest patterns under the proposal would remain NEGLIGIBLE under this alternative. Migratory birds are expected to experience MINOR effects due to oil spills associated with the proposal. This would not change under this alternative, since the combined probability of an oil spill occurring and contacting this area would remain the same as for the proposal. Thus, the bowhead whale harvest is the only subsistence-harvest pattern that might be affected by this alternative.

This alternative would remove the possibility of exploration or production occurring within Point Hope's marine-subsistence-hunting areas, which would decrease noise from seismic and vessel- and air-traffic disturbance as well as eliminate the presence of platforms in the deferred area. Bowhead whales are the species that would be affected by this action. As discussed under the proposal, although bowheads may avoid areas of high industrial activity, this is not likely to affect bowhead whaling in the Chukchi Sea region because the bowhead whaling season occurs during the spring migration, through narrow ice leads--at a time when floating drilling units are not likely to be in place. Bottom-founded units could be in place year-round for exploration or production. Noise and disturbance from these units as well as from support vessels and icebreakers could interfere with bowhead whaling. Deferral of this area would decrease these effects on the whale harvest. However, icebreakers could still be in the area and could cause disturbance to the whales and curtail or eliminate the whaling season. Thus, MODERATE effects on bowhead whales due to noise and traffic disturbance are expected in Point Hope under Alternative V.

Effects from the projected onshore pipeline would not be altered by this deferral alternative. A spill would have MODERATE biological effects on the fish populations in the river where it occurred (see Sec. IV.B.4), thus affecting fishing in the entire river for more than one generation. Such a biological effect would indicate that fish in the affected river would be unavailable for subsistence harvests for more than a year--a MAJOR effect, the same as for the proposal. Barrow and Atqasuk residents harvest fish from a number of sources; thus, effects in Barrow and Atqasuk most likely would be MODERATE. Nuiqsut residents are dependent solely on Colville River fish; thus, effects on Nuiqsut's fish harvest would be MAJOR.

Although the overall level of effect on subsistence resources under this alternative would not be lower than the overall effect from the proposal, this alternative does show a reduction of effects. Effects from noise and traffic disturbance on bowhead whale harvests in Point Hope would be decreased with removal of this deferred area from the whale-harvest areas. Despite these reductions in effects, the projected pipeline from Point Belcher to the TAP would not be altered; thus, MAJOR effects on Wainwright's bowhead whale harvest from construction activities in Peard Bay and MAJOR effects on Nuiqsut's fish harvest from a pipeline oil spill would cause the overall level of effects from this alternative to be the same as for the proposal.

CONCLUSION: The effect of the Southern Deferral Alternative on subsistence-harvest patterns is expected to be the same as for the proposal--MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

Cumulative Effects: The cumulative effects of this alternative on subsistence-harvest patterns are expected to be the same as for the proposal--MAJOR in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut, and MODERATE in Point Hope.

11. Effect on Sociocultural Systems: Alternative V would not alter the onshore industrial activities and population and employment projections for this sale since the resource estimate is the same for this alternative as for the proposal, and the effect on subsistence-harvest patterns would be the same as for the proposal (see Sec. IV.F.10). Consequently, the effect of this alternative on sociocultural systems would be the same as for the proposal--MODERATE.

CONCLUSION: The effect of the Southern Deferral Alternative on sociocultural systems is expected to be the same as for the proposal--MODERATE.

Cumulative Effects: The cumulative effects of this alternative on sociocultural systems also are expected to be the same as those for the proposal--MAJOR.

12. Effect on Archaeological Resources: The area deferred by Alternative V is estimated to contain negligible oil resources. Therefore, leasing activity would be minimal; and this alternative would not change the effects described for the proposal.

CONCLUSION: The effect of the Southern Deferral Alternative is expected to be the same as for the proposal--MINOR.

Cumulative Effects: The cumulative effects of this alternative are expected to remain the same as for the proposal--MINOR.

13. Effect on Land-Use Plans and Coastal Management Programs: Deferring the southern portion of Sale 109 near Point Hope and Cape Lisburne reinforces the assumptions used in the proposal, whereby the pipeline landfall and shorebase would be located near Point Belcher. Because these are the features that create a MAJOR effect, the effects under this alternative would be the same as for the proposal. The reductions in disturbance to birds using Capes Lisburne and Lewis, and in oil-spill risks to marine mammals using the ice-flaw zone or migration-lead system between the Bering Strait and Icy Cape, would mitigate problems that would be pertinent under the habitat standard; but this would not be sufficient to reduce the levels of conflicts noted for the proposal.

CONCLUSION: The level of conflict between activities associated with the Southern Deferral Alternative and land use, the NSB Land Management Regulations, and policies of the Alaska Coastal Management Program is expected to be the same as for the proposal--MAJOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as for the proposal--MAJOR.

G. Alternative VI - Coastal Deferral Alternative: Alternative VI would defer an area consisting of 1,632 blocks (about 3,485,131 hectares) located along the entire coast of the Sale 109 area and extending from 5 up to 113 kilometers offshore (see Fig. II-1). The MMS estimates the conditional mean-case resource for Alternative VI to be 2.24 billion barrels of oil--84 percent of the the mean-case resource estimate for the proposal (2.68 billion barrels). Deferring the entire coastal area would alter the number of wells drilled and platforms installed during exploration, delineation, and development but would not alter the timeframe in which these events would occur. Exploration still would begin in 1989 and continue through 1994 (Table II-9). However, during the years 1993 and 1994, one less exploration well would be drilled each year. Delineation would occur between 1991 and 1996 at a rate of three wells each year. This is one well less per year for the first 5 years than would be drilled for the proposal. The number and type of drilling units used for exploration and delineation would be the same as for the proposal (see Sec. II.A). Platform installation still would occur in 1997 and 1998. Although the type of production platforms would be the same as for the proposal, seven rather than nine platforms would be installed. The reduction would occur in the first year, when only two platforms would be installed under this alternative. Twenty-seven fewer production wells would be drilled. Most of the decrease would occur during the second year of development drilling (1998). During the third year of development drilling, the number of wells drilled would increase slightly with this alternative.

The transportation scenario would not change from the proposal. Mileage and timeframes for installation of the pipeline would remain the same, and the rate and timeframe for construction of the shorebase at Point Belcher also would be the same. For further discussion of the transportation scenario, refer to Section II.A.2.

The most likely number of oil spills of 1,000 barrels or greater assumed to occur under the Coastal Deferral Alternative is five or six, compared to seven for the proposal.

1. Effect on Air Quality: The magnitude and rates of air-pollutant emissions would be less than those for the proposal and would occur at least 41 kilometers from shore--the closest point of remaining blocks to shore (Table IV-17). Emissions during exploration of any individual block would not exceed exemption levels. Nitrogen-oxide emissions, particularly during peak development in 1998, could exceed exemption levels. Potential emissions of nitrogen oxides during peak development would be 34 percent lower than estimated for the proposal and farther offshore. Pollutant concentrations are likely to be highest along the more northern shoreline than in the south because the deferred area extends farther from the coast in the southern portion of the Sale 109 area.

CONCLUSION: The effect of the Coastal Deferral Alternative on air quality is expected to be MINOR with respect to standards, the same as for the proposal. The effect on air quality with respect to other considerations also is expected to be MINOR.

Cumulative Effects: Alternative VI would provide some protection to the U.S. Chukchi Sea coast from OCS pollutants, but nitrogen-oxide emissions from the OCS could still affect onshore air quality. State leasing nearshore, although currently not proposed, would not pose significant risk from pollutants. Alternative VI in the cumulative case still is expected to result in a MINOR effect on air quality with respect to standards, the same as for the proposal. The effect on air quality with respect to other considerations also is expected to be MINOR.

2. Effect on Water Quality: Effects associated with this alternative would be slightly less than those discussed for the proposal. One or two fewer spills of 1,000 barrels or greater are projected for this alternative. Platform spills and deliberate discharges would not occur in the deferred area. However, oil pipelines would still be built through the deferred area to shore; and pipeline spills are projected to occur in the deferred area. Winter spills would still occur under this alternative, causing short-term contamination of the ice pack over long distances.

CONCLUSION: The effect of the Coastal Deferral Alternative on water quality is expected to be MODERATE, the same as for the proposal.

Cumulative Effects: Most cumulative effects would be those resulting from oil spills, deliberate discharges, and construction activities associated with Alternative VI. Winter oil spills are still expected to cause the greatest degradation of water quality, contaminating the pack ice over long distances. A MODERATE effect on water quality is expected--the same as for the proposal.

3. Effect on Lower-Trophic-Level Organisms: By deferring a broad area near the coast from Point Hope to south of Point Barrow, Alternative VI has the potential for reducing effects from oil-related activities on marine plants and invertebrates in nearshore and lagoonal environments (including kelp beds and the abundant benthic invertebrates that are prey for numerous consumers), and on the dense planktonic community off Cape Lisburne that indirectly supports huge colonies of nesting seabirds. Under this alternative, there would be two fewer platforms used (7 rather than 9 for the proposal) and 32 fewer wells drilled (164 rather than 196). Since fewer wells are expected to be drilled, lesser amounts of drilling muds and cuttings would be released; drill cuttings would decline by 43,546 dry metric tons and drilling muds by from 7,673 to 21,948 dry metric tons. These reductions would decrease the extent of localized effects on marine plants and invertebrates; but the level of effect is expected to remain MINOR, as for the proposal. Potential risks to kelp beds and other organisms in more nearshore waters would be reduced, since construction activities and drilling discharges would occur in more distant, offshore areas.

Under this alternative, the most likely number of oil spills of 1,000 barrels or greater would be reduced from seven for the proposal to five or six. Oil spills would be less likely to occur within the deferred area, but the probability that at least one spill of 1,000 barrels or greater would occur and contact land segments of particular interest (Appendix A, Table A-16: Kasegaluk Lagoon, Land Segments 20 and 21; Peard Bay, Land Segment 23) within either 3 or 10 days in summer remains less than 0.5 percent, the same as for the proposal. There is a slight reduction in the probability of oil spills occurring and contacting Seabird-Concentration Area I; the probability of at least one spill of 1,000 barrels or greater occurring and contacting that target within 10 days in summer declines from 3 percent under the proposal to

Table IV-17

Estimated Emissions and USDOI Exemption Levels for All Offshore Platforms in the Coastal Deferral Alternative (Alternative VI)

(metric tons per year)

	Pollutant[1]				
	CO	NO_x	TSP	SO_2	VOC
Peak Exploratory Drilling[2]	386	1149	29	101	165
Per Block[3]	110	328	8	29	141
Peak Development plus Development/Production Drilling[4]	583	2172	103	213	75
Mean Production Years[5]	287	1079	44	48	4439
Peak Production Years[6]	457	1720	70	76	7078
Exemption Levels[7]	24,313	662.4	662.4	662.4	662.4

Source: MMS, Alaska OCS Region.

1/ NO_x= Nitrogen Oxides as NO_2

TSP= Total Suspended Particulates
SO_2= Sulfur Dioxide
CO= Carbon Monoxide
VOC= Volatile Organic Compounds (excluding nonreactive compounds such as methane and ethane)

2/ Seven wells per year, 45 days of drilling per well with emissions based on drillship estimates for Sale 87 exploratory wells (Entrix, Inc., 1985). Calculation assumes that natural gas flared in well tests.

3/ Two wells assumed maximum.

4/ In 1994, for construction of 5 platforms and drilling of 45 wells.

5/ 118 MMbbls/year.

6/ 188 MMbbls/year.

7/ Exemption levels 41 kilometers from shore, based on formulas in 30 CFR 250.57.

less than 0.5 percent under this alternative. The probability of contact within 3 days, when oil is more toxic, declines negligibly from 1 percent for the proposal to less than 0.5 percent for this alternative. These reductions would not alter the expected effects of oil spills on pelagic communities or on marine plants and invertebrates, in general. These effects are expected to remain MINOR, as for the proposal.

Elimination of drilling discharges and platform-construction activities from nearshore waters under this deferral alternative reduces potential effects of these activities on kelp beds and invertebrates. Although the extent of localized effects is reduced, the level of effect is expected to remain MINOR, the same as for the proposal. The probability that oil spills would contact areas of particular concern for marine plants and invertebrates declines only slightly under this deferral alternative.

CONCLUSION: The effect of the Coastal Deferral Alternative on lower-trophic-level organisms is expected to be MINOR, the same as for the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as discussed for the proposal--MINOR.

4. Effect on Fishes: Under this alternative, the main effect of oil exploration and development on fishes would come from oil spills. Onshore pipelines and pipelines that continue to cross the deferred area and come onshore at Point Belcher would still present the greatest risk of spills. This alternative decreases the number of oil spills from seven under the proposal to five or six and also decreases the probability of occurrence and contact of offshore oil spills with nearshore areas within 10 and 30 days during the summer and throughout the winter. The probability of 1,000-barrel-or-greater spills occurring and contacting land during the first 10 days throughout the summer is less than 0.5 percent (the same as for the proposal). Individual land segments along Kasegaluk Lagoon have a low probability of being contacted by an oil spill within 30 days in the summer (2% is the highest probability, the same as for the proposal); the probability of contact within 10 days is less than 0.5 percent. Peard Bay has a higher probability of contact, since offshore pipelines would converge to the southwest of Peard Bay. Under this alternative, there is a 49-percent chance that an oil spill would occur and contact the Peard Bay area within 10 days during the summer and throughout the entire winter (compared to 56% for the proposal). During the winter, there is a 57-percent probability that a 1,000-barrel-or-greater oil spill would occur and contact land somewhere in the nearshore zone in the Chukchi Sea (66% for the proposal). There is a 6-percent-or-lower probability that an oil spill would occur and contact individual land segments along Kasegaluk Lagoon throughout the winter (1-8% for the proposal). Although the probable effect of offshore oil spills on fish resources would decrease somewhat under this alternative, the effect is expected to remain MINOR, the same as for the proposal. In the unlikely event that an unweathered oil spill contacts an estuarine area during the summer when pink or chum salmon smolts or concentrations of capelins are present, or during the late winter when rainbow smelts are aggregated at the mouths of spawning rivers, MODERATE effects could occur. Potential spills from the projected onshore-pipeline would not be affected by this deferral alternative. Since the highest-order effects are likely to come from onshore-pipeline spills, the likely effect of

the Coastal Deferral Alternative on fishes remains the same as for the proposal--MODERATE. Although unlikely, a MAJOR effect could occur if the Colville River were contaminated by a large oil spill.

Under this alternative, there would be no drilling discharges or seismic disturbance in the shallower water near shore. Any discharges would be outside the deferred area, where currents and water depth would disperse them. The decrease in the numbers of wells would decrease the amount of drilling muds and cuttings that would be used and produced. Total drilling muds used for exploration and delineation wells are expected to be 18,954 dry metric tons, with 45,720 dry metric tons of cuttings produced. Toxic levels may be present immediately around the discharge point; however, dilution of the toxic substances would occur quickly. Airguns would still be used for seismic exploration and siting of the pipelines, thereby harming only a small percentage of fish eggs at the source, and would be used in deeper water where the densities of fishes are lower. Construction activities would still occur in part of the deferred area because of the offshore trunk-pipeline system for transporting oil to Point Belcher. The number of manmade berms built for bottom-founded drilling units most likely would decrease because these units are used in the shallower waters near the coast. This would decrease effects on small fishes and larvae from turbidity and by entrainment.

The effect of this alternative on fishes is likely to be MODERATE, as for the proposal. The likelihood of offshore oil spills leading to MODERATE effects on fishes in nearshore waters declines somewhat under this deferral alternative, but MODERATE effects from onshore-pipeline spills are still likely. Slight reductions in effects on fishes would result from elimination of drilling discharges and platform-construction activities in nearshore waters.

CONCLUSION: The effect of the Coastal Deferral Alternative on fishes is likely to be MODERATE, the same as for the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as those discussed for the proposal--MODERATE.

5. Effect on Marine and Coastal Birds: This alternative would defer exploration from 5 to 113 kilometers of the Alaskan coast from Point Hope to Point Barrow--the coastal habitat of over a million marine and coastal birds. The estimated number of oil spills of 1,000 barrels or greater would be reduced from seven under the proposal to five or six for this alternative. Oil spills would be less likely to occur within the deferred area and spill risks would be eliminated or reduced for bird coastal habitats such as Icy Cape and Ledyard Bay during the winter season and reduced for seabird populations at Cape Lisburne during the open-water season (Appendix A, Table A-18, Land Segments 17 and 21, and Table A-15, Seabird-Concentration Area I, respectively). However, coastal bird habitats would still be at some risk due to potential spills from pipeline transportation of oil to the landfall assumed to be located at Point Belcher under both this alternative and the proposal. The five or six oil spills associated with the four exploration drilling units, seven production platforms (2 fewer than the proposal), and 400 kilometers of offshore pipelines associated with this alternative could still kill several hundred or more birds in marine waters within or offshore of the deferred area and could have MINOR effects on bird populations.

Noise and disturbance of coastal concentrations of several thousand birds could be reduced somewhat because helicopters would travel to seven rather than nine platforms in the sale area. However, several thousand birds could still be temporarily disturbed by the helicopter trips to the seven platforms associated with this alternative. There would be a slight reduction in the duration of peak air traffic to and from the seven platforms. Noise and disturbance associated with air traffic under this alternative would still have MINOR, short-term effects on several thousand birds.

Temporary local-habitat alteration associated with seven production-platform installations would occur at least 41 kilometers away from the coast and would eliminate any indirect effects these platforms would have on most bird populations within the sale area. However, under the proposal, habitat-alteration effects on birds are likely to be NEGLIGIBLE. Under this alternative, onshore habitat effects on birds would be the same as for the proposal (MINOR) because the same shorebase facilities would be located at Point Belcher and the same 640-kilometer onshore pipeline would be built.

CONCLUSION: The effect of the Coastal Deferral Alternative on marine and coastal birds is expected to be MINOR, the same as for the proposal.

Cumulative Effects: The additive effects of other projects and this alternative on marine and coastal birds may be reduced slightly in the nearshore habitats of the Chukchi Sea from those of the proposal; but cumulative oil-spill, noise, and disturbance effects are still likely to be MODERATE on alcids, eiders, brant, snow geese, and other species. The cumulative effects on marine and coastal birds are expected to be MODERATE, the same as for the proposal.

6. Effect on Pinnipeds, Polar Bears, and Beluga Whales: This alternative would remove the potential for exploration activities within most of the spring-migration corridor (29% of the proposed sale area) used by over 200,000 pinnipeds and 13,000 beluga whales in the sale area. The estimated number of spills of 1,000 barrels or greater would be reduced from seven under the proposal to five or six under this alternative. Spills are less likely to occur within 41 to 113 kilometers of the coast. Oil-spill risks to that portion of the migration corridor between Point Hope and Icy Cape would be substantially reduced during the spring from 34 percent under the proposal to 21 percent for this alternative, as would spill risk to that portion of the migration corridor between Icy Cape and Point Barrow (Appendix A, Table A-17, Migration Corridors B and A, respectively). However, oil-spill risk to the offshore pack-ice habitats of over 200,000 walruses, ringed and bearded seals, and polar bears would not be greatly reduced under this alternative (Appendix A, Table A-15, Sea Segments 1-10). Because five or six oil spills are estimated under this alternative and because the risk of a spill contacting and affecting marine mammals--particularly walruses and spotted seals in the migration corridor and in coastal habitats--during the spring migration is lower, effects on walruses and spotted seals may be reduced from MINOR to NEGLIGIBLE. However, since spill risks and potential oil-spill effects on ringed and bearded seals and polar bears in the pack-ice habitats during the winter season are not appreciably reduced, effects on these species are likely to be MINOR, the same as for the proposal. Noise and disturbance of pinnipeds, polar bears, and beluga whales from icebreaker and other vessel traffic within the migration corridor could be appreciably reduced, since none

of the four exploration drilling units or seven production platforms under this alternative would be operating within the migration corridor (within about 41 km of the coast). However, helicopter flights to and from seven platforms could still temporarily disturb thousands of walruses and bearded, ringed, and spotted seals hauled out on the ice or along the coast of the sale area and could have brief noise and disturbance effects on these species--a MINOR effect.

Habitat-alteration effects on pinnipeds, polar bears, and beluga whales associated with seven platforms under this alternative could be reduced slightly, with any local changes in ice movements and ice conditions very near the platforms having temporary or MINOR effects on the movements or distribution of seals, walruses, polar bears, and beluga whales.

In summary, oil-spill effects on spotted seals and walruses could be reduced from MINOR under the proposal to NEGLIGIBLE under this alternative, while effects of spills on ringed and bearded seals and polar bears would be the same as under the proposal--MINOR. Icebreaker and other vessel-traffic noise and disturbance of beluga whales and pinnipeds could be appreciably reduced in the migration corridor; but helicopter traffic to and from seven platforms could still have MINOR effects on walruses and ringed, bearded, and spotted seals hauled out on the ice or along the coast of the sale area. Habitat-alteration effects associated with platform installation may be reduced slightly; but these effects are expected to be MINOR, the same as for the proposal.

<u>CONCLUSION</u>: The effect of the Coastal Deferral Alternative on pinnipeds, polar bears, and beluga whales is expected to be MINOR, the same as for the proposal.

<u>Cumulative Effects</u>: The additive effects on pinnipeds, polar bears, and beluga whales may be reduced slightly under this alternative but are still expected to be MINOR, the same as for the proposal.

7. <u>Effect on Endangered and Threatened Species</u>: This alternative would defer from exploration and development and production activities the bowhead spring-migration corridor and a portion of the area used by fall-migrating bowhead whales and summer-feeding gray whales. If spilled oil contacted a whale-habitat area, resulting effects would be as discussed under the proposal. Some bowhead whales (up to several hundred) and gray whales could experience one or more of the following: skin contact and possible irritation, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, and the consumption of contaminated prey items. The most likely result of these factors would be temporary discomfort and reduction in feeding efficiency for affected individuals without substantial effects on the population. Localized areas of gray whale feeding habitat also may be degraded. The probabilities of contact from a spill starting at a particular location during the summer or winter would not change under this alternative. However, the probabilities of one or more spills occurring and contacting specific targets over the expected production life of the field would change. Under this alternative, Migration Corridor A (see Fig. IV-22) changes from an 87-percent contact probability (for a summer spill) to an 80-percent contact probability within 10 days; and the most likely number of

spills expected to contact this target decreases from two to one. In addition, the Peard Bay area decreases from a 56-percent probability of contact within 10 days to 49 percent for a winter spill of 1,000 barrels or greater. Overall, endangered whales are somewhat less likely under this alternative to be contacted by oil based on the probability of a spill occurring and contacting a target where whales have been observed. However, under this alternative oil-spill-contact probabilities remain substantial; and overall oil-spill effects are expected to remain MINOR--the same as for the proposal.

The number of expected production platforms would decrease from nine to seven under this alternative. Also, no seismic surveys, exploratory-drilling sites, or production platforms would be located within the bowhead whale spring-migration corridor and coastal areas heavily used for gray whale feeding. This would result in a substantial decrease in noise-producing activities in the coastal areas, where most endangered whales have been observed; and the bowhead whale spring migration would not undergo delay or displacement from noise associated with exploratory drilling or production platforms. Support traffic for the exploratory-drilling units and production platforms would still pass through the deferred area; and pipeline construction would still occur within the deferred area, although any interactions between whales and these activities would occur during the open-water period when whales are more disbursed than during the spring migration. Disturbance to endangered and threatened species from aircraft and vessel traffic and pipeline construction would remain under this alternative, although at somewhat lower activity levels. Whales would avoid areas within several kilometers of vessels, seismic surveys, drilling units, and production platforms; and if closely approached by vessels, they would flee. Adoption of this alternative would essentially eliminate the potential for significant noise disturbance to the bowhead spring migration and a portion of the bowhead fall migration within the sale area. Oil-spill-contact probabilities would remain substantial due to the risk of oil spills from transportation of produced oil. As a result of the deferral, the potential for greater than MINOR effects on bowhead whales (already a low probability and an unlikely case) would be further reduced and nearly eliminated. The potential for MINOR disturbance to bowhead whales also would be significantly reduced, particularly in terms of the number of cases of minor disturbance. However, it appears that the potential for effects on bowhead whales, from oil spills and noise disturbance resulting from pipeline construction and from exploration and production activities outside the deferred area during the bowhead fall migration, would remain and that overall effects on bowhead whales are expected to be MINOR--the same as for the proposal.

For gray whales, the deferral alternative would result in a substantial reduction in the potential for noise disturbance within the deferred area, where most gray whales are believed to occur. However, oil-spill-contact probabilities would remain substantial due to the risk of oil spills from the transportation of produced oil; and gray whales outside the deferred area would likely experience MINOR disturbance from exploration and production activities conducted in these areas. Consequently, overall effects on gray whales, although probably reduced by over 50 percent, are still likely to be at the same effect level as under the proposal--MINOR.

CONCLUSION: Effects from OCS activities associated with the Coastal Deferral Alternative are expected to be the same as for the proposal--MINOR on bowhead and gray whales and arctic peregrine falcons and NEGLIGIBLE on fin and humpback whales.

Cumulative Effects: The slight decrease of activity levels associated with this alternative would not change overall cumulative effects on threatened and endangered species. Cumulative effects are expected to be the same as for the proposal--MODERATE on bowhead and gray whales, NEGLIGIBLE on fin and humpback whales, and MINOR on arctic peregrine falcons.

8. Effect on Caribou: This alternative would defer oil exploration from 5 up to 113 kilometers offshore of the coast. Oil-spill-contact risk to any coastline habitat that may be frequented by caribou of the Western Arctic herd would be reduced from 7 percent under the proposal to 2 percent under this alternative during the summer season (Appendix A, Table A-15, contact to land). However, oil-spill effects on caribou from the proposal or this alternative are likely to be NEGLIGIBLE because the estimated five oil spills under this alternative and the estimated seven oil spills under the proposal have no chance of contacting land (barrier islands, spits, etc.) used by caribou for insect relief within 10 days (Appendix A, Table A-15). Oil spills that contacted the coast after 10 days would be highly weathered and would have lost most of their toxicity. Caribou are not likely to suffer any lethal effects from encountering highly weathered oil along the coast.

Under this alternative, a shorebase is assumed to be located at Point Belcher and the 640-kilometer onshore pipeline from Point Belcher to the TAP would be located along the same route as that described for the proposal. Thus, onshore disturbance and habitat-alteration effects on the Western Arctic caribou herd would be the same as for the proposal--MINOR.

CONCLUSION: The effect of the Coastal Deferral Alternative on the caribou of the Western Arctic herd is expected to be MINOR, the same as for the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as discussed for the proposal--MODERATE.

9. Effect on the Economy of the North Slope Borough: The revenue and employment effects of this alternative would be only slightly lower than those of the proposal, because the resource estimate for this alternative is only 16 percent lower than the estimate for the proposal. This lower resource estimate reduces the number of production platforms installed and operated by over 20 percent and reduces the number of production wells drilled by over 15 percent. The effects of this alternative would, therefore, probably be about 90 percent as great as the effects indicated for the proposal.

CONCLUSION: The effect of the Coastal Deferral Alternative on the economy of the North Slope Borough is expected to be the same as for the proposal--NEGLIGIBLE.

Cumulative Effects: The cumulative effects of this alternative also are expected to be the same as for the proposal--NEGLIGIBLE.

10. Effect on Subsistence-Harvest Patterns: This alternative would provide a buffer along the eastern boundary of the sale area to protect the subsistence-harvest areas of Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk. Nuiqsut's subsistence-harvest area is outside of the Sale 109 area and this deferral area; therefore, the effects on Nuiqsut would be the same as for the proposal--MAJOR. Deferring this area would alter the risk of oil spills. For Barrow and Point Hope, the combined probability of one or more oil spills of 1,000 barrels or greater occurring and contacting their subsistence-harvest areas within 10 days in summer or a spill occurring during the winter and remaining in the ice throughout the winter remains less than 0.5 percent, as for the proposal. In Wainwright, the probability of such a spill occurring and contacting the subsistence-harvest area within 10 days in summer decreases from 76 percent to 68 percent; in Point Lay, the probability of such a spill decreases from 24 percent to 14 percent. In winter, such a spill occurring and contacting the Wainwright subsistence-harvest area decreases in probability from 77 percent to 69 percent; in Point Lay, the probability decreases from 45 percent to 33 percent. However, these changes in the probabilities of an oil spill are not significant enough to change effects from oil spills in the sale area, although the risk is reduced. Consequently, the effect of oil spills on subsistence-harvest patterns under this alternative are expected to remain the same as for the proposal--MODERATE.

The transportation routes--offshore pipelines to the landfall at Point Belcher and an onshore pipeline to the TAP--would remain the same under this alternative as for the proposal; therefore, effects on subsistence harvests due to construction activities and facility sitings would also remain the same as for the proposal. Effects from the projected onshore pipeline would not be altered by this deferral alternative. A spill would have MODERATE biological effects on the fish populations in the river where it occurred (see Sec. IV.B.4), thus affecting fishing in the entire river for more than one generation. Such a biological effect would indicate that fish in the affected river would be unavailable for subsistence harvests for more than a year--a MAJOR effect, the same as for the proposal. Barrow and Atqasuk residents harvest fish from a number of sources; thus, effects on Barrow and Atqasuk most likely would be MODERATE. Nuiqsut residents are dependent solely on Colville River fish; thus, effects on Nuiqsut's fish harvest are expected to be MAJOR.

This alternative would remove the possibility of exploration or production occurring within the subsistence-hunting area, which would decrease noise from boats and seismic and traffic disturbance as well as eliminate the presence of platforms in the deferred area. Under the proposal, disturbance from noise and traffic would have NEGLIGIBLE effects on seal, walrus, fish, bird, and polar bear subsistence-harvest patterns. Effects from noise and traffic disturbance on bowhead whale harvests are expected to be MODERATE in Wainwright and Point Hope; effects from noise and traffic disturbance on beluga whale harvests are expected to be MODERATE in Point Lay and MINOR in Wainwright and Point Hope. Thus, bowhead and beluga whale-harvest patterns are the only subsistence-harvest patterns that may be affected by this alternative.

Bowhead whales--harvested in Barrow, Wainwright, and Point Hope--in the proposed sale area and Nuiqsut, Kaktovik, Kivalina, Wales, Gambell, and Savoonga outside of the sale area--are the species that would be affected by this alternative. As discussed under the proposal, although bowheads may avoid areas of high industrial activity, this is not likely to affect bowhead whaling in the Chukchi Sea region because the bowhead whaling season occurs during the spring migration through narrow ice leads at a time when floating drilling units are not likely to be in place. The elimination of exploration drilling units in the vicinity of the bowhead whaling area would remove any possibility for such interference. Bottom-founded units could be in place year-round for exploration or production. Noise and disturbance from these units as well as from support vessels and icebreakers could interfere with bowhead whaling. Removal of this deferred area from the whale-harvest area would decrease these effects. However, icebreakers could still be in the area and could cause disturbance to the whales and curtail and eliminate the whaling season. This alternative and the proposed action would have the same interference from icebreakers. Thus, effects on Wainwright's and Point Hope's bowhead whale harvests due to noise and traffic disturbance under this alternative are expected to be MODERATE, the same as for the proposal.

As discussed under the proposal, beluga whales are susceptible to noise and traffic disturbance. The summer (open-water) months are the peak seasons for harvesting beluga whales in Barrow, Wainwright, Point Lay, and Point Hope. The elimination of the possibility of an exploration or production platform, vessel, or icebreaker being located near an open-water area used for beluga whaling would decrease the possibility of disruption of the beluga whaling season. Point Lay's short beluga-harvest period makes it more susceptible to interference and possible elimination of the harvest for the year. Consequently, under the proposal the MODERATE effect of noise and traffic disturbance on Point Lay's beluga whale harvest--combined with MODERATE effects from oil spills--resulted in an overall MODERATE effect on the beluga whale harvest. This alternative would reduce or eliminate the possibility of noise and traffic disturbing the beluga harvest in Point Lay, but the overall effect levels would remain MODERATE due to the effects from oil spills. This alternative would also reduce noise- and traffic-disturbance effects on Point Hope's and Barrow's beluga harvest from MINOR to NEGLIGIBLE. In Wainwright, noise and traffic would not be greatly decreased because the landfall still would be located at Point Belcher, which would concentrate noise and traffic in the Peard Bay area. Effects on Wainwright's beluga whale harvest from noise and traffic disturbance are expected to be MINOR, as for the proposal.

Although the overall level of effect on subsistence resources under this alternative would not be lower than the overall effect from the proposal, this alternative does show a reduction of effects. Effects from noise and traffic disturbance on bowhead whale harvests in Wainwright and Point Hope and on beluga whale harvests in Barrow, Wainwright, Point Lay, and Point Hope would be decreased with removal of this deferred area from the whale-harvest areas. Despite these reductions in effects, the projected pipeline from Point Belcher to the TAP would not be altered; thus, MAJOR effects on Wainwright's bowhead whale harvest from construction activities in Peard Bay and MAJOR effects on Nuiqsut's fish harvest from a pipeline oil spill would cause the overall level of effects from this alternative to be the same as for the proposal.

CONCLUSION: The effect of the Coastal Deferral Alternative on subsistence-harvest patterns is expected to be the same as for the proposal--MAJOR in Wainwright and Nuiqsut, and MODERATE in Barrow, Point Lay, Point Hope, and Atqasuk.

Cumulative Effects: In the cumulative case, the changes in probabilities of an oil spill are not significant enough to change effects from oil spills in the sale area. Consequently, the effect of oil spills in the cumulative case under this alternative is expected to remain the same as for the cumulative case under the proposal--MAJOR. Effects due to construction activities and facility sitings also are expected to remain the same in the cumulative case under this alternative as for the proposal--MAJOR.

The elimination of the possibility of exploration or production platforms, vessels, or icebreakers from the Point Lay beluga whale-harvest area decreases the possibility of disruption of the beluga whale harvest from MODERATE in the cumulative case under the proposal to MINOR in the cumulative case under this alternative. Other effects from noise and traffic disturbance are expected to be the same as for the proposal--MODERATE. In the cumulative case, the effect of this alternative on subsistence-harvest patterns is expected to be the same as for the proposal--MAJOR in Barrow, Wainwright, Point Lay, Atqasuk, and Nuiqsut, and MODERATE in Point Hope.

11. Effect on Sociocultural Systems: Alternative VI would not alter the onshore industrial activities and population and employment projections because the resource estimate is only 16 percent lower than the estimate for the proposal, and the effect on subsistence-harvest patterns would be the same as for the proposal (see Sec. IV.G.10). Consequently, the effect of this alternative on sociocultural systems would be the same as for the proposal--MODERATE.

CONCLUSION: The effect of the Coastal Deferral Alternative on sociocultural systems is expected to be the same as for the proposal--MODERATE.

Cumulative Effects: Cumulative effects of this alternative on sociocultural systems also are expected to be the same as those for the proposal--MAJOR.

12. Effect on Archaeological Resources: This alternative would remove from possible oil and gas leasing shipwrecks and cultural resources near-shore, but these sites--especially Land Segment 23--would have to be crossed by pipeline from other parts of the sale area to the landfall at Point Belcher. Therefore, this alternative would not lower the level of effects under the proposal because if there are still archaeological resources present, they could be disturbed by construction and oil-spill-cleanup activities--both offshore and onshore.

CONCLUSION: The effect of the Coastal Deferral Alternative is expected to remain the same as for the proposal--MINOR.

Cumulative Effects: Under this alternative, there would be some change in OCS activity but not enough to change the overall cumulative effects to another effect category. Therefore, the cumulative effects of this alternative are expected to remain the same as for the proposal--MINOR.

13. Effect on Land Use Plans and Coastal Management Programs: Deferring the coastal portion of the sale area reduces many of the negative effects identified under the proposal. Potential risks to kelp beds and other organisms--including fish, marine mammals, and birds--are reduced in nearshore

waters. Effects levels for these resources, however, are expected to remain the same as for the proposal. The scenario also would be exactly the same as for the proposal. Therefore, although fewer effects would need to be mitigated, the potential for conflicts with existing land use and management policies is expected to be the same as for the proposal--MAJOR.

CONCLUSION: The level of conflict between activities associated with the Coastal Deferral Alternative and land use, the NSB Land Management Regulations, and policies of the Alaska Coastal Management Program is likely to be the same as for the proposal--MAJOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as for the proposal--MAJOR.

H. Unavoidable Adverse Effects

1. Air Quality: An increase in emission of air pollutants would occur as a result of Sale 109. Many of the emissions could be appreciably reduced with existing control technologies. MINOR degradation of air quality, however, is expected from the proposal with respect to both standards and other considerations.

2. Water Quality: The only unavoidable adverse effect on water quality anticipated from the proposed action would be the input of large quantities of hydrocarbons through accidental spillage. If toxic, drilling muds and formation waters both could be reinjected into wells rather than discharged. Spillage is expected to have a MODERATE effect on the water quality of the Sale 109 area because of widespread contamination of the ice pack from multiple spills of 1,000 barrels or greater.

3. Lower-Trophic-Level Organisms: Accidental oil spills are considered to be unavoidable adverse effects. Their effects on marine plants and invertebrates in the Chukchi Sea are described in Section IV.B.3. The possible effects include the death of organisms in localized areas, with consequent changes in species composition; alterations in primary and secondary production; reduced reproduction and/or recruitment; and a variety of additional sublethal effects. Long-term changes could result if sediments became contaminated and if emigration, reproduction, and/or recruitment were reduced in affected areas. In general, unavoidable effects are expected to be MINOR on marine plants and invertebrates; however, MODERATE effects would be possible for the kelp-bed communities if they were contaminated by oil.

4. Fishes: Accidental oil spills are viewed as unavoidable adverse effects. Their overall effect on fish resources of the Sale 109 area, as described in Section IV.B.4, is likely to be MODERATE, with a potential for MAJOR effects if a large oil spill from an onshore pipeline contacted the Colville River and affected overwintering and rearing habitat, sensitive lifestages, and/or concentrations of fishes in freshwater.

5. Marine and Coastal Birds: In this discussion, most oil spills are considered unavoidable, while most human disturbance of nesting seabirds and most nesting waterfowl and shorebirds is considered avoidable through voluntary compliance with the recommendations on air and boat traffic in the proposed Information to Lessees on Bird and Marine Mammal Protection (see Sec. II.H).

The oil-spill-trajectory analysis indicates that coastal habitats such as Kasegaluk Lagoon and Ledyard Bay are at very low risk from oil spills that may be associated with the proposal. However, if spill contact to the coast occurred, oil-spill-cleanup efforts could provide for protection of Kasegaluk Lagoon by possibly diverting an oil spill away from the lagoon entrances and away from salt marshes.

If a large spill of 100,000 barrels or greater occurred within the drifting pack ice of the Chukchi Sea, it would be very difficult to contain and clean up with present oil-spill-cleanup technology. Such an oil-spill event would unavoidably affect some seabird flocks that might happen to be in the area of the spill. An unavoidable spill is expected to result in MINOR effects on some bird populations (see Sec. IV.B.5).

Assuming that oil development occurs throughout the proposed sale area, the seven projected offshore oil spills and local habitat changes on the tundra from the 640-kilometer onshore pipeline and Point Belcher shorebase are expected to have unavoidable MINOR effects on birds.

6. Pinnipeds, Polar Bears, and Beluga Whales: In this discussion, oil spills are considered unavoidable; most human disturbance of these marine mammals is considered avoidable through voluntary compliance with the recommendations on air and boat traffic in the proposed Information to Lessees on Bird and Marine Mammal Protection (see Sec. II.H). However, some disturbance of marine mammals near construction sites would be unavoidable.

The oil-spill-trajectory analysis indicates that the lead-system habitat from Point Barrow to Point Hope is at risk from oil spills that could be associated with the proposal. However, oil-spill-cleanup efforts could provide for some reduction in spill contact to marine mammals.

If a large spill of 100,000 barrels or greater occurred within the drifting pack ice of the Chukchi Sea, it would be very difficult to contain and clean up with present oil-spill-cleanup technology. Such an oil-spill event might unavoidably kill small numbers of highly stressed or young seals, walruses, and a few polar bears that happened to be in the area of the spill. Unavoidable spills could result in MINOR effects on seal, walrus, polar bear, and beluga whale populations (Sec. IV.B.6).

Assuming that oil development occurs throughout the proposed sale area, the seven projected oil spills and local-habitat alterations near the nine production platforms and near the Point Belcher shorebase facility are expected to have unavoidable, temporary MINOR disturbance and habitat effects on these marine mammals during construction activities. Onshore construction at Point Belcher or in other coastal areas could cause a few polar bears to abandon coastal denning sites, representing MINOR habitat loss to the population. Some unavoidable adverse effects on marine mammals, particularly polar bears, could be reduced under Alternative VI (Coastal Deferral Alternative). However, oil spills and habitat alterations under any of the alternatives are expected to have MINOR unavoidable effects on seals, walruses, polar bears, and beluga whales.

7. Endangered and Threatened Species: In the event of production, the probability of an oil spill occurring in certain areas indicates that summer-feeding and fall-migration-staging areas may be subject to at least localized risk. Unmitigated, uncontrolled noise and other forms of disturbance associated with the proposal (i.e., noise due to vessel activity or aircraft overflight, tanker traffic, or related geophysical activities) are expected to cause temporary behavioral responses.

The responses to unmitigated activities are not expected to preclude migrations or to disrupt feeding activities on a long-term basis. Such disturbance-related effects would be most likely to occur on bowhead whales during periods when they are migrating through the Chukchi Sea area and in the summer-feeding/calf-rearing areas used by gray whales. Other endangered whales that have been observed in other areas of the Chukchi Sea during the summer-feeding period (fin and humpback whales) also could be affected by the aforementioned activities. A number of mitigating measures are available to reduce possible adverse effects; however, unavoidable adverse effects are expected to remain MINOR on endangered whales.

Unavoidable adverse effects on the arctic peregrine falcon as a result of the proposed lease sale are expected to be MINOR.

8. Caribou: Most ground-vehicle disturbance of caribou, particularly on the pipeline/support road, and habitat alterations from the 640-kilometer pipeline and support road are probably unavoidable. Unavoidable effects of oil and gas exploration are likely to be NEGLIGIBLE, since no permanent onshore facilities would be built. Unavoidable disturbance of caribou along the pipeline would be temporary and would not affect migration or overall distribution and abundance. Habitat loss from the pipeline/road would be MINOR (1% or less of summer range). Unavoidable adverse effects on caribou from the proposal alone are expected to be MINOR.

9. Economy of the North Slope Borough: Based on the results of existing onshore petroleum development and the experiences with offshore exploration in the region--which have been overwhelmingly beneficial for the NSB economy--unavoidable adverse effects of this proposal are expected to be NEGLIGIBLE.

10. Subsistence-Harvest Patterns: Oil-spill incidents that are unavoidable could lead to the localized, direct loss of small numbers of beluga whales, seals, walruses, polar bears, fishes, birds, and caribou; however, none of these losses--except for the bowhead harvest--would lead to elimination of any subsistence harvest. Some of the risk to bowheads from oil spills can be mitigated. Only oil-spill effects on bowhead and beluga whales and walruses would lead to a reduction of total annual harvests. MODERATE effects on bowhead whale harvests due to noise and traffic disturbance--primarily from icebreakers--are expected to be avoidable if mitigated, thus decreasing effects from noise and traffic disturbance to MINOR.

11. Sociocultural Systems: Government- and community-supported social programs with adequate funding would mitigate many of the sociocultural consequences of Sale 109. One area of unavoidable adverse effects involves the potential repercussions to the sharing of subsistence resources.

12. Archaeological Resources: Accidental, sale-related occurrences--such as pipeline breaks, tanker accidents, or blowouts--could increase offshore activities. Offshore effects of oil spills from the accidental occurrences are caused by disturbance of the resources while repairing breaks in underwater pipelines while cleaning up oil spills. Onshore effects of oil spills are caused by disturbance of archaelogical resources while constructing, maintaining, or repairing pipelines and while digging and moving contaminated soil and building roads to bring in equipment from airports to shore. These sale-related activities are expected to have a MINOR effect on archaeological resources if carried out according to the National Historic Preservation Act and Executive Order 11593.

13. Land Use Plans and Coastal Management Programs: Many of the potential biological and social effects of Sale 109 are considered unavoidable. To the extent that these events are expected to conflict with coastal management policies noted in Section IV.B.13, there would be unavoidable conflict with land use, the NSB Land Management Regulations, and the Alaska Coastal Management Program. The conflicts are expected to be pertinent during permit reviews.

I. Worst-Case Analysis on the Bowhead Whale

The worst-case analysis for the endangered bowhead whale addresses scenarios drawn from scientific-study results. Because the major variable factors in cause and effect involve different degrees of uncertain and unknown conditions, it is necessary to assume some specific level or condition to perform realistic analysis. This information is presented below.

	Assumptions	Likelihood of Occurring
1.	Whales will migrate through the area	High
2.	Whales will feed in the area during the spring migration	Medium
3.	A large spill will be present during the spring migration	Medium to Low
4.	Noise disturbance will mask communications, interrupt social activities, disrupt feeding, adversely affect breeding or calving, or displace migration routes and/or timing	Medium
5.	An oil spill will kill a substantial quantity of food resources	Low
6.	Oil-contaminated baleen will interfere with feeding	Low
7.	Oil will remain on bowhead skin long enough to cause significant adverse effects	Low
8.	Whales will contact a large oil spill during the life of the field (24% probability of one or more spills of 100,000 barrels or greater)	Low
9.	Two exploratory-drilling units or production platforms will be operating in or near the bowhead-migration corridor during the migration period	Medium to low
10.	Calf rearing and/or calving will occur in the sale area	High

Scenario: The following is a speculative assessment of a worst-case analysis under these basic assumptions for a large-volume oil spill and noise associated with OCS activities that could interact with migrating bowhead whales. The probability of one or more spills of 100,000 barrels or greater occurring is 25 percent for the proposal.

1. A platform or pipeline spill occurs in broken ice during the winter-spring months, releasing 100,000 barrels of crude oil.

2. The spill occurs offshore of Point Belcher and cleanup efforts are ineffective until the open-water season (July 1).

3. Bowhead whales will be in the lead system off Point Belcher during April 15 to June 15 and will be feeding at this time.

4. Oil will be released into the lead systems through which the bowhead whales migrate.

5. Bowhead whales will not detect or avoid the oil spill in the lead system.

6. Physiological stress will occur due to toxic vapors, ingestion of oil, ingestion of oil-contaminated prey, and/or absorption of hydrocarbons through the skin.

7. Extensive noise (geophysical surveys, drillships, aircraft, dredging, and vessel traffic) will be present east of Barter Island in the Alaskan Beaufort Sea during August and September.

8. Bowhead whales will be assimilating the last major portion of their nutrient requirements in this area before beginning their fall migration.

9. Exploratory-drilling units will be operating within the fall bowhead-migration corridor and within fall-feeding areas.

10. Seismic-survey operators will not consistently detect migrating or feeding whales and will approach within 5 kilometers of some bowheads.

11. Stress will occur due to the noise-producing activities, thus displacing whales from traditional feeding areas and migration activities.

Analysis of the Worst-Case Scenario: Assuming that an oil-spill/whale interaction occurs within the spring lead system, it is possible that most of the Beaufort Sea bowhead whale population would come in contact with spilled oil. If a large quantity of oil were spilled into such a lead, the bowheads present in the immediate vicinity of the spill (probably less than 50 individuals) could inhale toxic hydrocarbon vapors and may suffer respiratory distress or die. Oil could come in contact with skin and eyes, causing irritation; coat the baleen, temporarily decreasing feeding efficiencies; and/or be ingested, causing gastric problems. Massive acute reactions are possible, though unlikely; chronic problems are more likely. These could include increased susceptibility to disease and increased concentrations of petroleum hydrocarbons in the tissues. Petroleum hydrocarbons might be incorporated in the blubber and released as the blubber is metabolized. Blubber would be metabolized during increased demands upon the body, such as during the overwintering period or during migration, pregnancy, or lactation. Petroleum hydrocarbons released from the blubber at this time may have adverse physiological effects upon the body, possibly resulting in reduced fitness. The bioaccumulated hydrocarbons might be passed through the milk to the offspring, where they could have toxic effects or result in poor survival for a low number of calves (probably less than 20).

Geophysical surveys, which are the most intense source of noise associated with oil exploration, will not occur during the bowhead spring migration. However, bowheads will react to noise from helicopters, exploratory-drilling units, and production platforms associated with the lease sale. Low-flying helicopters (less than 450 m in altitude) may cause bowheads near the aircraft to dive. However, assuming the aircraft maintains a direct course, the disturbance should not prevent whales from continuing their migration. Based upon the expected level of helicopter activity (one visit/drilling unit/day), it is unlikely that bowheads will be significantly disturbed or will substantially alter their migration route. Many bowheads will alter their migration route somewhat to avoid approaching drilling units and production platforms; however, this alteration in migration route should not significantly affect the fitness of the species population (see Sec. IV.B.7.a(3)).

Assuming that extensive noise-producing activities (geophysical surveys, drillships, dredging, and aircraft and vessel traffic) are present during the late summer and early fall (August and September) in an area where bowheads mill and feed in the eastern Alaskan Beaufort Sea, noise/whale interaction would occur. The resulting stress could be enough to cause several hundred whales to prematurely migrate from this feeding area. The abandonment of this area may alter the timing of the migration and the length of time bowheads are present in Alaskan waters. Displacement from feeding areas could, in the worst case, result in several hundred bowheads not acquiring necessary nutrient levels, thus decreasing blubber accumulation. This may stress the population during the fall-through-spring period of fasting or reduced food intake and might result in a reduced rate of reproduction. Also, noise displacement of bowheads from fall-feeding areas could further stress individuals already stressed or weakened from exposure to a spring oil spill. This additional stress might reduce the survivability of these individuals (probably less than 50).

Conclusion: Direct effects of an oil spill and noise disturbance on bowhead whales probably would be chronic rather than acute. In the unlikely event that all negative effects occurred, a low number of whales (less than 100) might be killed; and the overall effect would be to slow the recovery of the bowhead whale population to a nonendangered status. Effects are expected to be MODERATE.

J. Worst-Case Analysis on the Gray Whale

This worst-case analysis on the gray whale addresses scenarios drawn from scientific-study results and from worst-case effects of oil spills and noise disturbances (including geophysical-seismic surveys). Since the major variable factors relating cause and effect involve different levels of uncertain and unknown conditions, it is assumed that certain levels or conditions exist to perform this analysis. The assumptions are presented below.

Assumptions	Likelihood of Occurring
1. Seismic testing and other noise-producing activities will occur when gray whales are present in the sale area (June-October)	High
2. Noise disturbances will interfere with communication, displace feeding gray whales, or interfere with cow/calf activities	Medium
3. Gray whales primarily will be feeding in nearshore waters (§20 km)	Medium to High
4. Cow/calf-rearing activities will be occurring	Medium to High
5. Gray whales will contact at least one of the seven projected spills of 1,000 barrels or greater	Medium to High
6. Hydrocarbon pollution will kill prey items	Medium
7. Oil will contact the baleen and interfere with feeding	Medium to Low
8. Oil will remain on the skin long enough to cause damage or result in bioaccumulation	Low

Scenario: The following is a speculative assessment of a worst-case scenario including a large-volume, continuous spill and noise associated with OCS activities that would interact with gray whales during their high-use period (July-October). The probability of one or more spills of 100,000 barrels or greater occurring is 25 percent for the proposal.

1. A blowout of a production well occurs and creates an oil slick (which spreads to 500 km^2) at a rate of approximately 10,000 barrels per day for 10 days, for a total spill volume of 100,000 barrels, at which time natural bridging or well control occurs.

2. Gray whales will be in the spill area and generally will not avoid or detect the spill.

3. Whales will contact oil and their health will be affected due to ingestion or absorption that ultimately results in chronic long-term effects.

4. Stress also will occur from noise disturbances that displace feeding whales or disrupt migration routes or timing.

It is assumed that gray whales summering on their traditional feeding and calf-rearing grounds near Point Belcher would be exposed to significant increases in noise levels due to OCS activities, including air- and vessel-support traffic, dredging operations, drilling from platforms, and geophysical-seismic surveys. These noise levels are of a sufficient degree that gray whales react in a negative manner. The whales can react by increasing dive times, decreasing surface time, moving away from the sound source, and interrupting socializing activities (including cow/calf interactions).

The daily or twice-daily movements of support traffic from the shorebase at Point Belcher to the rigs would create a high level of noise above ambient levels and an associated zone of influence along traffic-flow patterns. The concentration of several noise sources into a limited area could create enough of a disturbance to cause cow/calf pairs to abandon the area (similar to what happened at Laguna Guerrero Negro, Baja, California [Consiglieri and Braham, 1982]). Whales displaced from optimal feeding grounds may be forced to relocate in suboptional habitat which, in turn, may result in these animals becoming weak and more susceptible to disease, predation, or other mortality factors.

If during their displacement from a noisy area, gray whales encounter the 100,000-barrel spill (described in Sec. IV.A), short- and long-term effects could occur. Short-term effects include loss of prey, baleen fouling, and transient skin damage (see Sec. IV.B.7 for further details). Long-term effects could include bioaccumulation of toxic hydrocarbons in adults (via ingestion or absorption), which could be passed to nursing calves and could increased stress levels. Previously weakened or very old whales may die as a result of increased stress levels, lack of nutrients, disease, or the extra expenditure of energy.

In conclusion, massive acute reactions are unlikely to occur; but chronic problems would probably be expressed on a long-term basis as a lower fecundity rate and lower population-growth rate. The combination of noise disturbances and oil-spill contact could affect a portion of young-of-the-year gray whales, especially by disturbing cow/calf pairs while on their summer-feeding areas in the Point Belcher vicinity. In the unlikely event that all negative effects occurred, localized summer-feeding/calf-rearing areas could be abandoned; dispersal from optimal habitats to other areas could take place; and calf death could result from disruption of a few cow/calf pairs. Loss of young-of-the-year would slightly lower the recovery rate of the gray whale population. Effects on gray whales from this scenario would be MINOR.

K. 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 Chukchi Sea Sale 109 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 preparatory activities (seismic-data collection and exploration drilling) of oil development and ending when natural environmental balances might be 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 that time beyond the lifetime of the proposal. The producing life of the field development in the Chukchi Sea Sale 109 area has been estimated to be about 30 years--based on the conditional mean-case resource estimate. In other words, 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. The definitions for short-term and long-term as used in this section differ from those used in Sections IV.B through IV.G; also, see Table S-2.

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 could be further reduced by the mitigating measures discussed in Section II.H.

Major construction projects such as the 640-kilometer onshore pipeline and support road would cause definite changes in both the short and the long terms. Some species, such as nesting birds, may have difficulty repopulating altered habitats and could be permanently displaced from local areas. In the short term, biological productivity would be reduced or lost on all onshore lands used in the proposed project; however, the productivity of some of these areas could be largely regained in the long term with habitat reclamation. Although complete restoration would not be feasible, the overall local loss would be a MINOR adverse effect.

In offshore areas, construction projects could cause long-term changes by altering local habitats of some marine-benthic organisms. Short-term oil pollution and the possibility of long-term accumulation 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, offshore regional decrease in water quality may be considered to be a tradeoff for obtaining hydrocarbon resources.

The biota would be threatened in the short term by potential oil pollution. Displacement could be significant through the combined effects of harassment by humans and the increased volume and frequency of noise from vessel traffic or overflying aircraft. In theory, such disturbances could alter behavior patterns and could drive fauna away from some traditional feeding and breeding grounds or to other habitat areas within their range, reducing the local populations of species over a long period of time.

Habitat destruction could cause a local reduction in subsistence resources, which could weaken the regional economy and the core values of subsistence as a way of life and of sharing Native goods. The improved accessibility to primitive areas from increased construction is a short-term and possible long-term result of this proposal. The overall wilderness value of the coast would decrease from increased land use. Land use changes would be dramatic at the shorebase site and along the pipeline route. Short-term changes include a shift in land use from subsistence-based activities to industrial activities throughout the life of the proposal. Zoning for the area would change from Conservation District to Resource Development District. This could 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 or residents or nonresidents who have become accustomed to the convenience of traveling the associated roads.

Increased population, minor gains in revenues, and the consequences of oil spills all contain the potential for disrupting Native communities in the short term. A 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 could be factors in long-term consequences for Native social and cultural systems.

Archaeologic and historic finds discovered during development would enhance long-term knowledge. Overall, finds may help to locate other sites; but destruction of artifacts would represent long-term losses.

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 proposed production system would enhance extraction.

The production of oil and gas from the Chukchi Sea Sale 109 area would provide short-term energy and, perhaps, provide time either for the development of long-term alternative-energy sources or substitutes for petroleum feedstocks. Regional planning would aid in controlling changing economics and populations and, thus, in moderating any adverse effects.

As explained in the preceding effects sections, alternatives to the proposal--such as cancellation, delay, and partial deferral options--would reduce to varying degrees both the long- and short-term environmental effects as well as the long- and short-term energy-supply benefits.

L. Irreversible and Irretrievable Commitment of Resources

1. Minerals Resources: The conditional mean-case resource estimate for the proposed action is 2.68 billion barrels of oil. Should these resources be discovered, they would be irretrievably consumed.

2. Biological Resources: Industrial activities onshore and along the coast of the Chukchi Sea such as air and ground-vehicle traffic, and land-based development projects such as roads and airstrips could permanently displace some birds (such as nesting waterfowl and shorebirds) and mammals (such as denning polar bears) from favorable habitats to unfavorable habitats. This displacement and habitat loss could result in reduced population levels and become irretrievable if alterations to the environment, such as roads and airstrips, were permanently maintained by man. However, the degree of displacement (within a few miles of airstrips and roads) and amount of irretrievable habitat loss (no more than perhaps 60-70 km^2) are likely to represent a MINOR effect on these bird and mammal populations.

3. Endangered and Threatened Species: Under the proposal, it is possible that endangered whales could be subjected to long-term effects from oil spills, noise disturbances, or loss of habitat due to facility developments. It is expected that such effects would not lead to permanent irreversible losses of these species, but individuals may be lost. Effects are not expected to exceed MINOR.

4. Subsistence-Harvest Patterns: MAJOR and MODERATE effects are expected on subsistence resources. Hunters may have to travel farther and longer, and the hunt may be more costly and may result in some reductions in harvests. A subsistence harvest most likely would have to be unavailable for many years before the effect would be irreversible or irretrievable, although the absence of the harvest of some species could have irreversible effects on sociocultural systems. It is not likely that any subsistence harvests would become unavailable for more than a few years or that effects would become irreversible or irretrievable.

5. Sociocultural Systems: Many important aspects of Inupiat society and culture are centered around subsistence activities (see Sec. III.C.3). Virtually every family on the North Slope participates in the hunting of the bowhead whale and the sharing of its meat. In the event that oil spills or offshore noise and traffic disturbance disrupted the harvesting of bowhead whales, there would be a loss to Inupiat social and cultural values. Such a loss could be irreversible and irretrievable, resulting in social stress in the communities, breakdown of family ties, increased drug and alcohol abuse, and a breakdown in the communities' sense of well-being. The activities associated with the taking of seals, walruses, birds, and fishes are less important to the integration of the region as a whole, but are just as important to the social organization of each community as well as to the domestic economies of most households. As with the bowhead whale, the inability to harvest sufficient quantities of these resources would be a loss to the Inupiat diet, to Inupiat values of sharing and reciprocity, and to the fundamental aspects of Inupiat identity. The contribution of Sale 109 to the cumulative consequences of offshore and onshore energy development, in conjunction with other processes of social change, may in the long term lead to the irretrievable loss of Inupiat language and other cultural behaviors.

6. Archaeological Resources: Irretrievable material products of prehistoric culture, such as archaeological sites, may be lost through looting and indiscriminate or accidental activity on known and unknown sites. Loss of ground context in which artifacts are located is a very important factor in dating and relating an artifact to other artifacts. The orientation program and the archaeological-resource stipulations (Sec. II.H) would protect against some such losses.

7. Land Use Plans and Coastal Management Programs: It is unlikely that the landscape could ever revert exactly to its predevelopment characteristics. However, use of the land could revert to previous subsistence uses in spite of the changes. Planning documents have a short life span; changes that would occur, however, would be neither irretrievable nor irreversible.

M. Effect of Natural Gas Development and Production

Natural gas also may be discovered in the Sale 109 area during exploration drilling. Although gas resources are not considered economic to exploit at this time (Cooke, 1985), they may be developed and produced in the future; natural gas production probably would not occur until after oil production has begun. Thus, leases containing nonassociated natural gas that may be recoverable in the future probably will 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.) Hence, the effects of potential gas development and production on the environment of the Sale 109 and adjacent areas that are in addition 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 platforms to an onshore gas-processing facility; the gas pipeline would be separated from any existing oil pipelines to the extent necessary to minimize risks that occur during installation and operation. No offshore booster-pump stations would be required between the platforms and the gas facility. Both the offshore and onshore sections of the gas pipeline would be buried.

A new facility would be needed to process gas produced from offshore reservoirs. Onshore, the gas pipeline would parallel the oil pipeline assumed in the base case to take advantage of the hypothetical road system. Because gas from offshore production would be taken into account in the final design of the Alaska Natural Gas Transportation System or the Trans-Alaska Gas System, the pipeline to market would be appropriately sized to accommodate the offshore production of gas. The gas would be refrigerated before it is pumped into the pipeline; at the refrigerated temperatures, there would be no significant threat to the permafrost.

Only in the event of a southern find would LNG tankers be a possibility. In that case, the large-diameter pipeline carrying unrefined gas would continue onshore to a gas facility near Kivalina where it would be processed into LNG and shipped to market.

The effects of natural gas development and production on the biological resources, social systems, and physical regimes of the Sale 109 and adjacent areas might 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 be the result of a gas-well blowout or a pipeline rupture. In the unlikely event that it occurred, a gas-well blowout probably would not persist for more than 1 day and would release perhaps 20 metric tons of gaseous hydrocarbons; as noted in Section IV.B.1.b., 60 percent of all blowouts since 1974 have lasted 1 day or less.

From such a blowout, a hazardous plume of gas could extend downwind for about a kilometer but would quickly dissipate once the blowout ceased. The amount of volatile organic compounds (VOC) released by such a blowout would be less than that evaporated from an oil spill of 1,000 barrels or greater.

The rupture of a gas pipeline would result in a short-term (less than 1 hour) release of gas. A sudden decrease in the gas pressure would automatically initiate procedures to close those valves that would isolate the ruptured section of the pipeline and thus prevent further escape of gas.

The primary air pollutant would be VOC, of which more than 90 percent 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 Basin Sale 100 FEIS (USDOI, MMS, 1985c). The emissions from any gas blowouts (principally VOC) would be quickly evaporated or burned and dissipated by winds with minimal effect on air quality (USDOI, MMS, 1985c).

The estimated level of effects on air quality resulting from natural gas development and production is not expected to exceed the estimated level of effects resulting from oil development and production--MINOR with regard to standards and MINOR for other environmental effects.

1. <u>Effect on Air Quality</u>: The development drilling and platform and pipeline installation associated with natural gas resources would result in additional emissions of CO, NO_x, SO_2, and VOC. These emissions would be from the same kinds of sources as in oil development and production activities. On an energy-equivalent basis, production and offshore processing of natural gas emits fivefold fewer of the air pollutants than does oil production and processing. The amount of activity and emissions is expected to be less than for oil-related activities (MINOR).

2. <u>Effect on Water Quality</u>: The risk to water quality from gas blowouts due to natural gas development and production would be less than the risk from oil spills due to oil development and production. The effects of pipeline trenching on water quality would be the same as for oil pipelines. Because of gas-production-well drilling, additional drill cuttings would be discharged, but drilling muds would be recycled between oil and gas wells on the same platform without additional discharge. Production of an associated gas cap above an oil zone would result in no additional discharge of formation waters beyond that anticipated for oil development.

The estimated level of effect on water quality resulting from gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MODERATE).

3. <u>Effect on Lower-Trophic-Level Organisms and Fishes</u>: If a natural gas blowout occurred--with possible explosion and fire--marine plants, invertebrates, and fishes 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. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site but is not expected to be hazardous for more than 1 kilometer downwind or

for more than 1 day. It is not likely that the plume would affect any marine plants, invertebrates, and fishes except individuals present in the immediate vicinity of the blowout. In order to affect these organisms, the blowout would have to occur below or on the surface of the water.

The drilling of gas-production wells would entail the release of drilling fluids and cuttings. The effect of this release would be similar to that described for oil exploration, development and production (see Secs. IV.B.3 and IV.B.4, and Appendix I)--MINOR. Trenching activities associated with laying a gas pipeline would have localized effects on marine organisms. For mobile animals like fishes, virtually no adverse effects are expected (except for eggs on the bottom); however, longer-term but extremely localized effects over a small area would be expected for benthic organisms. Onshore construction activities could affect fish habitat through removal of gravel, laying of pipelines, etc. These effects are expected to be similar to those described for fishes in Section IV.B.4.

The estimated level of effect on marine plants, invertebrates, and fishes resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR for marine plants and invertebrates and MODERATE for fishes).

4. <u>Effect on Marine and Coastal Birds</u>: The most likely effects on marine and coastal birds associated with natural gas development and production would include some habitat alterations and noise and disturbance from air-support traffic and road traffic along the gas-pipeline route, at the production-platform sites, and at the gas-processing-facility site. These effects would be similar to those noise and disturbance and habitat-alteration effects associated with oil development and production.

If there were a natural gas blowout with 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 fumes would affect birds or their food sources, except for those very near the source of the blowout.

The additional short-term and local effects of noise and disturbance and blowouts indicate that the estimated level of effect on marine and coastal birds resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

5. <u>Effect on Pinnipeds, Polar Bears, and Beluga Whales</u>: The most likely effects of natural gas development and production on pinnipeds, polar bears, and beluga whales would come from air traffic to and from the production platforms and the support facility (at Wainwright) and from platform and offshore-pipeline installation. The air traffic associated with gas production would be an additive source of noise and disturbance of marine mammals. However, the effect of this noise and disturbance is likely to be very brief and result in only a temporary displacement of some marine mammals along the flight paths.

The effect of installing gas-production platforms and laying gas pipelines would be similar to the effect of installing oil-production platforms and laying oil pipelines. These activities would temporarily (one to three seasons) alter the availability of some food organisms of marine mammals near the gas-production platforms and along the pipeline routes. Although this effect could be additive to the habitat alterations associated with oil development, the changes in availability of some food organisms of marine mammals are expected to be short term and local.

If a natural gas blowout occurred, with possible explosion and fire, marine mammals in the immediate vicinity of the blowout could be killed, particularly if the explosion occurred below the water surface. Natural gas and gas 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; it is not likely that these pollutants would affect any marine mammals except individuals present in the immediate vicinity of the blowout. For any marine mammals to be exposed to high concentrations of gas vapors or condensates, the blowout would have to occur below or on the surface of the water, not from the top of the platform or drillship.

The additional short-term and local effects of blowouts, noise and disturbance, and platform- and pipeline-installation activities indicate that the estimated level of effect on pinnipeds, polar bears, and beluga whales resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

6. Effect on Endangered and Threatened Species: Should natural gas development and production occur, trenching for the gas pipeline would disturb a small amount of habitat that may support benthic invertebrates, a primary food source for gray whales and a secondary food source for bowhead whales. However, the amount of seafloor disturbed would be insignificant when compared with the habitat available. Endangered whales may avoid approaching within a few kilometers of the vessels involved in trenching or pipelaying operations. This might result in the temporary displacement of a few summer-feeding gray whales. Spring-migrating bowhead whales might be disturbed and might have difficulty migrating past the pipeline installation site if pipelaying barges and ships were to operate in the spring lead system during the bowhead migration; however, it is unlikely--due to heavy ice conditions--that pipeline construction would occur during this season. The fall bowhead migration might be affected to a minimal degree as bowheads divert around the construction site. Fin and humpback whales would seldom be present in the area; therefore, their populations would not be expected to be adversely affected by natural gas operations.

If a natural gas blowout occurred--with possible explosion and fire--endangered whales in the immediate vicinity probably would be killed, particularly if the explosion occurred under the water surface. 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. It is not likely that they would affect any endangered whales except individuals present in the immediate vicinity of the blowout; and, in the case of a platform blowout, it is not expected that endangered whales would often be found near a platform.

For any endangered whales to be exposed to high concentrations of gas vapors or condensates, the blowout would have to occur below or at the surface of the water, not from the top of the production platform. It is conceivable, although unlikely, that a gas blowout under ice cover would result in the formation of gas pockets under the ice. Should bowheads surface and breathe in these gas pockets, they would be exposed to concentrated gas vapors. After several minutes of repeated inhalation, whales might become sufficiently disoriented to impair their ability to find an uncontaminated breathing hole. The threat would decrease over a period of weeks or months, as the gas percolated through brine channels in the ice, to be released into the atmosphere (Milne, 1977). The greatest vapor concentrations would likely occur if a blowout occurred during the winter months, but bowheads are unlikely to be present at this time. During the spring when bowheads would be present, the rate of gas dissipation through the ice would be most rapid and would tend to reduce the time period when such exposure might occur (Geraci and St. Aubin, 1986). Also, one might expect that gas pockets would be more prevalent under landfast ice than under moving ice, through which bowheads would be expected to migrate.

Any effects of natural gas development and production are expected to be limited to potential disturbance of a few migrating peregrine falcons for a single season during construction of the gas pipeline. However, effects on the falcon population would likely be NEGLIGIBLE because it is expected that any gas pipelines would be buried and would parallel oil pipelines to take advantage of existing roads.

The additional short-term and local effects of pipeline installation and blowouts indicate that the estimated level of effect on endangered and threatened species resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR for bowhead and gray whales and NEGLIGIBLE for fin and humpback whales and peregrine falcons).

7. Effect on Caribou: The most likely effects of natural gas development and production on caribou would come from motor-vehicle traffic and construction activities associated with installing the onshore part of the pipeline system that connects the production platforms with the onshore-processing facility. Onshore, the gas pipelines would run parallel to the oil pipeline from Point Belcher to Tap Pump Station No. 2 and would be serviced by the same roads. The gas pipelines probably would be buried. Road-traffic disturbance of caribou along the gas-pipeline routes would be most intense during the construction period, when motor-vehicle traffic is highest, but would subside after construction is complete. Caribou are likely to successfully cross the pipeline corridor within a short period of time (perhaps within a few hours or no more than a few days) during breaks in the traffic with little or no restrictions in general movements and no effect on overall caribou distribution and abundance. As with construction of the oil pipeline, the construction of the gas pipeline would alter only a small fraction of caribou range.

The estimated level of effect on caribou resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

8. Effect on the Economy: Both the onshore pipeline and the gas-processing facility would generate additional property-tax revenues for the NSB. However, the additional revenues would not be sufficient to reverse the long-term downtrend in revenues resulting from the declining production from the Prudhoe Bay area. The long-term downtrends in population and employment would not be reversed. The estimated level of effect on the economy of the NSB resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (NEGLIGIBLE). In the event of a southern find, the portions of the pipeline and the LNG facility located within the recently formed Northwest Arctic Borough would be subject to borough property taxes. A small number of borough residents would be employed, directly or indirectly, by the construction and operation of these facilities. The estimated level of effect on the economy of the Northwest Arctic Borough resulting from natural gas development and production would be MINOR.

9. Effect 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 in the above Sections IV.M.3 through IV.M.7. If a natural gas blowout occurred, the subsistence harvest of any species in the vicinity could be affected. Gas would affect organisms exposed to high concentrations, but it is dispersed rapidly (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 have any measurable effect on 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 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 were occurring).

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.

Thus, the additional short-term and local effects of blowouts, noise and disturbance, and construction activities indicate that the estimated level of effect on subsistence-harvest patterns resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MAJOR).

10. Effects on Sociocultural Systems: Effects on sociocultural systems would be due to changes in employment and population and effects on subsistence-harvest patterns. In the event of natural gas development and production in the Chukchi Sea for Sale 109, there would be a slight increase in employment and population. However, these increases in employment and population are expected to be limited 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. Effect levels of gas development and production on subsistence-harvest patterns in and adjacent to the proposed Sale 109 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 the sociocultural systems because of disruptions in subsistence harvests.

The estimated level of effect on sociocultural systems resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MODERATE).

11. Effect on Archaeological Resources: Offshore archaeological resources could be affected by activities associated with potential gas-production-platform installation and pipeline installation. Such activities would require surveying of the area if there were a medium or high probability of finding archaeological resources. However, there would not be a need to survey for prehistoric resources in the Sale 109 area because of extensive ice gouging in the area (see Appendix E, Archaeological Analysis). Offshore shipwrecks are more likely to be affected by activities associated with gas-production-platform installation and pipeline installation than prehistoric resources. The area along the coastline, especially west of Wainwright and Cape Krusenstern, is where shipwrecks could be disturbed (see Figs. III-34 and III-35). Lease blocks with a medium or high probability of shipwrecks are shown in Appendix E, Table E-2.

Onshore archaeological resources would be affected by activities associated with gas-processing-facility and gas-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 blowout or explosion. Cleanup after such accidents could result in disturbance by graders or bulldozers being transported overland to the accident site.

The estimated level of effect on archaeological resources resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

12. Effect on Land Use Plans and Coastal Management Programs: If natural gas development and production occurred concurrently with oil development and production as assumed in the scenario, the project would be consistent with the major siting elements of the energy-facility-siting policy of

the Alaska Coastal Management Program (ACMP) and with the policies of the NSB Land Management Regulations. The gas-processing plant and pipelines would be located in areas already used for oil and gas development. The greatest disruptions would occur during construction of the gas pipeline, creating effects comparable to those experienced during installation of the oil pipelines. Because these disruptions would be similar to those experienced while installing the oil pipelines, they can be identified in advance; and potential problems can be resolved or circumvented.

Natural gas development and production is expected to increase marginally the degree of conflict between oil development and production and existing land use, land use plans, and coastal management programs.

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