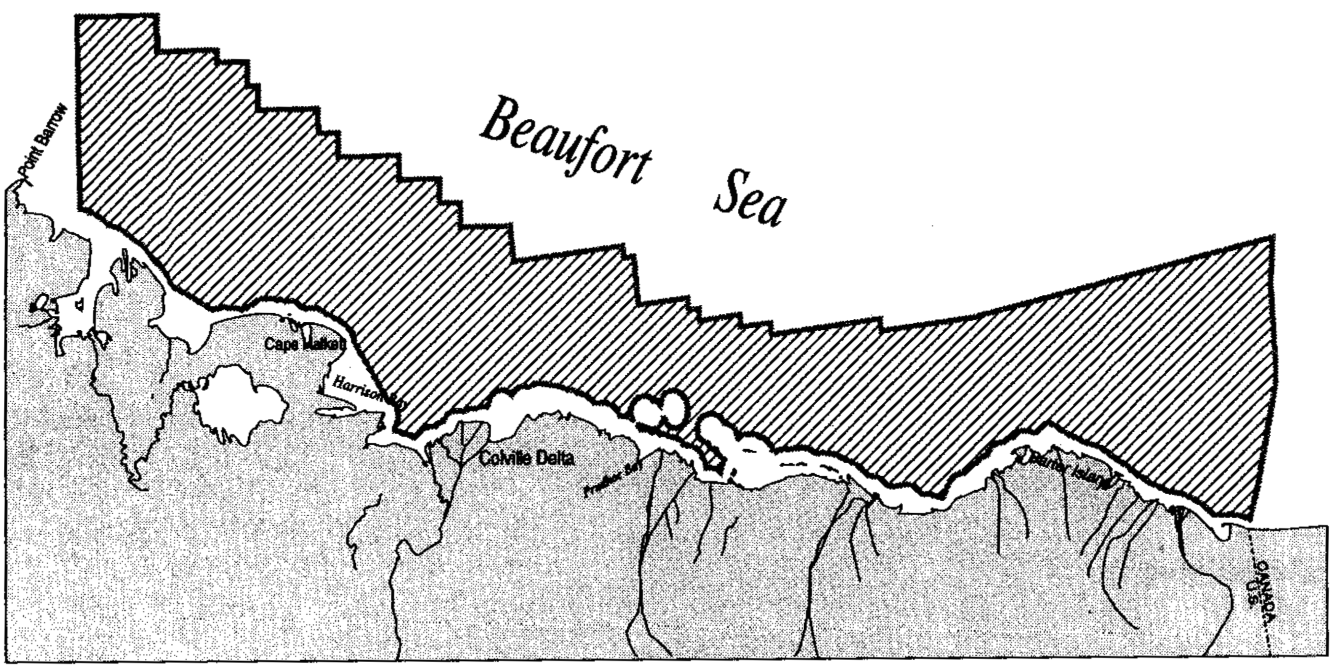
Alaska Outer Continental Shelf

OCS EIS/EA
MMS 96-0012

Beaufort Sea Planning Area Oil and Gas Lease Sale 144

Final Environmental
Impact Statement

Volume I



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

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Cooperating Agency

U.S. Environmental Protection Agency
Region 10

Published by

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

May 1996

COVER SHEET

Environmental Impact Statement for Proposed Beaufort Sea
OCS Lease Sale 144
(1996)

Draft ( ) Final (X)

Type of Action:

Administrative (x) Legislative ( )

Area of Proposed Effect:

Offshore marine environment, Beaufort Sea coastal plain, and the North Slope Borough of Alaska

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ABSTRACT

This *Final Environmental Impact Statement* (EIS) covers the proposed Beaufort Sea OCS Oil and Gas Lease Sale 144. This document includes the purpose and background of the proposed action, the alternatives, the descriptions of the affected environment, and the potential environmental effects of the proposed action and the alternatives. Proposed mitigating measures and their potential effects are analyzed, in addition to potential cumulative effects resulting from the proposed activities.

Additional copies of this EIS may be obtained from the MMS, Alaska OCS Region, 949 E. 36th Avenue, Anchorage, Alaska 99508-4302, or by telephone 1-800-764-2627.

SUMMARY

This environmental impact statement (EIS) addresses a proposed Federal action that will offer for lease areas in the Alaska Outer Continental Shelf (OCS). These areas may contain economically recoverable oil and gas resources. At this time, gas is not considered economically recoverable. Lease Sale 144 is proposed for 1996 and is comprised of lease blocks in the Beaufort Sea Planning Area. Up to 1,879 blocks will be available for lease under the proposed action; only a small percentage is expected to be actually leased. Of the blocks that will be leased, only a portion will be drilled and possibly result in production.

The analytical methods used in this EIS have been formulated over a period of years. The first step of the analysis is the identification of significant environmental and socioeconomic resources through the scoping process outlined in Section I.D. The MMS then derives a range of energy resource estimates from geologic and economic assumptions and establishes alternatives to the proposed action. The MMS assumes estimated levels of exploration and development activity for the purposes of analysis. The MMS then conducts an analysis of the potential effects expected from the interaction between the significant environmental resources and the OCS-related activities.

The scoping process (Sec. I.D) was used to obtain information and comments on the proposed action and the potential environmental effects from diverse interests, including the affected States, Federal agencies, the petroleum industry, environmental and public interest groups, and concerned individuals. The input from these sources aided MMS in the identification of significant issues, possible alternatives to the proposal, and potential mitigating measures. The following is a brief description of the proposal, its alternatives, mitigating measures, and various issues addressed in the EIS.

The Proposed Action and Its Alternatives

Alternative I (Proposed Beaufort Sea Lease Sale 144) is scheduled to be held in September 1996 and would offer for lease 1,879 unleased blocks in the Beaufort Sea Planning Area. This area includes about 4 million hectares (ha) (9.8 million acres) located from 5 to 120 kilometers (km) (3-75 miles [mi]) offshore in water depths ranging up to 1,000 meters (3,300 feet). This alternative comprises approximately 16 percent of the total MMS Beaufort Sea Planning Area and offers for lease blocks that have been previously offered but not leased as well as those that have been previously leased and relinquished. The proposed action assumes the application of existing regulations and MMS-proposed lease stipulations designed to reduce environmental risk. It is estimated that, over the productive life of the proposal, production would likely range from 300 to 2,100 million barrels (MMbbl) of oil.

Alternative II (No Sale) equates to cancellation of the sale. Neither potential environmental effects nor possible oil and gas production resulting from the proposed action would occur.

Alternative III (The Barter Island Deferral) would offer all the blocks proffered by the proposed action, with the exception of 439 blocks located in the far eastern part of the American Beaufort Sea. Deferring these blocks from the lease sale could reduce effects on subsistence resources, particularly the bowhead whale. A total of 1,440 blocks (3.06 million ha) (7.56 million acres) would remain available for lease under this alternative. It is estimated that, over the productive life of this alternative, production could range from 270 to 1,890 MMbbl. This is approximately 10 percent less than Alternative I.

Alternative IV (The Nuiqsut Deferral) would offer all the blocks proffered by the proposed action with the exception of 234 blocks located in the central American Beaufort Sea off the Prudhoe Bay shoreline. Deferring these blocks from the lease sale also could reduce effects on subsistence resources, particularly the bowhead whale. This deferral alternative was specifically requested by the community of Nuiqsut. A total of 1,636 blocks (3.4 million ha) (8.3 million acres) would remain available for lease under this alternative. It is estimated that over the productive life of this alternative, production could range from 180 to 1.26 MMbbl. This is approximately 40 percent less than Alternative I.

Mitigating Measures

Five lease stipulations are included as part of the proposed action: Protection of Biological Resources, an Orientation Program, Transportation of Hydrocarbons, Industry Site-Specific Bowhead Whale-Monitoring

Program, and Subsistence Whaling and Other Subsistence Activities. Actual application of each of these stipulations to leases resulting from the proposed action is an option available to the Secretary of the Interior. The MMS has included these stipulations in previous Beaufort Sea lease sales.

Action Scenarios Analyzed

The MMS's environmental analysis of resources that may be affected by OCS activities is based on oil and gas resources MMS assumes will be leased and developed from the proposed lease sale. The assumed resources are based on many factors such as geologic structure, economic assumptions, and proximity to existing development. Three scenarios are analyzed for Alternative I. The primary scenario analyzed is called the base case, which examines the mean or expected amounts of undiscovered, unleased hydrocarbon resources calculated as being likely according to the factors analyzed, and the resultant developmental activities. The second scenario analyzed is called the high case, which is the statistically less likely possibility that the upper end of the range of energy-resource estimates would be leased, discovered, and developed. The third scenario analyzed is called the low case. The low case is the low end of the resource estimates.

The environmental analyses are based on these levels of assumed development and activities correlated with the amount of resources estimated to be leased. These activities include the number of platforms, wells, pipelines, service-vessel trips, oil spills, etc. The MMS analyzes interactions of all OCS activities expected to result from the lease sale with environmental resources. A key component of this document is the analysis of effects associated with hypothetical oil spills that could be associated with Alternative I, Alternative III, Alternative IV, and the cumulative case. For the Alternative I base case, two spills of ≥1,000 barrels (bbl) are assumed; for the high case of Alternative I, six spills of ≥1,000 bbl are assumed; the low case of Alternative I assumes no spills≥1,000 bbl, because the low case assumes exploration only; for Alternative III and IV, one spill of ≥1,000 bbl is assumed; and for the cumulative case, three spills of ≥1,000 bbl are assumed.

The cumulative analysis considers environmental effects expected to result from the incremental effect of the lease sale when added to all past, present, and reasonably foreseeable future human activities, such as those resulting from other OCS lease sales, as well as non-OCS activities.

Significant Issues

Primary issues of concern identified through scoping include general effects on the marine and coastal environment, potential effects on subsistence resources, and impacts to cultural and social values. Specific resources and activities determined through the scoping process to warrant an environmental analysis included the following: water and air quality; lower trophic-level organisms; fishes; marine and coastal birds; pinnipeds, polar bears, and belukha whales; endangered and threatened species; caribou; economy of the North Slope Borough; sociocultural systems; subsistence-harvest patterns; archaeological resources; and land use plans and coastal management programs.

The scoping process is an ongoing effort whereby contacts are made with other Federal and State agencies, the public, academia, and environmental groups to identify those resources about which there is concern. Through this process, the significant resources and activities analyzed in the EIS are determined.

Impact Conclusions

Section II.F provides a comparison of the impacts of proposed Sale 144 and the deferral alternatives under the base case and cumulative analyses. The summaries presented are based on the comprehensive analyses in Sections IV.B, IV.D, IV.E, and IV.H. A general summary of impacts resulting from the proposed action is as follows:

Summary of Effects on Abiotic Resources

Over the anticipated more than 22-year life of the field, concentrations of contaminants may exceed water quality criteria for sublethal levels but not acute (toxic) levels. Two oil spills of ≥1,000 bbl could temporarily and locally increase water-column hydrocarbon concentrations over a few hundred square kilometers. The large number of very small spills anticipated over the life of the field could result in local, chronic contamination within the margins of the oil field. Regional water quality would not be affected. Air emissions are expected to be 6 percent of the maximum allowable PSD Class II increments. Principally because of the distance of emissions from land, the effects of air-pollutant concentrations at the shore would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

Summary of Effects on Biological Resources

Overall, the activities associated with the base case are expected to affect a very small portion of some of the populations of biological resources in the sale area. Each of the two assumed oil spills is expected to have lethal and sublethal effects on up to 2 percent of the lower trophic-level organisms, which include the phytoplankton, zooplankton, benthic, and epontic communities for a period of <7 years. Fisheries effects are expected for a small portion of some populations consisting of several generations. Effects to marine and coastal birds may consist of habitat alteration and the loss of several thousand birds to oil contamination, but recovery is expected within one generation (2-3 years). Small numbers of pinnipeds, polar bears, and belukha whales may be affected, with recovery within one generation (2-5 years). Bowhead whales exposed to noise-producing activities and oil spills could experience temporary sublethal effects; however, oil spills could result in lethal effects to a few individuals, with the population recovering within 1 to 3 years. Effects to spectacled and Steller's eiders are expected to be minimal, affecting <2 percent of the population; however, mortality from an oil spill is expected to require up to two generations for recovery. Effects to caribou are expected to include displacement within 1 to 2 km (0.62-1.2 mi) along the pipeline and roads for more than one generation and perhaps over the life of the proposal, but these disturbances are not expected to affect caribou migration and overall distribution.

Summary of Effects on Sociocultural Resources

Effects on the sociocultural systems of communities in the sale area could occur as a result of assumed industrial activities, effects on subsistence patterns, and expected changes in population and employment. These effect agents could affect the social organizations, cultural values, and social health of the communities. Nuiqsut and Kaktovik could be affected because of their proximity to the proposed development sites. However, Nuiqsut and Kaktovik are small, relatively homogenous communities that would not absorb the presence of non-Natives as well as a community like Barrow; and they could experience an increase in social problems because of the increased presence of oil workers in their communities and the possible construction of roads from the villages to the development sites. Overall, chronic disruptions to sociocultural systems are expected to occur for a period of 1 to 2 years, and possibly longer; but these disruptions are not expected to cause the displacement of ongoing community activities and the traditional practices for harvesting, sharing, and processing subsistence resources.

The effects on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. Barrow's subsistence resources could be affected for a period not exceeding 1 year; but no resource should be unavailable, undesirable for use, or greatly reduced in number.

With regard to the economy of the North Slope Borough, both resident and nonresident employment would be expected to increase. Direct employment would reside in existing industrial enclaves. Property-tax revenues would increase above the declining existing-condition levels at about 2 percent through the 22-year life of the field.

Other Resources

There should be no effects on submerged prehistoric sites as a result of the lease sale, because it is unlikely that there are prehistoric sites within the sale area. The effect on shipwrecks should be low because of the requirement to review geophysical data prior to any lease activity. Oil-spill effects on onshore archaeological resources are expected to be <3 percent. Conflicts are possible with the North Slope Borough Coastal Management Plan concerning effects on subsistence resources if spilled oil contacted the subsistence-hunting areas of Kaktovik and Nuiqsut.

BEAUFORT SEA PLANNING AREA
OIL AND GAS LEASE SALE 144

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AAC	Alaska Administrative Code
AADT	Annual Average Daily Vehicle Traffic
AART	Alaska Regional Response Team
ACI	Alaska Consultants, Inc. or American Concrete Institute
ACMA	Alaska Coastal Management Act
ACMP	Alaska Coastal Zone Management Plan
AD&G	Alaska Department of Fish and Game (State)
AEDP	Area Evaluation and Decision Process
AEWC	Alaska Eskimo Whaling Commission
AHRF	Alaska Heritage Resources Survey
AMSA's	areas meriting special attention
ANCSA	Alaska Native Claims Settlement Act
ANHB	Alaska Native Health Board
ANWR	Arctic National Wildlife Refuge
AOGCC	Alaska Oil and Gas Conservation Commission
APD	Application for Permit to Drill
API	American Petroleum Institute
Area ID	Area Identification
ARRT	Alaska Regional Response Team
BACT	Best Available Control Technology
Bbbl	Billion barrels (of oil)
bbl	barrel/s
BIOS	Baffin Island Oil Spill Project
BLM	Bureau of Land Management
BOP	Blow Out Prevention (equipment) or Blowout Preventers
BTF	Biological Task Force
BWASP	Bowhead Whale Aerial Survey Project (MMS)
CAH	Central Arctic Herd (caribou)
Call	Call for Information and Nominations
CIP	Capital Improvements Program
CIP's	Capital Improvement Projects
CISPRI	Cook Inlet Spill Prevention and Response, Inc.
CFR	Code of Federal Regulations
cm	centimeter
cm/sec	centimeters per second
$C/m^2/yr$	grams of Carbon per square meter/year
$Cm/^3$	cubic centimeters
CMP	Coastal Management Program
cm/sec	centimeters per second
CO	carbon monoxide
COE	Corps of Engineers (U.S. Army)
CP	Comprehensive Program
CPC	Coastal Policy Council (Alaska)
CPUE	catch-per-unit-effort
CWA	Clean Water Act
CZMA	Coastal Zone Management Act (Federal)
DEC	Department of Environmental Conservation (State of Alaska)
DEIS	Draft Environmental Impact Statement
DNR	Department of Natural Resources (State of Alaska)
DPP	Development and Production Plan
EDS	Exploration and Development Schedule
EIS	Environmental Impact Statement
EP	Exploration Plan

ERA	Environmental Resource Area
ESA	Endangered Species Act
ESD	Emergency Shutdown System
ESP	Environmental Studies Program
ESS	Emergency Support System
EVOS	*Exxon Valdez* oil spill
FFA	Fall Feeding Area
FEIS	Final Environmental Impact Statement
FOSC	Federal On-Scene Coordinator
FR	*Federal Register*
ft	foot/feet
ft^2	square foot/feet
ft/yr	feet per year
FWS	Fish and Wildlife Service (Federal)
FY	Fiscal Year
G&G	geological and geophysical
GIS	Geographic Information System
GMT	Greenwich Mean Time
ha	hectare
Hz	Hertz
IBR	Information Base Review
IRA	Indian Reorganization Act
IS	Ice/Sea Segments
ISER	Institute of Social and Economic Research (University of Alaska)
ISS	International Sea State
ITL	Information to Lessees
ITU's	integrated terrain units
IWC	International Whaling Commission
kg	kilogram
km	kilometer
km^2	square kilometer
km^3	cubic kilometers
kn	knot/s
LC_{50}	lethal concentrations at which 50 percent of the test animals die
LFM	Limited Fine Mesh (National Weather Service model)
LMR	Land Management Regulations
LMW	low-molecular-weight (hydrocarbons)
LOA	Letter of Authorization
LS	Land Segment
m	meter
m/yr	meters per year
m^2	square meter
m^3	cubic meter
mi	mile
mm	millimeter
ml	milliters
MMbbl	Million barrels (of oil)
MMPA	Marine Mammal Protection Act of 1992
MMS	Minerals Management Service
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NLS	Northern Lead System
NLSS	Northern Lead System during Spring
NMFS	National Marine Fisheries Service
nmi	nautical mile(s)
nmi^2	square nautical mile
NOAA	National Oceanic and Atmospheric Administration

NOI	Notice of Intent
NO	nitrous oxide
NO_2	Nitrogen dioxide
NO_x	nitrogen oxides
NPDES	National Pollution Discharge Elimination System
NPR-A	National Petroleum Reserve-Alaska
NRC	National Resource Council
NPS	National Park Service
NSB	North Slope Borough
NSBMC	North Slope Borough Municipal Code
NTL	Notice to Lessees
O_3	ozone
OCD	Offshore Coastal Dispersion (model)
OCRM	Office of Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
OCSLA	OCS Land Act
OPA	Oil Pollution Act
OSCP	Oil Spill Contingency Plan
OSRA	Oil-Spill-Risk Analysis (model)
PAAM	Proposed Action and Alternatives Memorandum
PAH	polynuclear aromatic hydrocarbons
PCH	Porcupine Caribou Herd
PINC	Potential Incident of Non-Compliance
PM	particulate matter
PM-10	particles in the size range $< 10\mu$ in diameter
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration Program
RELI	Resident Employment and Living Improvement (Program)
RII	Request for Interest and Information
RP	recommended practices
RS/FO	Regional Supervisor/Field Operations
Sag	Sagavanirktok River
SLSN	Northern Spring Lead System
SO_2	sulfur dioxide
SRA	Subsistence Resource Area
TAH	total aromatic hydrocarbons
TAPS	Trans-Alaska Pipeline System
TLH	Teshekpuk Lake Herd (caribou)
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
VOC	volatile original composites
WAH	Western Arctic Herd (caribou)
yd	yard
yd^3	cubic yard
Y-K Delta	Yukon-Kuskokwim Delta
yr	year
μ	micron
μg/l	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
μm	micrometer
dB re 1μpa	decibels per 1 microPascal
>	greater than

<	less than
≥	greater than or equal to
≤	less than or equal to
°	degree symbol
°C	degrees centigrade/celsius
$^{\circ}/_{oo}$	parts per thousand/salinity
2-D	two dimensional
3-D	three dimensional

SECTION I

PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

Purpose: The purpose of the proposed action is the offering for and subsequent exploration, development, and production of oil and gas resources on the Outer Continental Shelf (OCS) in the Beaufort Sea Planning Area to meet national energy demands.

A. LEASING PROCESS: The OCS Lands Act (OCSLA) charges the Secretary of the Interior with administering mineral exploration and development on the U.S. OCS and with conserving its natural resources. The Secretary has delegated authority to carry out offshore mineral development functions to the Minerals Management Service (MMS). Pursuant to this authority, the MMS has, among other things, developed programs to produce relevant information about potential effects of natural gas and oil activities on the environment (the OCS Environmental Studies Program [ESP]) and on communities and regions of Alaska as a whole (the Social and Economic Studies Program). Information produced by the ESP is used by staff analysts as part of the baseline data used in measuring the effects of any proposed OCS oil and gas lease sale. The ESP also supports monitoring of potential postsale changes in environmental conditions to provide a basis for mitigating any unforeseen effects. For specific information on the MMS studies program, refer to Appendix D. The OCS oil and gas leasing program is implemented by 30 CFR 256. Lease supervision and regulation of offshore operations are implemented by 30 CFR 250. The following steps summarize the leasing process for the proposed sale.

1. Leasing Schedule: The OCSLA, as amended, requires that the Secretary of the Interior prepare and maintain a 5-year OCS natural gas and oil leasing schedule and review the program annually to ensure that it is current. The present 5-year program announced by the U.S. Department of the Interior (USDOI) in July 1992 (the OCS Natural Gas and Oil Resource Management Comprehensive Program 1992-1997 (CP) (USDOI, MMS, 1992) consists of 18 proposed lease sales for the period 1992 through 1997. Six of these proposed lease sales are in planning areas offshore Alaska. Beaufort Sea Sale 144 tentatively is scheduled to be held in September 1996. The OCS 5-year leasing CP does not represent a decision to lease in a particular area. Instead, it represents only the Department's intent to consider leasing in identified areas and to proceed with the offering of such areas only if it should be determined that leasing and development would be environmentally and socially acceptable as well as technically feasible.

An Area Evaluation and Decision Process (AEDP) has been implemented for Sale 144 under the present 5-year CP. The AEDP provides a framework for the activities that precede the decision of whether and under what conditions to hold an individual OCS natural gas and oil lease sale. These activities include coordination and consultation, information acquisition, environmental studies, resource evaluations, decisions, and review and comment procedures under the OCSLA and the National Environmental Policy Act of 1969 (NEPA). This process may include an Information Base Review (IBR), Request for Interest and Comments or Request for Interest and Information (RII), Call for Information and Nominations (Call), Notice of Intent (NOI) to Prepare an Environmental Impact Statement (EIS), and scoping and other coordination meetings.

2. Information Base Review: The goal of this process is to document the acquisition of environmental, geologic, and economic information to be used in OCS management and decisionmaking. If it is determined that sufficient information exists to proceed with the prelease process, the MMS would implement the next step. If a determination is made that additional studies are needed before the next step can proceed, studies are requested.

Preparations for Sale 144 originally began in April 1991 with an IBR. Groups invited to attend included the Regional Technical Working Group, Alaska Eskimo Whaling Commission (AEWC), Eskimo Walrus Commission, Federal and State agencies, the North Slope Borough, village leaders, industry, environmental groups, and the general public. The final decision for the 5-year program for 1992-1997 delayed the sale date and the process was begun again. In January 1993, an Information Transfer Meeting was held in Anchorage as part of a second IBR. Information was exchanged, and although participants identified study areas and specific studies they felt would be beneficial and would enhance MMS's knowledge of the Beaufort Sea, no information needs were identified that would warrant stopping the leasing process.

3. Request for Interest and Information: This step obtains information to assist MMS in determining the level of industry and public interest. On December 31, 1992, an RII was published in the *Federal Register (FR)* at 57 *FR* 62582 as part of the IBR. The RII asked the oil and gas industry to provide up-to-date information on its interest in leasing and conducting oil and gas operations within the Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas. Other information requested from all parties included recent geophysical data; recent geological data; biological, archaeological, environmental, or socioeconomic data; recent interpretation of existing data; and recent estimates of cost of production. The area identified in the RII as available for consideration of leasing in the Beaufort Sea Planning Area was 5,420 blocks covering 29.5 million acres, as included in the draft comprehensive program for 1992-1997.

Eight comments were received. Seven responses were from oil companies, indicating a range of interest from none to high, with most companies indicating a moderate interest. The Arctic Marine Resources Commission submitted recommendations on future research and information gathering to enhance the decisionmaking process. This information, along with the results of the IBR, was considered in deciding whether to proceed with the Call and NOI.

4. Call for Information and Nominations and Notice of Intent to Prepare an Environmental Impact Statement (EIS): A Call/NOI to Prepare an EIS are notices published in the *Federal Register* inviting the oil industry, governmental agencies, environmental groups, and the general public to comment on areas of interest or special concern in the proposed lease-sale area.

The Call/NOI for proposed Beaufort Sea Sale 144 was published in the *Federal Register* on December 10, 1993 (58 *FR* 649964). In response to the Call, 12 comments and/or nominations were received: 5 companies commented and nominated blocks, 1 comment was received from the State of Alaska, 2 from USDOI Agencies (Fish and Wildlife Service [FWS] and National Park Service [NPS]), 1 from the North Slope Borough, 1 from the Alaska Eskimo Whaling Commission, and 2 from environmental entities (Greenpeace and the Wilderness Society). The nominations received indicated interest in all 5,420 blocks. The comments received on the NOI are discussed in Section I.D, Results of the Scoping Process.

5. Scoping: The NOI, published in the same document as the Call (Sec. I.A.3), serves to announce and describe the scoping process followed for the EIS. The Council on Environmental Quality defines scoping as "an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). It is a means for early identification of important issues deserving of study in an EIS. The intent of scoping is to avoid overlooking important issues that should be analyzed in the EIS. Comments are invited from any interested persons, including affected Federal, State, and local governmental agencies; any affected Native groups; conservation groups; and private industry. Information obtained from the IBR, RII, and the Call is considered part of scoping. Based on information gained through the scoping process—which includes staff evaluation and input—major issues, alternatives to the proposed action, and measures that could mitigate the effects of the proposed action are identified for analysis in the EIS. For proposed Beaufort Sea Sale 144, MMS held scoping meetings in Nuiqsut, Kaktovik, and Barrow March 28-30, 1994. A scoping meeting was held in Anchorage in April 1994.

6. Proposed Action and Alternatives Memorandum (PAAM): The purpose of this step is to determine whether to proceed with, delay, or cancel the further development and analysis of a leasing proposal. If the decision is to proceed, MMS determines and announces the scope of that review and analysis (alternatives, mitigation, and issues to be analyzed). The PAAM documents the consultation process and the information used to ensure an informed decision on the identification of the proposed action to be analyzed in the draft EIS. The PAAM reports relevant conclusions of the IBR; summarizes and analyzes responses to the Call; presents and summarizes the scoping process and the comments and concerns raised in that process; and discusses and recommends alternatives, mitigating measures, and issues to be analyzed in the draft EIS. The PAAM provides the background information necessary to make an informed decision regarding the leasing proposal.

7. Area Identification (Area ID): The Regional Director, MMS, uses the PAAM to make a recommendation to headquarters as to whether, when, and how to proceed with Area ID . The Area ID formally identifies the location and extent of the proposed lease sale area, and is the area of study for the EIS. A final

PAAM is prepared in headquarters, and the MMS Director forwards recommendations on the Area ID and scope of the EIS to the Secretary/Assistant Secretary, Lands and Minerals, for approval. The Secretary/ Assistant Secretary will approve or disapprove the Director's recommendation. If the decision is to proceed with preparation of the draft EIS, an Area ID announcement is made.

The PAAM was sent to the Secretary/Assistant Secretary on September 12, 1994, and the Area ID announcement for Sale 144 was made on September 13, 1994, and included 1,879 blocks covering 4 million hectares (9.8 million acres). This configuration defers the blocks off Point Barrow that comprise the whale migration corridor (Fig. II.A.1).

8. Preparation of Draft Environmental Impact Statement (DEIS): Consistent with Section 102(2)(C) of the NEPA, the DEIS prepared by the MMS describes the proposed lease sale and the natural and human environments, presents an analysis of potential adverse effects on these environments, describes potential mitigating measures to reduce the adverse effects of offshore leasing and development, describes alternatives to the proposal, and presents a record of consultation and coordination with others during EIS preparation.

The DEIS was filed with the U.S. Environmental Protection Agency (USEPA), and its availability was announced in the *Federal Register* on August 23, 1995, at 60 *FR* 43813. The public has 90 days to review and comment on the DEIS.

A copy of the proposed notice of sale was made available to the public on September 26, 1995. The availability of the proposed notice was announced in the *Federal Register* on that date at 60 *FR* 49629. A copy also was sent to the Governor of Alaska, pursuant to Section 19 of the OCSLA, so that he and any affected local governments may comment on the size, timing, and location of the proposed sale. Comments must reach the Secretary within 90 days after the proposed notice is released.

9. Endangered Species Consultation: Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended, MMS consults with the FWS and the National Marine Fisheries Service (NMFS), as appropriate, to determine whether a species that is listed as endangered or threatened may be jeopardized by the proposed action. Both formal and informal consultations are conducted on the potential effects of OCS leasing and subsequent activities on endangered and threatened species in Beaufort Sea.

In accordance with the ESA Section 7 and regulations governing interagency cooperation, the MMS notified the NMFS and FWS on January 23, 1995, of the endangered and threatened species that would be included in a biological evaluation for Section 7 consultation. The NMFS responded on February 7, 1995, and the FWS responded on March 13, 1995, confirming that the species to be evaluated in the EIS were correctly specified (see Appendix F).

Requests for formal consultation on leasing and any exploration that may occur as a result of proposed Sale 144 were transmitted to the FWS and NMFS on July 31, 1995. A Biological Evaluation analyzing potential effects of this action accompanied these requests. The NMFS, in a letter dated November 16, 1995, determined that the Arctic Biological Opinion satisfies the requirement of Section 7 of the ESA for the Sale 144 planning process. The Arctic Biological Opinion, dated November 23, 1988, concluded that the proposed lease sale and exploration activities in the Beaufort Sea are not likely to jeopardize the continued existence of any endangered or threatened cetaceans. A draft Biological Opinion from FWS dated November 13, 1995, found that the proposed oil and gas lease sale and associated exploration in the Beaufort Sea would not jeopardize any listed species for which the FWS is responsible.

10. Public Hearings: Public hearings are held after release of the DEIS, and specific dates and locations for public hearings are announced in the *Federal Register*. The MMS obtains oral and written comments at the hearings from the interested public.

Public hearings on the DEIS for Sale 144 were held in Anchorage on October 26, Nuiqsut on November 6, Kaktovik on November 7, and Barrow on November 8, all in 1995.

11. Recommendation and Report: . A recommendation to proceed with preparation of the FEIS was prepared based on oral and written comments received on the DEIS and the proposed Notice of Sale.

Recommendations included a new alternative, new ITL's, and modified mitigating measures. These changes are noted in Section I.G.

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

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

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

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

The major analytic, decision, legal, and policy documents comprise the Sale 144 record of decision as required by Council on Environmental Quality regulations implementing NEPA. Of particular relevance are the decision documents at the Area ID stage, the EIS, the decision documents for the proposed and final Notices of Sale, the consistency determination, and the sale-related correspondence with Governors.

16. Lease Sale: The Beaufort Sea Sale 144 is tentatively scheduled to be held in September 1996. Sealed bids for individual blocks and bidding units (those listed in the final notice) are opened and publicly announced at the time and place of the sale. The MMS assesses the adequacy of the bids, and the Department of Justice—in consultation with the Federal Trade Commission—may review them for compliance with antitrust laws. If bids are determined to be acceptable, leases may be awarded to the highest bidders. However, the Secretary reserves the right to withdraw any blocks from consideration prior to written acceptance of a bid and the right to accept or reject bids, generally within 90 days of the lease sale.

17. Lease Operations: After leases are awarded, the MMS's Field Operations Office is responsible for approving, supervising, and regulating operations conducted on the lease. Prior to any exploration activities on a lease, except certain preliminary activities, a lessee must submit to MMS for approval an exploration plan, an Oil-Spill-Contingency Plan, and an Application for Permit to Drill. The Office of Ocean and Coastal Resource Management, FWS, NMFS, USEPA, NPS, U.S. Army Corps of Engineers, U.S. Coast Guard, the State of Alaska, and the public are provided an opportunity to comment on the exploration plan. The exploration plan must be approved or disapproved within 30 days, subject to the State of Alaska's concurrence or presumed concurrence with the lessee's coastal zone consistency certification (pursuant to the Federal Coastal Zone Management Act). The MMS's ESP is designed to monitor changes in human, marine, and coastal environments during and after oil exploration and development and is authorized in Section 20(b) of the OCSLA: "Subsequent to the leasing and development of any area or region, the Secretary shall conduct such additional studies to establish environmental information as he deems necessary and shall monitor the human, marine, and coastal environments of such area or region in a manner designed to provide time-series and data trend information which can be used for comparison with any previously collected data for the purpose of identifying any significant changes in the quality and productivity of such environments, for establishing trends in the areas studied and monitored, and for designing experiments to identify the causes of such changes."

B. LEASING AND DRILLING HISTORY:

1. Previous Lease Sales: Five lease sales have been held in the Beaufort Sea Planning Area. Sale BF was held in December 1979, Sale 71 in October 1982, Sale 87 in August 1984, Sale 97 in March 1988, and Sale 124 in June 1991. These sales resulted in the issuance of 631 leases, generating over $3.5 billion in bonuses. All of the leases issued in the Beaufort Sea Planning Area were issued with a primary term of 10 years; however, companies may choose to relinquish leases prior to the expiration of the primary term. Of the original 631 leases issued, 574 have been relinquished or have expired; 57 leases remain as of November 1, 1995.

2. Drilling: In the Beaufort Sea Planning Area, 28 exploratory wells have been drilled; 9 have been determined producible, although none of them has been determined economically producible under current economic and market conditions.

C. LEGAL MANDATES, AUTHORITIES, AND FEDERAL REGULATORY RESPONSIBILITIES:

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

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

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

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

D. RESULTS OF THE SCOPING PROCESS:

Scoping for this EIS consisted of comments received during the IBR, the RII, the Call, and the NOI; written and verbal comments submitted at the scoping meetings; reevaluation of the issues raised and analyzed in the EIS's for previous Beaufort Sea lease sales (Sales BF, 71, 87, 97, and 124); and MMS staff investigation. Scoping comments for the proposed lease sale were requested from the public through newspaper, radio, and television advertisements in the North Slope Borough (NSB). Letters were sent to the Mayor of the NSB as well as the Mayors of Barrow, Nuiqsut, and Kaktovik. The IBR provided a forum in which concerned groups had the opportunity to review the MMS Beaufort Sea database and comment on appropriate areas for future studies.

Sale 144 scoping meetings were held in Nuiqsut, Kaktovik, and Barrow on August 19-21, 1991. The sale process was then delayed; a second round of scoping meetings was held in the same communities on March 28-30, 1994. A meeting also was held in Anchorage on April 28, 1994. The MMS received eight written comments as a result of the Call and NOI. The following submitted comments: The Office of the Governor, State of Alaska; ARCO; the FWS; the NPS; the NSB; the AEWC; and the Wilderness Society. The Office of the Governor declined to make specific comments; ARCO supported the sale but otherwise did not make specific comments. Additional written comments were received from Greenpeace and the Office of the Mayor of the NSB after the close of the scoping comment period; however, these also were considered within the scoping record.

Scoping, which is an ongoing process, has continued with several outreach/scoping meetings conducted since April 1994. Meetings on eliciting comments on the status of information on Beaufort Sea oceanography were held in Barrow in October 1994; in November 1994, an outreach meeting was held in Nuiqsut to disseminate information on MMS's inspection and offshore safety program.

1. Major Issues Considered in the EIS: The major issues that frame the environmental analysis contained in this EIS are the direct result of concerns raised during the scoping process. These concerns, registered in the form of oral and written comments, were raised during the lengthy scoping period preceding the compilation of this document. From the concerns and comments raised during the scoping process, the resource topics selected for effects analyses in Section IV.B were chosen. The Section IV.B topics are Water Quality; Lower Trophic-Level Organisms; Fishes; Marine and Coastal Birds; Pinnipeds, Polar Bears, and Belukha Whales; Endangered and Threatened Species; Caribou; Economy of the North Slope Borough; Sociocultural Systems; Subsistence-Harvest Patterns; Archaeological Resources; Air Quality; and Land Use Plans and Coastal Management Programs.

The following subsection describes significant issues identified through comments received during the scoping process.

a. Significant Environmental Issues: The following environmental issues are related to important resources, activities, systems, or programs that could be affected by petroleum exploration, development and production, and transportation activities associated with the proposal.

(1) Concerns Regarding the Effects of Oil Spills:

(a) Contamination and Effects: Concern was noted that if spilled oil occurred, it would contaminate the affected marine and coastal environments and, depending on the amount, have short- to long-term, local to regional effects on those resources and sociocultural systems adjacent to the planning area. A spill event, especially one of a large quantity of hydrocarbons, it was noted, could have a significant effect on water quality, while the in situ burning of spilled oil would affect the region's air quality. Building on this, it was noted that a spill could adversely affect the economic well-being of the North Slope by placing at risk many of the food sources of the Inupiat. The temporary or permanent elimination of primary subsistence foods would cause North Slope residents either to shift to less desired subsistence resources or to replace them with expensive Euro-American "groceries."

Specific concerns were raised regarding contamination effects on marine mammals, particularly the endangered bowhead whale; the threatened spectacled eider; the proposed Steller's eider; anadromous fishes; coastal birds; lower trophic-level organisms; and other migratory species, i.e., polar bears and caribou, within the spill area that also might be affected. The endangered bowhead whale occupies an important niche in the cultural life of the Inupiat and is considered to be an important subsistence meat; comment was made that the bowhead whale population could be affected by spilled oil as the bowheads migrate through the Beaufort Sea. The Steller's eider has been designated as warranted for listing as threatened but has not yet achieved the threatened designation. A full discussion of the effects of the proposal on the various resources discussed in this subparagraph is contained in Section IV.B.

(b) Fate, Behavior, and Cleanup of Spilled Oil: Of great concern to many parties was the fate and behavior of spilled oil in the marine and coastal environments and the strategies and methods of spill cleanup. During scoping, concerns were raised regarding the following: the availability and adequacy of containment and cleanup technologies; the ability to detect and clean up pipeline spills and spills under ice; the effect of winds and currents on the transport of spilled oil within ice; the removal of oil from contaminated water sediments and ice; the toxicological properties of fresh and weathering oil; and the air pollution that would result from the at-sea evaporation or burning of spilled oil.

(2) Effect of Discharges Associated with Petroleum Operations: Concerns were noted regarding discharges, including those of formation waters, associated with petroleum operations. It was feared that such discharges would affect water quality, lower trophic-level organisms, and fishes.

(3) Habitat Disturbance and Alteration: During the scoping process, it was noted that both offshore and onshore construction activities and activities associated with the operation of petroleum facilities are likely to cause some habitat disturbance and alteration.

(a) Habitat Disturbance: Habitat disturbance, including noise, caused by air traffic, vessel operations, traffic along roads, marine and over-the-ice seismic activities, offshore drilling, dredging, vessels involved in icebreaking and management operations, and facility construction were of concern. Depending on the type of operation and the time of occurrence, it was observed, these habitat disturbances could have some effects on fishes (particularly anadromous species), marine and coastal birds, marine mammals, caribou, and endangered and threatened species such as the bowhead whale and the spectacled eider.

(b) Habitat Alteration: Habitat alteration, including reduction, caused by both onshore and offshore construction activities that include pipeline and road construction, dredging (excavation and dumping of dredged material), removal of gravel from onshore sites, and dumping of onshore gravel in offshore locations were of concern. During the scoping process, it was observed that, depending on the type of operation and the time and location of occurrence, some effects may occur to lower trophic-level organisms; fishes (especially anadromous species); marine and coastal birds; marine mammals; bowhead whales (endangered species), especially in the spring-lead system and fall-feeding area; caribou; archaeological resources; and subsistence hunting and fishing activities as they relate to reduced access to the resources and changes in practices.

(4) Protection of Inupiat Culture and Way of Life: Of particular concern was that the Inupiat culture and way of life may need to be protected from effects associated with petroleum-development activities. Concern was voiced that petroleum activities might lead to social disruption and a change in cultural values through population changes (emigration of large numbers of non-Inupiats to the North Slope), employment changes (further displacement of the subsistence lifestyle by a cash economy), and the alteration of subsistence-harvest patterns as discussed in relation to other significant issues previously noted in this section.

(5) Other Significant Issues: Following are other significant issues related to petroleum-development activities that were raised during the scoping process:

□□ Effects of discharging combustion gases and particulates into the atmosphere are a concern regarding the air quality and water quality of coastal plain lakes and ponds and flora.

□□ The scoping process raised concerns about the cumulative effects on the biological and physical resources and social systems in and adjacent to the planning area from present and future arctic region OCS oil and gas lease sales and other major projects; see (b) below.

□□ Concerns were expressed during scoping regarding potential conflicts with coastal management programs and consistency requirements and the effects of OCS lease sales. It was noted that OCS development-related activities may result in land use changes that may occur from the construction of onshore-support facilities, docking facilities, and airfields. Also, that petroleum-related activities may result in the establishment of pipeline rights of way and new transportation corridors.

□□ As a result of these varying concerns and comments, the synergistic responses of the affected species to exposure to the various effect-causing activities of multiple industrial activities also will be analyzed.

b. Cumulative Effects: The cumulative effects of present and future major activities on each of the resources, activities, systems, or programs that were identified as significant issues in this section are analyzed in this EIS (see Sec. IV.A.6 and IV.H).

Future major activities analyzed under the cumulative case and the oil-spill-risk analysis for Sale 144 are (1) petroleum-development and -production projects and transportation systems with estimated resources, (2) major construction projects with approved construction permits or other indications of coming to fruition, and (3) other major natural resource-related projects. Future activities that do not meet these criteria are mentioned and described if they affect the resources, systems, programs, or activities that have been identified as significant issues.

c. Issues Raised During Scoping that Were Considered but Did Not Warrant Detailed Analysis in the EIS: The following issues were raised during the scoping process for this sale and previous Beaufort Sea lease sales. These concerns were fully evaluated by the MMS staff but are not to be analyzed or separately considered for the reasons indicated.

(1) Earthquakes and Tsunamis: Earthquake data indicate that the Sale 144 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.

(2) The Effects 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 are not available to provide industry with an adequate supply of freshwater. One option currently used to supply freshwater for Prudhoe Bay operations relies on water that collects in the pits that remain after gravel has been extracted. Gravel extraction used to support sale-related activities might generate a similar source of water.

(3) Completion of Land Status and Compatibility Tests on Refuge Lands Before Industrial Activities are Permitted: Parts of the Arctic National Wildlife Refuge (ANWR) are in the vicinity of proposed Sale 144. The refuge was established to conserve fish and wildlife populations and habitats in their natural diversity, fulfill international fish and wildlife treaty obligations, provide for continued subsistence use by local residents, provide for scientific research, and ensure water quality and quantity. As done for previous OCS lease sales, this EIS examines the potential effects of Sale 144 on the physical and biological resources and subsistence pursuits in and adjacent to the sale area, which includes the ANWR.

(4) Statewide Economy: The economic effect of proposed Sale 144 would occur primarily in the NSB. The State of Alaska would receive an indeterminate amount of money from Section 8(g) blocks; these blocks lie within 3 to 6 miles (mi) offshore, and the State receives a percentage of all revenues collected in accordance with Section 8(g) of the OCS Lands Act. Some sale-related and -induced employment effects would be experienced outside of the NSB, but the magnitude of these effects is not expected to significantly affect the Statewide economy. Therefore, the effect of Sale 144 is not considered a significant issue for the Statewide economy.

(5) Availability of Adequate Information: Since the Beaufort Sea Planning Area was first placed on the 5-Year OCS Oil and Gas Leasing Program, more than 100 studies pertinent to increasing the knowledge of this area have been completed. In addition, more than 25 studies are ongoing or planned for the future. Although more studies can be conducted in the sale area, it is the judgment of the MMS and the opinion of a lengthy 1994 report by the National Research Council (NRC) on available Outer Continental Shelf information that the database currently available is adequate for environmental assessment and for the Secretary of the Interior to make a decision concerning this lease sale. The NRC review of the scientific database for the Alaskan environment stated that some additional sociocultural work was needed, but not necessarily any additional scientific studies. Instead, the NRC stated that more contact with the concerned communities by agency representatives and social scientists was needed. This position has been a major justification for the extensive community-outreach program that has been initiated for each sale area. Scientific studies on oceanography and marine biology have been deemed appropriate by the NRC.

(6) Eligibility of Archaeological Sites for Inclusion in the National Register of Historic Places: The identification of previously recorded archaeological sites, an evaluation of the probability of finding additional archaeological resources in a given area, and a determination of effects of petroleum development were included in the Sale 124 EIS and will be repeated in the Sale 144 EIS. The MMS will not consider making a recommendation of eligibility for the National Register of Historic Places until site-specific exploration and development and production plans are submitted to MMS.

(7) 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, because the Eskimo curlew has not been sighted in Alaska for decades, the effects of oil and gas development associated with Sale 144 on this bird will not be analyzed.

(8) 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 human health or to oil and gas operations.

(9) Increased Federal Revenue Sharing: Impact assistance beyond that provided for under the OCS Lands Act would require congressional action. The likelihood of adopting additional impact assistance is uncertain, and it is not considered an issue warranting detailed analysis in this EIS.

2. Alternatives:

a. Alternatives Suggested During the Scoping Process: Several block-configuration alternatives, including delaying or canceling the sale, were suggested during the Sale 144 scoping process. The following alternatives appear in two sets. Those alternatives comprising the first set are labeled Alternatives I (the Proposal), II (No Sale Case), and III (the Barter Island Deferral). Alternative IV (Nuiqsut Deferral) was subsequently added as result of comments on the DEIS. These alternatives were developed during the scoping process as a response to comments and concerns and further refined by MMS decisionmakers. They form the alternatives upon which this EIS is based. The second set consists of the Barrow Deferral Alternative, Delete Pack Ice Zone Tracts,, and the River Deltas Deferral. These alternatives were suggested during the scoping process and were considered but rejected by the decisionmakers.

(1) Description of Alternative I, The Proposal: Alternative I, the Proposal, would offer for lease those parts of the Beaufort Sea Planning Area that were selected as a result of Area Identification (Area ID). The proposed action, titled the Western Option during the alternative-selection process, would offer for lease 1,879 blocks, approximately 4.0 million hectares (ha) (9.89 million acres), and include those blocks east of Barter Island that have received industry nominations. As a result of previous lease sales, 518 leases have been issued within the boundaries of Alternative I. As of November 1, 1995, 57 still were active.

(2) Alternative II, No Sale: This alternative would remove the entire area of the Proposal from leasing.

(3) Alternative III, Barter Island Deferral Alternative: This alternative would offer for leasing all the area described for Alternative I except for a subarea located in the eastern part of the proposed sale area. The subarea removed by the deferral alternative, the Barter Island Subarea Deferral, consists of about 439 whole and partial blocks (about 940,000 ha) (2.33 million acres) located between Barter Island and the Canadian border. The subarea of the deferral was part of areas the State of Alaska, NSB, the Alaska Eskimo Walrus Commission, and the National Oceanic and Atmospheric Administration (NOAA) recommended for deferral. The Barter Island Subarea Deferral, with some variation in the boundaries of the deferral, have been analyzed in Sales 87, 97, and 124. The boundaries of the proposed deferral lie between 6 and 40 kilometers offshore. Blocks that were leased as a result of Sales 87, 97, and 124 are located near and adjacent to the boundaries of the subarea of the deferral.

Bowhead whales use the Barter Island Subarea Deferral as part of the fall migration route and for feeding. The Inupiat residents of Kaktovik use the subarea to hunt bowheads as well as polar bears, ringed seals, and migratory birds for subsistence purposes.

(4) Alternative IV, Nuiqsut Deferral Alternative: In response to concerns raised during the comment and public hearings process, a third alternative (Alternative IV) to the proposed action (Alternative I) was included for analysis with in the FEIS. Alternative IV would defer 243 blocks out of the 1,879 offered by Alternative I and 559,872 hectares out of 4 million (Fig II.D-1). The deferred area comprises about 14 percent of the area offered by Alternative I.

The deferral was offered by the community of Nuiqsut and the Inupiat Whaling Commission. The area proposed for deferral encompasses Cross Island—a location viewed by the community of Nuiqsut as their primary harvest area for the bowhead whale and other marine mammals. The blocks offered in the Nuiqsut Deferral Alternative have been offered in other OCS lease sales and lie immediately offshore of active State and Federal leases, including the Northstar Unit. Currently, the Corps of Engineers is in the process of issuing a developmental EIS for the Federal portion of those resources produced from the Northstar Unit.

b. Alternatives Not Selected for Inclusion in the EIS: Some alternatives identified during the scoping process or during previous EIS processes have been determined to warrant no further analysis in the draft EIS. These include concerns related to (1) streamlining and accelerated leasing, which are moot as a result of the new proposed comprehensive plan and the Area Evaluation and Decision Process, and (2) areawide leasing, which also is moot based on the change of the size of the proposal under consideration from those of previous EIS's.

The size of the proposed action is a sharp reduction from the boundaries of Sale 124. This reduction renders the following previously considered deferral requests irrelevant because they are outside the proposed sale area (see Sec. III.B.1). Among these are the area around Barrow deferred in previous sales, the Chukchi Sea Shelf, the disputed Canadian blocks, and the area in the vicinity of river deltas. This latter area is associated with State leases, not Federal. Of the areas previously and presently recommended for deferral by FWS, only the Kaktovik area and the area beyond the landfast ice remain within the sale area. The Kaktovik area is discussed within the EIS under Alternative III. An alternative dealing with the pack-ice zone was considered by USDOI decision makers but not included in the EIS (see below).

(1) Barrow Deferral Alternative: This alternative would have removed 201 whole and partial blocks, about 412,354 ha (1.02 million acres), located along the coast of northwestern Alaska from Elson Lagoon on the Beaufort Sea side of Point Barrow to Peard Bay on the Chukchi Sea side. The boundaries of Alternative I, the proposed action, exclude these blocks from leasing at this time, rendering this deferral alternative moot.

(2) Delete Pack-Ice-Zone Tracts (Waters Deeper than 40 Meters): Removal of blocks located in the pack-ice zone was recommended by NOAA because of (1) ice hazards throughout the year, (2) the proposed use of exploratory drilling technologies and procedures that had not been used previously in the Alaskan Beaufort Sea, and (3) the proximity of the bowhead whale-migration routes in the pack-ice zone.

Deletion of the pack-ice zone is not analyzed as a separate alternative for the following reasons: (1) about 120 blocks in waters 40 meters (m) (130 feet [ft]) or deeper in the Beaufort Sea already have been leased, and 15 of these blocks lie in waters about 100 m (330 ft) deep; (2) technologies and procedures used to drill exploration wells in waters deeper than 40 m (130 ft) will be the same as those proven by use in the U.S. and Canadian Beaufort Sea; (3) the adequacy of technology to operate in the pack-ice zone is more appropriately evaluated on a site-specific basis when exploration plans are submitted in accordance with Coordinated Offshore Operating Regulations (30 CFR Parts 250 and 256, Oil and Gas and Sulphur Operations in the Outer Continental Shelf, Final Rule); and (4) adoption of measures affecting the potential of oil spills and noise would reduce the risks to bowhead whales during the spring and fall migrations.

(3) River Deltas Deferral: The FWS recommended, in a letter dated July 26, 1991, that MMS consider a deferral alternative that would prohibit the leasing of blocks off of river deltas of special concern. Of specific note were the Colville, Canning, and Kongakut deltas. Protection of the Kongakut River Delta is addressed in MMS's Barter Island deferral recommendation (Alternative III). In regard to the Colville and Canning river deltas, most subsistence-related activities take place within the delta itself and within the 3-mi limit of State jurisdiction. Specifically of interest was the protection of anadromous fishes in the channels of the river deltas and of migratory bird-nesting habitat. The State has leased several blocks for oil and gas exploration within the subject delta areas, and the USDOI has leased a number of blocks beyond the 3-mi limit off of the deltas. When contacted in June of 1993 by MMS, representatives of the FWS stated that they were most concerned about the establishment of support facilities for offshore exploration and development within the delta regions. The issue of support facilities is one directly covered under the Coastal Zone Management policies of the North Slope Borough and as such will be dealt with as a Borough land use planning issue. Please see Section IV.A.2.m.

(4) Delay the Sale 2 Years: Past EIS's have contained a Delay of Sale Alternative to the proposed action. A Delay of Sale Alternative was not considered for this EIS because delaying the sale 2 years would put Sale 144 into the next 5-year program. A Beaufort Sea sale is assumed for the next 5-year program. Overlapping timeframes between the sale assumed for the proposed 5-year program and a delayed Sale 144 would occur, and it is likely that Sale 144 would be then canceled. In any case, a delay of this extent would require the process to be restarted and is, in this instance, virtually the same as a no-sale alternative.

3. Mitigating Measures:

a. Mitigating Measures Suggested During the Scoping Process: The following suggestions for mitigating measures to protect certain resources were received and are discussed below. Section II.D contains an extensive discussion of the details of the mitigating measures that are part of the proposed action and the alternatives.

(1) Stipulations (All stipulations are considered part of the proposed action and all alternatives.):

- ***No. 1, Protection of Biological Resources***
- ***No. 2, Orientation Program***
- ***No. 3, Transportation of Hydrocarbons***
- ***No. 4, Industry Site-Specific Bowhead Whale-Monitoring Program***
- ***No 5, Subsistence Whaling and Other Subsistence Activities***

No.1, Protection of Biological Resources:

If biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

No 2, Orientation Program:

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.33 and 250.34 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas.

No. 3, Transportation of Hydrocarbons:

This measure requires the use of pipelines: (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.

No. 4, Industry Site-Specific Bowhead Whale-Monitoring Program:

This stipulation mandates that lessees conduct a site-specific monitoring program during exploratory drilling activities, including seismic 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 stipulation requires a peer review of monitoring plans and the resulting draft reports. The monitoring plan must include provisions for recording and reporting information on sightings of other marine mammals and must provide an opportunity for an AEWC or NSB representative to participate in the monitoring program. No monitoring program will be required if the RS/FO, in consultation with the NSB and the AEWC, determines that a monitoring program is not necessary based on the size, timing, duration, and scope of the proposed operations.

This stipulation was rewritten in response to concerns raised during the comment and public hearings process. The stipulation ensures participation by the NSB, the AEWC, and the State of Alaska in the design and review of proposed bowhead whale-monitoring plans, and to ensure the establishment of an independent peer review of the monitoring plans and draft reports.

No. 5, Subsistence Whaling and Other Subsistence Activities:

This stipulation mandates that all exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities, particularly the subsistence bowhead whale hunt. It also provides a mechanism to address unresolved conflicts between the oil and gas industry and subsistence activities.

This stipulation was rewritten in response to concerns raised during the comment and public hearings process. The State of Alaska specifically stated that the addition of a conflict-resolution mechanism in this stipulation would result in the stipulation being a more effective alternative to seasonal drilling requirements if it identified a means for resolving conflicts. The stipulation as it is rewritten provides for a conflict-resolution mechanism.

(2) Information to Lessees (ITL's) (No's. 1 through 19 apply to OCS activities in the Beaufort sea area and are considered part of the proposed action and alternatives.):

- ***No. 1, Information on Community Participation in Operations Planning***
- ***No. 2, Information on Kaktovikmiut Guide-"In this Place"***
- ***No. 3, Information on the Arctic Biological Task Force***
- ***No. 4, Information on Bird and Marine Mammal Protection***
- ***No. 5, Information to Lessees on River Deltas***
- ***No. 6, Information on Endangered Whales and the MMS Monitoring Program***
- ***No. 7, The Availability of Bowhead Whales for Subsistence-Hunting Activities***
- ***No. 8, Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System***

- ☐☐ *No. 9, Information on High Resolution Geological and Geophysical Survey Activity*
- ☐☐ *No. 10, Information on Polar Bear Interaction*
- ☐☐ *No. 11, Information on Spectacled Eider and Steller's Eider*
- ☐☐ *No. 12, Information on Sensitive Areas to be Considered in the Oil-Spill Contingency Plans*
- ☐☐ *No. 13, Information on Oil-Spill-Cleanup Capability*
- ☐☐ *No. 14, Oil-Spill-Response Preparedness*
- ☐☐ *No. 15, Information on the Oil Pollution Act of 1990*
- ☐☐ *No. 16, Information on Coastal Zone Management*
- ☐☐ *No. 17, Information on Navigational Safety*
- ☐☐ *No. 18, Information on Offshore Pipelines*
- ☐☐ *No. 19, Information on Affirmative Action Requirements*
- ☐☐ *No. 20, Information on Nuiqsutmiut Paper*

No. 1. Information on Community Participation in Operations Planning:

Lessees are encouraged to bring one or more residents of communities in the area of operations into their planning process. Local communities often have the best understanding of how oil and gas activities can be safely conducted in and around their area without harming the environment or interfering with community activities. Community representation on management teams that develop plans of operation and oil spill contingency plans that involve local community residents in the earliest stages of the planning process for proposed oil and gas activities can be beneficial to the industry.

ITL No. 2 was added in response to concerns raised during the comment and public-hearings process.

No. 2. Information on Kaktovikmiut Guide "In This Place":

The people of Kaktovik, the Kaktovikmiut, have compiled "A Guide for Those Wishing to Work in The Country of the Kaktovikmiut." The guide's intent, in part, is to provide information that may promote a better understanding of their concerns. Lessees are encouraged to obtain copies of the guide and to incorporate it into their Orientation Program to assist in fostering sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which they will be operating.

This ITL was added in response to concerns raised during the comment and public-hearings process.

No. 3. Information on the Arctic Biological Task Force:

This ITL advises lessees that in the enforcement of the Protection of Biological Resources stipulation, the RS/FO will consider recommendations from the Arctic Biological Task Force (BTF) composed of designated representatives of the MMS, FWS, National Marine Fisheries Service (NMFS), and the U.S. Environmental Protection Agency (USEPA).

No. 4. Information on Bird and Marine Mammal Protection:

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

No. 5. Information on River Deltas:

Lessees are advised that certain river deltas of the Beaufort Sea coastal plain (such as the Kongakut, Canning, and Colville) have been identified by the FWS as special habitats for bird-nesting and fish-overwintering areas, as well as other forms of wildlife. Shore-based facilities in these river deltas may be prohibited by the permitting agency.

No. 6. Information on Endangered Whales and MMS Monitoring Program:

This ITL advises lessees that the MMS intends to continue its areawide endangered whale-monitoring program in the Beaufort Sea during exploration activities. The program will gather information on whale distribution and abundance patterns and will provide additional assistance to determine the extent, if any, of adverse effects to the species.

No. 7. The Availability of Bowhead Whales for Subsistence Hunting Activities:

Lessees are advised that the NMFS issued regulations for incidental take of marine mammals, including bowhead whales. Incidental-take regulations are promulgated only upon request, and the NMFS must be in receipt of a petition prior to initiating the regulatory process. Incidental takes of bowhead whales are allowed only if a Letter of Authorization (LOA) is obtained from the NMFS pursuant to the regulations in effect at the time. A LOA must be requested annually. In issuing a LOA, the NMFS must determine that proposed activities will not have an unmitigable adverse effect on the availability of the bowhead whale to meet subsistence needs by causing whales to abandon or avoid hunting areas, directly displacing subsistence users, or placing physical barriers between whales and subsistence users.

No. 8. Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System:

Lessees are advised that MMS and NMFS will review exploration plans to ascertain if endangered species consultation will be required for activities planned during the spring (April 15-June 15). The MMS has been advised by the NMFS that, based on currently available information and technology, NMFS believes that development and production activities in the spring-lead systems used by bowhead whales in the western part of the lease-sale area along the Chukchi Sea coast and extending to the northeast of Point Barrow would likely jeopardize the continued existence of the bowhead whale population.

No. 9. Information on Geological and Geophysical Survey Activity:

Lessees are advised of the potential effect of geological and geophysical (G&G) activity to bowhead whales and subsistence hunting activities. The MMS may impose restrictions (including the timing of operations relative to open water) and other requirements (such as having a locally approved coordinator on board) on G&G surveys to minimize unreasonable conflicts between the G&G survey and subsistence whaling activities. Lessees will coordinate any proposed G&G activity with potentially affected subsistence communities, the NSB, and the AEWC to identify potential conflicts and develop plans to avoid these conflicts.

This ITL was added in response to concerns raised during the comment and public-hearings process.

No. 10. Polar Bear Interaction:

Lessees are advised that polar bears may be present in the area of operations, particularly during the solid-ice period. Lessees should conduct their activities in a manner that will limit potential encounters and interaction between lease operations and polar bears.

No. 11. Information on Spectacled Eider and Steller's Eider:

Lessees are advised that the spectacled eider (*Somateria fischeri*) is newly listed as threatened by the FWS and is protected by the ESA of 1973, as amended, 16 U.S.C. 1531 et seq. Lessees are further advised that the Steller's eider (*Polysticta stelleri*) is being considered by the FWS for listing as an endangered species under the ESA.

No. 12. Information on Sensitive Areas To Be Considered in the Oil-Spill Contingency Plans (OSCP's):

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, or other biological resources or cultural resources and should be considered when developing OSCP's.

No. 13. Information on Oil-Spill-Cleanup Capability:

Exploratory drilling, testing, and other downhole activities may be prohibited in broken-ice conditions unless the lessee demonstrates to the RS/FO the capability to detect, contain, clean up, and dispose of spilled oil in broken ice

No. 14. Oil-Spill-Response Preparedness:

Lessees are advised that they must be prepared to respond to oil spills which could occur as a result of offshore oil and gas exploration and development activities. With or prior to submitting a plan of exploration or a development and production plan, the lessee will submit for approval an oil-spill-contingency plan in accordance with 30 CFR 250.42.

No. 15. Information on the Oil Pollution Act of 1990 (33 U.S.C. 2701 et seq.):

Lessees are advised that Section 1016(c)(1) of the Oil Pollution Act (OPA) of 1990 (33 U.S.C. 2716(c)(1)) requires that lessees establish and maintain evidence of financial responsibility of $150,000,000 for offshore facilities. This provision supersedes the $35,000,000 requirement under Title III of the OCS Lands Act, as amended (43 U.S.C. 1814). The authority to administer this provision has been transferred from the U.S. Coast Guard (USCG) to the MMS.

No. 16. Information on Coastal Zone Management:

Lessees are advised that the State of Alaska will review OCS plans through the review process for consistency with the Alaska Coastal Management Program. Oil-spill-contingency plans will be reviewed for compliance with State standards, the use of best available and safest technologies, and with State and regional contingency plans on a case-by-case basis.

This ITL supercedes and replaces the previous ITL on Coastal Zone Management and the ITL on State Review of Exploration Plans and Associated Oil-Spill Contingency Plans that appeared in the DEIS. The wording suggested by the State of Alaska for the Coastal Zone Management ITL was adopted, effectively addressing the points previously addressed in the two separate ITL's.

No. 17. Information on Navigational Safety:

Operations on some of the blocks offered for lease may be restricted by designation of fairways, precautionary zones, anchorages, safety zones, or traffic-separation schemes established by the USCG pursuant to the Ports and Waterways Safety Act (33 U.S.C. 1221 et seq.), as amended.

No. 18. Information on Offshore Pipelines:

This ITL advises lessees that the Department of the Interior and the Department of Transportation have entered into a Memorandum of Understanding, dated May 6, 1976, concerning the design, installation, operation, and maintenance of offshore pipelines. Bidders should consult both departments for regulations applicable to offshore pipelines

No. 19. Information on Affirmative Action Requirements:

Revision of Department of Labor regulations on affirmative action requirements for Government contractors (including lessees) has been deferred, pending review of those regulations (see *Federal Register* of August 25, 1981, at 46 *FR* 42865 and 42968).

No. 20. Information on Nuiqsutmiut Paper:

The people of Nuiqsut, the Nuiqsutmiut, have compiled a paper that provides information that may promote a better understanding of their concerns. Lessees are encouraged to obtain copies of the paper and to incorporate it into their Orientation Program to assist in fostering sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which they will be operating.

This ITL was added in response to concerns raised during the comment and public-hearings process.

b. *Mitigating Measures Not Considered in this EIS:*

Seasonal Drilling Restriction: The NSB and State of Alaska are recommending that industrial activities, including drilling, seismic operations, and tug and icebreaker operations, be prohibited during the spring migration of bowhead whales to protect the traditional whale migratory and feeding areas and subsistence-hunting areas. There also is concern that industrial activities may have detrimental effects on other species.

The seasonal drilling restriction was originally proposed in early (1979-1984) OCS oil and gas lease sales in the Beaufort Sea to protect the endangered bowhead whales from the risk of an oil spill. The stipulation was written in response to an earlier jeopardy opinion by the NMFS. In their Arctic Region Biological Opinion (November 23, 1988), NMFS found that exploratory-drilling activities would not jepardize the continued existence of the bowhead whales. However, consultation will be reinitiated with NMFS in the event oil is discovered and development and production activities are proposed.

Waivers on seasonal drilling restictions imposed on leases issued as a result of oil and gas lease sales held previous to 1985 have been granted. The granting of these waivers was based on the operator (1) conducting site-specific monitoring of the reactions of bowhead whales to drilling noises and (2) cooperating with whalers in an effort to eliminate industry and whaling conflicts. For the two sales held since 1985 (Sale 97 and Sale 124), the Subsistence Whaling and Other Subsistence Activities stipulation, the Industry Site-specific Bowhead Whale Monitoring Program stipulation, and the ITL's on Availability of Bowhead Whales for Subsistence Hunting Activities and Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System, have been used to mitigate any potential effects to the bowhead whale and to provide for the prevention of unreasonable conflicts with subsistence harvests. The Subsistence Whaling and Other Subsistence Activities stipulation provides for implementing a seasonal drilling restriction, if the RS/FO, in consultation with other agencies and the public, determines that such a restriction is necessary to prevent unreasonable conflicts. The ITL on Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System provides for additional review by MMS and NMFS for exploration plans for activities planned during the spring (April 15-June 15). This ITL also advises lessees that additional mitigating measures may be developed as new information or technology is developed. The ITL on Availability of Bowhead Whales for Subsistence Hunting Activities further illustrates the intent to impose additional restrictions or requirements if necessary. This ITL states that MMS may limit or require operations be modified if they could result in significant effect on the availability of the bowhead whale for subsistene use. It also commits to establishing, with NMFS, procedures to coordinate results for site-specific surveys to determine if further modificationa to lease operations are necessary.

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

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

Environmental concerns generally were identified during the scoping process and in response to comments on the draft EIS for Sale 144. The potential effects of Sale 144 on the issues raised by these concerns are addressed in those sections that analyze the effects of the sale on the Economy, Subsistence-Harvest Patterns, and Sociocultural Systems and marine mammals—Sections II and IV, respectively.

G. SIGNIFICANT DIFFERENCES BETWEEN THE DRAFT EIS AND THE FINAL EIS:

The following summarizes some of the more significant changes that have been made in the FEIS as a result of the public review of the DEIS. These changes include one additional alternative (Alternative IV, the Nuiqsut Deferral), the rewrite of two stipulations, the addition of four new ITL's, the deletion of one ITL, and significant text revisions. The Nuiqsut Deferral and the reasons for its addition have been discussed in Section I.A.2.a.(4). The two stipulations that were rewritten are No. 4, Industry Site-Specific Bowhead Whale-Monitoring Program, and No. 5, Subsistence Whaling and Other Subsistence Activities. These stipulations were rewritten to (1) ensure greater participation by the North Slope in the design and review of proposed bowhead whale-monitoring plans, (2) ensure the establishment of an independent peer review of the monitoring plan, and (3) provide for a conflict resolution mechanism.

The ITL's added were:

ITL No. 1, Information on Community Participation in Operations Planning: This ITL's purpose is to encourage lessees to bring residents on the North Slope communities into the planning process.

ITL No. 2, Information on Kaktovikmiut Guide "In This Place": Lessees are encouraged to obtain this guide and to incorporate it into Orientation Programs to assist in fostering understanding and sensitivity to community values.

ITL No. 9, Information on Geological and Geophysical Survey Activity: This ITL advises of the potential effects of seismic surveys and reminds lessees of the specifics of the bowhead whale-monitoring program.

No. 20. Information on Nuiqsutmiut Paper: Lessees are encouraged to obtain this guide and to incorporate it into Orientation Programs to assist in fostering understanding and sensitivity to community values.

The ITL deleted was:

Information on the State Review of Exploration Plans and Associated Oil-Spill-Contingency Plans: This ITL, included in the DEIS, is redundant with current Coastal Zone Management regulations and the provisions of ITL No. 16 and thus was deleted.

Significant text revisions focused on major issues dealing with marine mammals, subsistence, and the bowhead whale. These sections incorporated new information on the effect of noise (particularly on the bowhead whale) as well as sources of "traditional knowledge." Where comments warranted other changes or presented new or additional information, revisions were made to the appropriate text in the EIS.

SECTION II

ALTERNATIVES INCLUDING THE PROPOSED ACTION

II. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

A. ALTERNATIVE I - THE PROPOSAL:

Alternative I, the proposed action, would offer 1,879 whole and partial blocks (about 4 million hectares [ha]) (9.8 million acres) of the Beaufort Sea for leasing. This area is located offshore the area extending from the Canadian border to the vicinity of Point Barrow (at 156° W. long.) (Fig. II.A-1).

For Alternative I, three hypothetical scenarios were developed to assess the potential environmental effects of the sale. These three scenarios, a low case, a base case, and a high case, each represent an estimated range of potential resources (oil and gas) and resource values derived from available geologic and economic information. The scenario for the base case of Alternative I is discussed below. The analyses of effects of the base case are discussed in detail in Section IV.B.

The scenarios for the low and high cases are discussed below, and the analyses of effects generated by the low and high cases are discussed in detail in Sections IV.F and IV.G, respectively.

1. The Base Case: For the base case of Alternative I, the range of potential resources varies from 300 million barrels (MMbbl) of oil produced over the anticipated >22-year life of the field to 2.1 billion barrels (Bbbl) produced during the same period (Appendix A, Table A-2). This resource range is based on an assumed value of $22.50 per barrel for produced crude oil. The oil-field-development scenario for the base case of the proposed action is based on this same value for a barrel of oil. Appendix A, Table A-2, shows the infra- structure and the developmental timeframes proposed for the base case. The Section IV analyses of the effects of the base case of the proposal use a resource number that is comparable to a midpoint between the base-case-low (the lower end of the potential resource range for the base case) and base-case-high resource estimates (the highest end of the potential resource range for the base case).

Under the base case, exploratory-drilling activities would be expected to occur between 1997 and 2003 (Appendix A, Table A-2). During this period, it is estimated that 4 to 11 exploration wells and 2 to 21 delineation wells will be drilled. The type of units that may be used in exploration drilling would depend on water depth, sea-ice conditions, ice-resistant capabilities of the units, and availability of drilling units. Artificial-ice islands are likely to be employed as drilling platforms in shallow-water, nearshore areas (<15 meters [m]) (<50 feet [ft]). Construction and resupply operations for ice-island drilling platforms would be supported by ice roads. Bottom-founded platforms of various designs are most likely to be used to drill prospects farther offshore in water depths of 10 to 25 m (35-80 ft); and because of mobile ice conditions, these operations would be supported by supply boats during the open-water season. For water depths >25 m (>80 ft), floating drill rigs (drillships or floating concrete platforms) would be employed to drill exploration wells in open-water or broken-ice conditions. These far-offshore operations would be supported by icebreaker-support/ supply ships, with support and supply operations issuing from existing Prudhoe Bay/Kuparuk infrastructure.

Activities associated with development and production would begin in 2001 with the installation of a production platform (Appendix A, Table A-2); 2 to 11 platforms would be installed during a 2- to 6-year period between 2001 and 2006. The estimated level of activities associated with crude oil production is based on this range; the low end of the activity range under the base case is associated with the 300-MMbbl estimate and the high end with the 2.1-Bbbl estimate. Between 2001 and 2006, an estimated 54 to 396 production and service wells would be drilled using 4 to 12 drilling rigs. Crude oil production is expected to begin in 2003-2004 and continue from 2023 through 2025; the production life of the Sale 144 field is expected to be ≥22 years. Peak production is estimated to occur between 2004 and 2009 and range broadly between 25 and 176 MMbbl yearly.

Depending in part on site and environmental conditions, the size and shape of the field, and the oil reserves, the types of production platforms that may be used in the Sale 144 area include—among others—production islands; bottom-founded concrete structures; and deep-water, floating production systems with fixed subsea wells. Produced crude oil would be transported via pipeline to intermix with either the onshore Prudhoe Bay and/or Kuparuk pipeline systems. Produced crude would be transported to Valdez via the Trans-Alaska Pipeline System (TAPS) and then to the west coast of the U.S. and the Far East via tanker. A more detailed discussion of the transportation scenario for Alternative III is contained in Section IV.A.1.

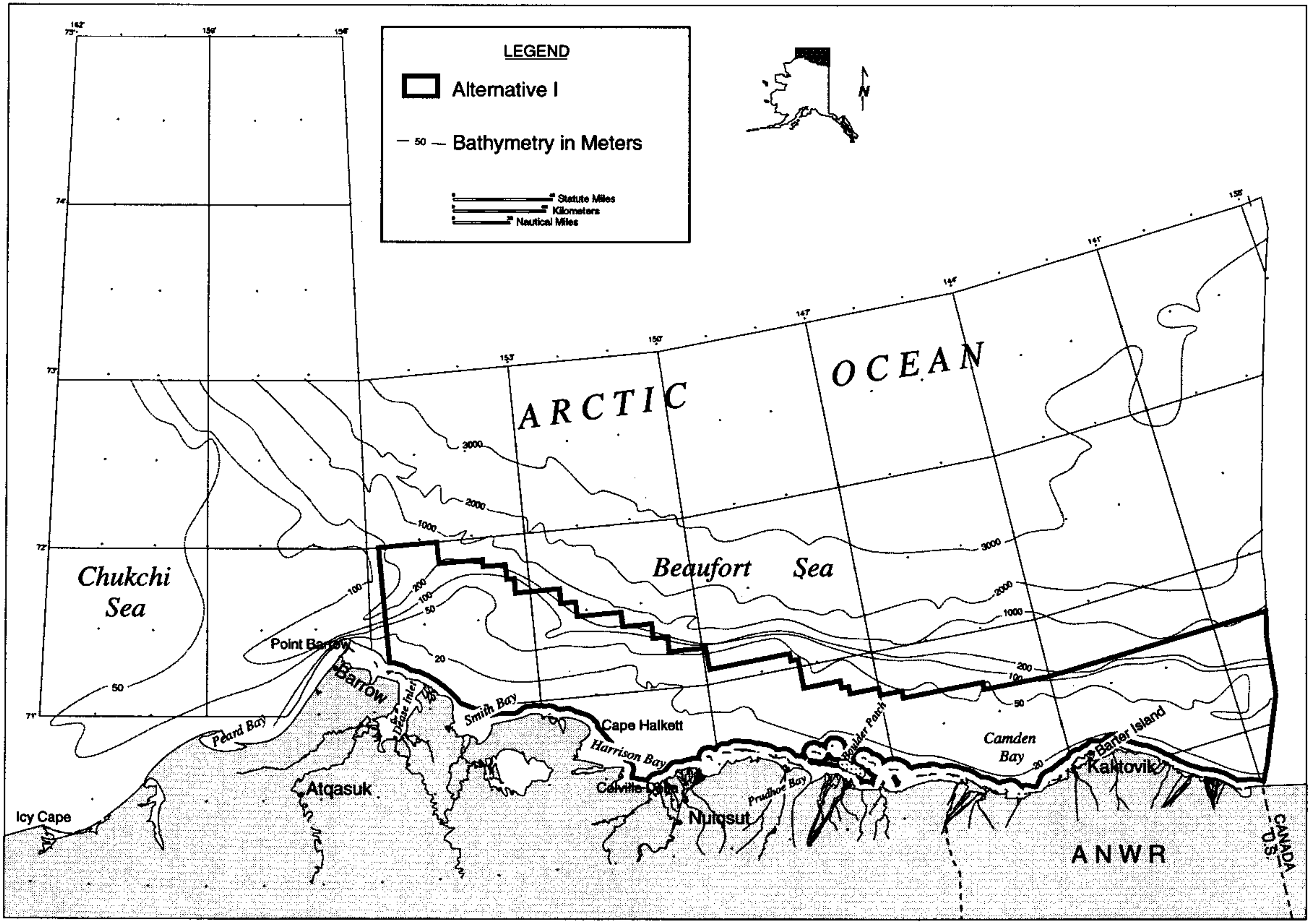


Figure II.A.-1. Alternative I - The Proposal

2. ***The Low Case:*** The low case of resource (oil and gas) possibilities analyzed for the proposed alternative features resource estimates that could range up to 130 MMbbl. Economic analysis indicates that resource estimates at that level are not commercially viable for production within the Beaufort Sea Outer Continental Shelf (OCS) region. Thus, activities associated with this alternative are considered to be exploration-only. Exploratory drilling should begin by 1997 and cease by 2001 with four wells drilled by a single rig. All support functions would issue from Prudhoe Bay facilities (see Appendix A, Table A-1).

3. ***The High Case:*** For the high case of Alternative I, the range of resources produced varies from a low of 2.8 to a high of 5.0 Bbbl. Under the high case, the life of the field is estimated to be ≥27 years (Appendix A, Table A-3). The value per barrel of oil assigned to these resources is $29.10. The oil-field-development scenario and related infrastructure necessary to develop the high case of the proposed action are based on this assumed value per barrel of oil. Appendix A, Table A-3, shows the infrastructure and the developmental timeframes proposed for the high case. The analyses of the effects of the high case of the proposed action are based on a resource midpoint between the high-case-low (the lower end of the potential resource range for the high case) and the high-case-high resource estimates (the highest end of the potential resource range for the high case).

Exploratory-drilling activities are expected to occur between 1997 and 2010 (Appendix A, Table A-3). During this period, 19 to 28 exploration wells and 35 to 48 delineation wells are estimated to be drilled. The type of units that may be used in exploration drilling will depend on water depth, sea-ice conditions, ice-resistant capabilities of the units, and availability of drilling units. Artificial-ice islands are likely to be employed as drilling platforms in shallow-water, nearshore areas (<15 m [<50 ft]). Construction and resupply operations for ice-island drilling platforms would be supported by ice roads. Bottom-founded platforms of various designs are most likely to be used to drill prospects farther offshore in water depths of 10 to 25 m (35-80 ft); and because of mobile ice conditions, these operations would be supported by supply boats during the open-water season. For water depths >25 m (>80 ft), floating drill rigs (drillships or floating concrete platforms) would be employed to drill exploration wells in open-water or broken-ice conditions. These far-offshore operations would be supported by icebreaker support/supply ships, with support and supply operations issuing from existing Prudhoe Bay/Kuparuk infrastructure.

Activities associated with development and production would begin in 2001 with the installation of a production platform (Appendix A, Table A-3); 19 to 28 platforms would be installed during a 7- to 11-year period between 2001 and 2011. The estimated level of activities under the high case of the proposed action associated with crude oil production is based on this range; the low end of the activity range is associated with the 2.8-Bbbl estimate and the high end with the 5.0-Bbbl estimate. Between 2001 and 2014, an estimated 668 to 991 production and service wells would be drilled. Crude-oil production is expected to begin in 2004 and continue through 2031; the production life of the Sale 144 field is expected to be at least 27 years. Peak production is estimated to occur between 2008 and 2012, and is expected to range from a yearly rate of 235 to 378 MMbbl.

Depending in part on site and environmental conditions, the size and shape of the field, and the oil reserves, the types of production platforms that may be used in the Sale 144 area, under a high-case assumption, include—among others—production islands; bottom-founded concrete structures; and deep-water, floating production systems with fixed subsea wells. Produced crude oil would be transported via pipeline to intermix with either the onshore Prudhoe Bay and/or Kuparuk pipeline systems.

B. ALTERNATIVE II - NO LEASE SALE: This alternative would be tantamount to cancellation of Sale 144. As a result of such a cancellation, the oil estimated to be produced under Alternative I would be neither discovered nor developed. Should the sale not be held, the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources.

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

- Oil-supply substitutes
  - Domestic onshore oil production
  - Imported oil

- Fuel substitutes in the transportation sector

- ☐ Imported methanol
- ☐ Gasohol
- ☐ Compressed natural gas
- ☐ Electric cars

☐☐ Conservation

- ☐ In the transportation sector
- ☐ Reduced consumption of plastics

In the case of the no-lease-sale alternative, substitute energy flows probably would be provided by a mix of the substitutes listed above. The mix would depend on economic and regulatory factors as well as the short-run availability of the capacity to produce and transport sufficient quantities of the various substitutes. Appendix C provides a detailed discussion of substitute energy sources if leasing were not to occur in the Beaufort Sea Planning Area.

C. ALTERNATIVE III - BARTER ISLAND DEFERRAL: This alternative would result in the offering of 1,440 blocks or 3.06 million ha (7.56 million acres)—approximately 77 percent of the proposal (Fig. II.C-1). This alternative was drafted to delete blocks from the Canadian border to the area in and around Barter Island. The area that would be deferred under Alternative III includes blocks used for subsistence activities by the residents of the community of Kaktovik. This alternative would ensure that no exploration and development drilling would occur in the deferred blocks, which encompass a key whale-feeding area; the potential for oil spills or use conflicts originating from the unoffered portion of the planning area would be reduced accordingly. Deferring this area was supported by the Fish and Wildlife Service (FWS) and Native groups during the scoping process for Sale 144.

Resources forecast for this alternative do not differ substantially from those of the base case of Alternative I. The resources range from roughly 270 MMbbl to about 1.89 Bbbl—approximately 10 percent less than estimated for the base case of the proposal. Again, this production range is based on oil selling for $22.50 a barrel. The general exploration and development and production profile of this alternative is almost exactly that of the base case of Alternative I. Appendix A, Table A-7, contains the specific development and production profiles for Alternative III.

Alternative III activities would be supported from marine and air facilities located in and around Prudhoe Bay/ Kuparuk. Produced crude would be transported to Valdez via the Trans-Alaska Pipeline System (TAPS) and thence to the west coast of the U.S. and the Far East via tanker. A more detailed discussion of the transportation scenario for Alternative III is contained in Section IV.A.1.

D. ALTERNATIVE IV - NUIQSUT DEFERRAL: Alternative IV would defer 243 blocks out of the 1,879 offered by Alternative I and 559,872 hectares out of 4 million (1.5 million acres out of 9.8) (Fig. II.D-1). The deferred area comprises about 14 percent of the area offered by Alternative I. The resource levels forecast for this alternative range from 180 Mbbl to 1.26 MMbbl, approximately 40 percent less than the proposed action. Similarly, infrastructure, i.e., numbers of exploration and delineation wells as well as production platforms, also would be decreased by approximately 40 percent. Oil-field-support activities for this alternative would be in the same pattern as those for Alternative I—activities also would be supported from marine and air facilities located in and around Prudhoe Bay/Kuparuk. Produced crude would be transported to Valdez via the Trans-Alaska Pipeline System (TAPS) and then to either the west coast of the U.S. or the Far East via tanker. Please see Section IV.A.1 for a further discussion of this alternative's transportation scenario and Section IV.D for a further analysis of infrastructure differences between this alternative and the Proposal.

The area proposed for deferral encompasses Cross Island—a location viewed by the community of Nuiqsut and the Inupiat Whaling Commission as Nuiqsut's primary harvest area for the bowhead whale and other marine mammals. The blocks offered in the Nuiqsut Deferral Alternative have been offered in other OCS lease sales and lie immediately offshore of active State and Federal leases, including the Northstar Unit.

E. MITIGATING MEASURES THAT ARE PART OF THE PROPOSED ACTION AND THE ALTERNATIVES: Laws and regulations that provide mitigation are considered

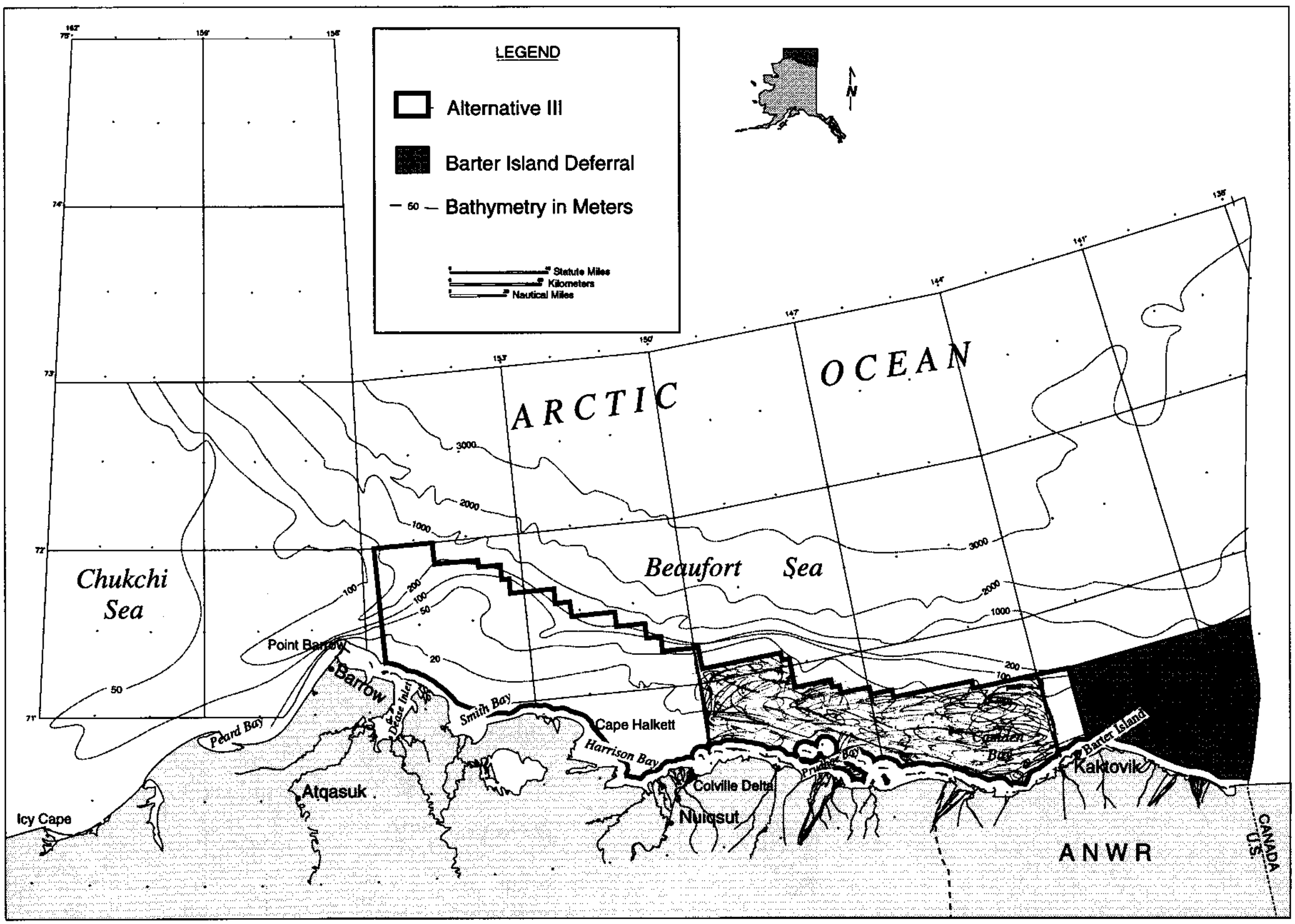


Figure II.C-1. Alternative III - Barter Island Deferral

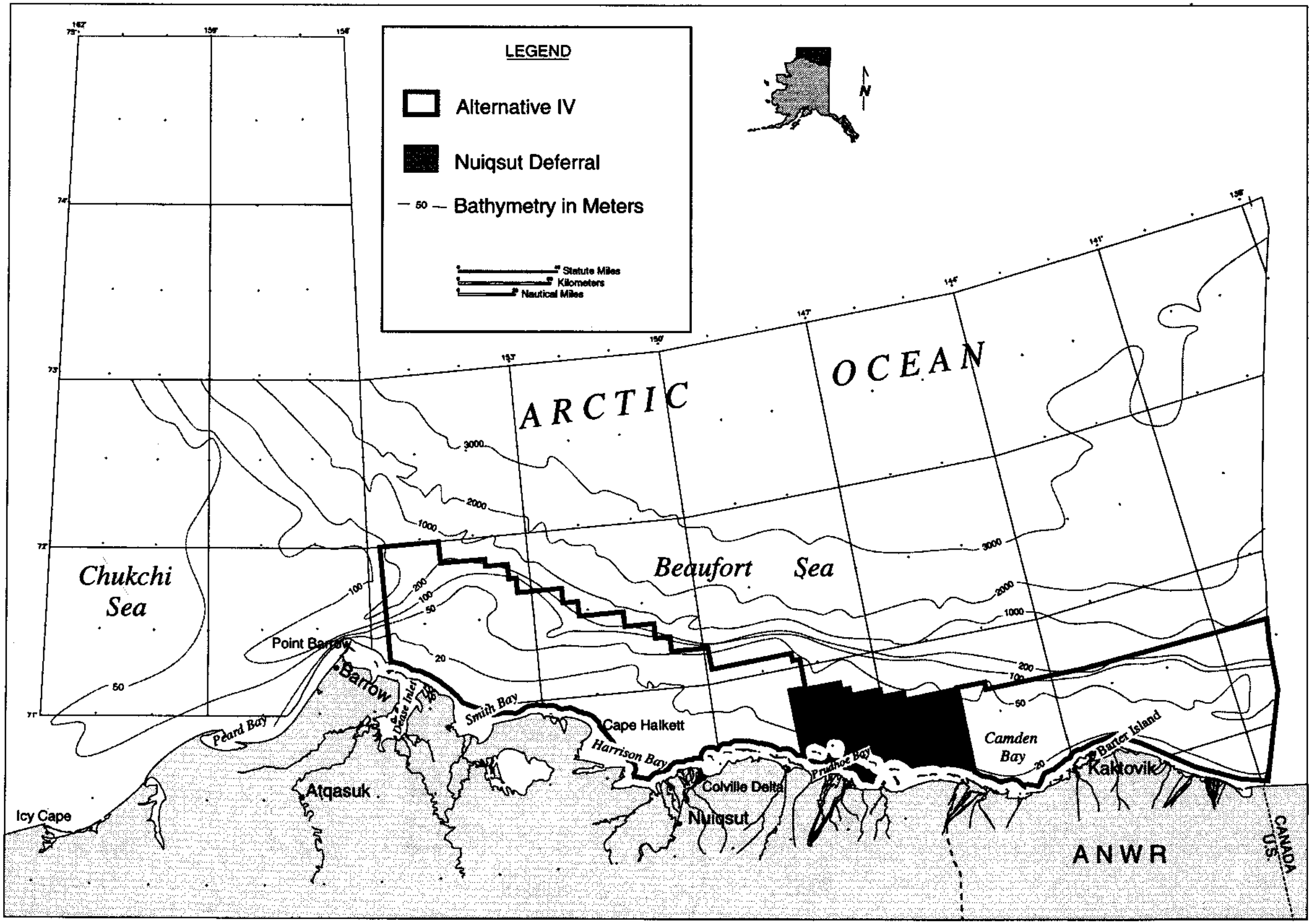


Figure II.D-1. Alternative IV - Nuiqsut Deferral part of the proposal. Examples include the Outer Continental Shelf Lands Act (OCSLA), which grants broad authority to the Secretary of the Interior to control lease operations and, where appropriate, undertake environmental monitoring studies (see Appendix D); the Consolidated Offshore Operating Regulations (which rescinded and replaced Alaska OCS Orders effective May 31, 1988); and the Fishermen's Contingency Fund. Incorporated by reference in Section I.C is OCS Report MMS 86-003, *Legal Mandates and Federal Regulatory Responsibilities* (Rathbun, 1986). This report details the laws and regulations under which the MMS OCS leasing program operates; the report also outlines permit requirements, engineering criteria, testing procedures, and information requirements. These requirements are developed and administered by the MMS. The mitigating effect of these measures has been factored into the environmental effects analyses.

In addition, the following mitigating measures (Stipulations and Information to Lessees [ITL] Clauses) also are considered as part of the proposed action and alternatives. Accordingly, the mitigating effects of these measures also have been factored into the environmental effects analyses (Sec. IV). The Section IV.B environmental effects analyses contains a discussion of the effectiveness of the mitigating measures described in this section where germane to a given resource topic.

1. Stipulations (All stipulations are considered part of the proposed action and alternatives.):

□□ ***No. 1, Protection of Biological Resources***
□□ ***No. 2, Orientation Program***
□□ ***No. 3, Transportation of Hydrocarbons***
□□ ***No. 4, Industry Site Specific Bowhead Whale-Monitoring Program***
□□ ***No. 5, Subsistence Whaling and other Subsistence Activities***

No. 1, Protection of Biological Resources

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

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

(1) Relocate the site of operations;
(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or
(4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

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

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions. The RS/FO will utilize the best available information as determined in consultation with the Arctic Biological Task Force.

No. 2, Orientation Program

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

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

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

No. 3, 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 recommendations of any advisory groups and 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.

No. 4, Industry Site-Specific Bowhead Whale-Monitoring Program

Lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration will be required to conduct a site-specific monitoring program approved by the Regional Supervisor, Field Operations (RS/FO); unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determine that a monitoring program is not necessary. The RS/FO will provide the NSB, AEWC, and the State of Alaska (State) a minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. In designing the program, lessees must consider the potential scope and extent of effects that the type of operation could have on bowhead whales. Scientific studies and individual experiences relayed by subsistence hunters indicate that, depending on the type of operations, individual whales may demonstrate avoidance behavior at distances of up to 24 km.

The program must also provide for the following:

(1) Recording and reporting information on sighting of other marine mammals and the extent of behavioral effects due to operations;

(2) Inviting an AEWC or NSB representative to participate in the monitoring program as an observer;

(3) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project (BWASP),

(4) Submitting daily monitoring results to the MMS BWASP;

(5) Submitting a draft report on the results of the monitoring program to the RS/FO within 60 days following the completion of the operation. The RS/FO will distribute this draft report to the AEWC, the NSB, the State of Alaska, and the National Marine Fisheries Service (NMFS);

(6) Submitting a final report on the results of the monitoring program to the RS/FO. The final report will include a discussion of the results of the peer review of the draft report. The RS/FO will distribute this report to the AEWC, the NSB, the State of Alaska, and the NMFS.

Lessees will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the NSB, the AEWC, industry, NMFS, and MMS. The results of these peer reviews will be provided to the RS/FO for consideration in final approval of the monitoring program and the final report, with copies to the NSB, AEWC, and the State.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from the NMFS, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. Lessees must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NMFS and advise the lessee if the LOA or IHA will meet these requirements.

This stipulation applies to the following blocks for the time periods listed and will remain in effect until termination or modification by the Department of the Interior, after consultation with the NMFS and the NSB: (Official Protraction Diagram [OPD])

SPRING MIGRATION AREA
April 1 through June 15

OPD	Blocks Included
NR 05-01, Dease Inlet	6004 - 6011, 6054 - 6061, 6104 - 6111, 6154 - 6167, 6204 - 6220, 6254 - 6270, 6304 - 6321, 6354 - 6371, 6404 - 6423, 6454 - 6473, 6504 - 6523, 6554 - 6573, 6604 - 6623, 6654 - 6673, 6717 - 6723
NR 05-02, Harrison Bay North	6401 - 6404, 6451 - 6454, 6501 - 6506, 6551 - 6556, 6601 - 6612, 6651 - 6662, 6701 - 6716

CENTRAL FALL MIGRATION AREA
September 1 through October 31

OPD	Blocks Included
NR 05-01, Dease Inlet	6704 - 6716, 6754 - 6773, 6804 - 6823, 6856 - 6873, 6908 - 6923, 6960 - 6973, 7011 - 7023, 7062 - 7073, 7112 - 7123
NR 05-03, Teshekpuk	6015 - 6024, 6067 - 6072
NR 05-02, Harrison Bay North	6751 - 6766, 6801 - 6818, 6851 - 6868, 6901 - 6923, 6951 - 6973, 7001 - 7023, 7051 - 7073, 7101 - 7123
NR 05-04, Harrison Bay	6001 - 6023, 6052 - 6073, 6105 - 6123, 6157 - 6173, 6208 - 6223, 6258 - 6274, 6309 - 6324, 6360 - 6374, 6360 - 6374, 6410 - 6424, 6461 - 6471, 6512 - 6519, 6562 - 6566, 6613 - 6614
NR 06-01, Beechey Point North	6901, 6951, 7001, 7051 - 7062, 7101 - 7113
NR 06-03, Beechey Point	6002 - 6014, 6052 - 6064, 6102 - 6114, 6152 - 6169, 6202 - 6220, 6251 - 6274, 6301 - 6324, 6351 - 6374, 6401 - 6424, 6456 - 6474, 6509 - 6524, 6568 - 6574, 6618 - 6624, 6671 - 6674, 6723 - 6724, 6773
NR 06-04, Flaxman Island	6301 - 6303, 6351 - 6359, 6401 - 6409, 6451 - 6459, 6501 - 6509, 6551 - 6559, 6601 - 6609, 6651 - 6659, 6701 - 6709, 6751 - 6759, 6802 - 6809, 6856 - 6859

EASTERN FALL MIGRATION
August 1 through October 31

OPD	Blocks Included
NR 06-04, Flaxman Island	6360 - 6364, 6410 - 6424, 6460 - 6474, 6510 - 6524, 6560 - 6574, 6610 - 6624, 6660 - 6674, 6710 - 6724, 6760 - 6774, 6810 - 6824, 6860 - 6874, 6910 - 6924, 6961 - 6974, 7013 - 7022, 7066 - 7070, 7118 - 7119
NR 07-03, Barter Island	6401 - 6424, 6451 - 6474, 6501 - 6524, 6551 - 6574, 6601 - 6624, 6651 - 6674, 6701 - 6724, 6751 - 6774, 6801 - 6824, 6851 - 6874, 6901 - 6924, 6958 - 6974, 7010 - 7024, 7061 - 7074, 7113 - 7124
NR 07-04, MacKenzie Canyon North	6401 - 6408, 6451 - 6458, 6501 - 6507, 6551 - 6557, 6601 - 6607, 6651 - 6657, 6701 - 6707, 6751 - 6757, 6801 - 6806, 6851 - 6856, 6901 - 6906, 6951 - 6956, 7001 - 7006, 7051 - 7055, 7101 - 7105
NR 07-05, Demarcation Point	6016 - 6026, 6067 - 6076, 6118 - 6126, 6169 - 6176, 6221- 6226, 6273 - 6276, 6323 - 6326
NR 07-06, Mackenzie Canyon	6001 - 6004, 6051 - 6054, 6101 - 6103, 6151 - 6153, 6201 - 6203, 6251 - 6252, 6301 - 6302, 6351

No. 5, Subsistence Whaling and Other Subsistence Activities

Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting).

Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to the MMS for activities proposed during the bowhead whale migration period, the lessee shall consult with the potentially affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan. In particular, the lessee shall show in the plan how activities will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Lessees shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the plan. The RS/FO shall send a copy of the exploration plan or development and production plan (including associated oil-spill contingency plans) to the potentially affected communities, and the AEWC at the time they are submitted to the MMS to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the lessee, the AEWC, the NSB, the National Marine Fisheries Service (NMFS), or any of the subsistence communities that could potentially be affected by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NMFS, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. Upon request, the RS/FO will assemble this group before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO, of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. Lease-related use will be restricted when the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities.

In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts, (for example, timing operations to avoid the bowhead whale subsistence hunt). These efforts might include a seasonal drilling restrictions, seismic and threshold depth restrictions, and requirements for directional drilling and the use of other technologies deemed appropriate by the RS/FO.

Subsistence whaling activities occur generally during the following periods:

August to October: Kaktovik whalers use the area circumscribed from Anderson Point in Camden Bay to a point 30 kilometers north of Barter Island to Humphrey Point east of Barter Island. Nuiqsut whalers use an area extending from a line northward of the Nechelik Channel of the Colville River to Flaxman Island, seaward of the Barrier Islands.

September to October: Barrow hunters use the area circumscribed by a western boundary extending approximately 15 kilometers west of Barrow, a northern boundary 50 kilometers north of Barrow, then southeastward to a point about 50 kilometers off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Cape Halkett.

2. Information to Lessees (No's. 1 through 19 are considered part of the proposed action and alternatives):

- ☐☐ ***No. 1, Information on Community Participation in Operations Planning***
- ☐☐ ***No. 2, Information on Kaktovikmiut Guide-"In this Place"***
- ☐☐ ***No. 3, Information on the Arctic Biological Task Force***
- ☐☐ ***No. 4, Information on Bird and Marine Mammal Protection***
- ☐☐ ***No. 5, Information to Lessees on River Deltas***

- ☐☐ *No. 6, Information on Endangered Whales and the MMS Monitoring Program*
- ☐☐ *No. 7, The Availability of Bowhead Whales for Subsistence-Hunting Activities*
- ☐☐ *No. 8, Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System*
- ☐☐ *No. 9, Information on High Resolution Geological and Geophysical Survey Activity*
- ☐☐ *No. 10, Information on Polar Bear Interaction*
- ☐☐ *No. 11, Information on Spectacled Eider and Steller's Eider*
- ☐☐ *No. 12, Information on Sensitive Areas to be Considered in the Oil-Spill Contingency Plans*
- ☐☐ *No. 13, Information on Oil-Spill-Cleanup Capability*
- ☐☐ *No. 14, Oil-Spill-Response Preparedness*
- ☐☐ *No. 15, Information on the Oil Pollution Act of 1990*
- ☐☐ *No. 16, Information on Coastal Zone Management*
- ☐☐ *No. 17, Information on Navigational Safety*
- ☐☐ *No. 18, Information on Offshore Pipelines*
- ☐☐ *No. 19, Information on Affirmative Action Requirements*
- ☐☐ *No. 20, Information on Nuiqsutmiut Paper*

Information on Community Participation in Operations Planning

Lessees are encouraged to bring one or more residents of communities in the area of operations into their planning process. Local communities often have the best understanding of how oil and gas activities can be safely conducted in and around their area without harming the environment or interfering with community activities. Involving local community residents in the earliest stages of the planning process for proposed oil and gas activities can be beneficial to the industry and the community. Community representation on management teams developing plans of operation, oil spill contingency plans, and other permit applications can help communities understand permitting obligations and the help the industry to understand community values and expectations for oil and gas operations being conducted in and around their area.

Information on Kaktovikmiut Guide - "In This Place"

The people of Kaktovik, the Kaktovikmiut, have compiled "A Guide for Those Wishing to Work in The Country of the Katovikmiut." The guide's intent, in part, is to provide information that may promote a better understanding of their concerns. Lessees are encouraged to obtain copies of the guide and to incorporate it into their Orientation Program to assist in fostering sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which they will be operating.

Information on the Arctic Biological Task Force

Lessees are advised that in the enforcement of the Protection of Biological Resources stipulation, the Regional Supervisor, Field Operations (RS/FO), will consider recommendations from the Arctic Biological Task Force (BTF) composed of designated representatives of the Minerals Management Service, Fish and Wildlife Service, National Marine Fisheries Service, and 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 RS/FO will consult with the Arctic BTF on the conduct of biological surveys by lessees and the appropriate course of action after surveys have been conducted.

Information on Bird and Marine Mammal Protection

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

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

Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA and/or the ESA are met. Section 101(a)(5) of the MMPA (16 U.S.C. 1371(a)(5)) allows for the taking of small numbers of marine mammals incidental to a specified activity within a specified geographical area. Section 7(b)(4) of the ESA (16 U.S.C. 1536(b)(4)) allows for the incidental taking of endangered and threatened species under certain circumstances. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

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

Lessees are advised that specific regulations must be applied for and in place and that a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) must be obtained by those proposing the activity to allow the incidental take of marine mammals whether or not they are endangered or threatened. The regulatory process may require one year or longer.

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

Lessees should exercise particular caution when operating in the vicinity of species whose populations are known or thought to be declining and which are not protected under the ESA; specifically, Steller's eider and Pacific walrus. The FWS issued incidental take regulations for walruses in the Beaufort Sea and adjacent northern coast of Alaska that were in effect for an 18-month period beginning December 16, 1993 (50 CFR 18.121 et seq.). These regulations have been extended until December 15, 1998. Incidental take regulations are promulgated only upon request and the FWS must be in receipt of a petition prior to initiating the regulatory process. Incidental, but not intentional, taking is authorized only by U.S. citizens holding a LOA issued pursuant to these regulations. An LOA or IHA must be requested annually.

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

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

Human safety should take precedence at all times over these recommendations.

Information on River Deltas

Lessees are advised that certain river deltas of the Beaufort Sea coastal plain (such as the Kongakut, Canning, and Colville) have been identified by the U.S. Fish and Wildlife Service as special habitats for bird nesting and fish overwintering areas, as well as other forms of wildlife. Shore based facilities in these river deltas may be prohibited by the permitting agency.

Information on Endangered Whales and MMS Monitoring Program

Lessees are advised that the MMS intends to continue its areawide endangered bowhead whale monitoring program in the Beaufort Sea during exploration activities. The program will gather information on whale distribution patterns which will be used by MMS and others to assess impacts on bowhead whales.

The MMS will perform an environmental review for each proposed exploration plan and development and production plan, including an assessment of cumulative effects of noise on endangered whales. Should the review conclude that activities described in the plan will be a threat of serious, irreparable, or immediate harm to the species, the Regional Supervisor, Field Operations (RS/FO), will require that activities be modified, or otherwise mitigated before such activities would be approved.

Lessees are further advised that the RS/FO has the authority and intends to limit or suspend any operations, including preliminary activities, as defined under 30 CFR 250.31, 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 RS/FO will require the lessee to suspend operations causing such effects, in accordance with 30 CFR 250.10. Any such suspensions may be terminated when the RS/FO determines that circumstances which justified the ordering of suspension no longer exist. Notice to Lessees No. 86-2 specifies performance standards for preliminary activities.

Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA and/or the ESA are met. Section 101(a)(5) of the MMPA (16 U.S.C. 1371(a)(5)) allows for the taking of small numbers of marine mammals incidental to a specified activity within a specified geographical area. Section 7(b)(4) of the ESA (16 U.S.C. 1536(b)(4)) allows for the incidental taking of endangered and threatened species under certain circumstances. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

Information regarding endangered whales will be reviewed periodically by the MMS in consultation with the NMFS, the State of Alaska, the North Slope Borough, and the Alaska Eskimo Whaling Commission. The sources of information include: the MMS monitoring program; the industry site-specific monitoring program; pertinent results of the MMS environmental studies; observations of subsistence hunters utilizing the area and other applicable information. The purpose of the review will be to determine whether existing mitigating measures adequately protect the endangered whales. Should the review indicate the threat of serious, irreparable, or immediate harm to the species, the MMS will take action to protect the species, including the possible imposition of a seasonal drilling restriction, or other restrictions if appropriate.

Information on the Availability of Bowhead Whales for Subsistence Hunting Activities

Lessees are advised that the National Marine Fisheries Service (NMFS) issues regulations for incidental take of marine mammals, including bowhead whales. Incidental take regulations are promulgated only upon request and the NMFS must be in receipt of a petition prior to initiating the regulatory process. Incidental takes of bowhead whales are allowed only if a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) is obtained from the NMFS pursuant to the regulations in effect at the time. An LOA or IHA must be requested annually. In issuing a LOA or IHA, the NMFS must determine that proposed activities will not have an unmitigable adverse effect on the availability of the bowhead whale to meet subsistence needs by causing whales to abandon or avoid hunting areas, directly displacing subsistence users, or placing physical barriers between whales and subsistence users.

Lessees are also advised that, in reviewing proposed exploration plans which propose activities during the bowhead whale migration, the MMS will conduct an environmental review of the potential effects of the activities, including cumulative effects of multiple or simultaneous operations, on the availability of the bowhead whale for subsistence use. The MMS may limit or require operations be modified if they could result in significant effects on the availability of the bowhead whale for subsistence use.

The MMS and the NMFS will establish procedures to coordinate results from site-specific surveys required by Sale 144 Stipulation No. 4 and NMFS LOA's or IHA's to determine if further modification to lease operations are necessary.

Information on Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System

The MMS has been advised by the National Marine Fisheries Service (NMFS) that, based on currently available information and technology, NMFS believes that development and production activities in the spring lead systems used by bowhead whales along the Chukchi Sea coast and extending to the northeast of Point Barrow 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. In addition, NMFS biological opinions are based on the assumption that there will not be any exploration within the spring-lead system. Therefore, the lessees are advised that MMS and NMFS will review exploration plans to ascertain if endangered species consultation will be required for activities planned during the spring (April 1 to June 15). Lessees are advised that specific options, alternatives, and/or mitigating measures may be developed for exploration, production, and development activities during MMS consultation with NMFS as new information or technology is developed for specific development plans, but that the possibility exists that exploration, development, and production on leases in this area may be constrained or precluded.

Information on Geological and Geophysical Survey Activity

Lessees are advised of the potential effect of geological and geophysical (G&G) activity to bowhead whales and subsistence hunting activities. High resolution G&G surveys are distinguished from 2-D and 3-D geophysical surveys by the magnitude of the energy source used in the survey, the size of the survey area, the number and length of arrays used, and duration of the survey period. High resolution G&G surveys are typically conducted after a lease sale in association with a specific exploration or development program or in anticipation of future lease sale activity. 2-D and 3-D geophysical surveys are typically conducted prior to lease sales.

Lessees are advised that all G&G survey activity conducted in the Beaufort Sea Planning Area, either under the pre-lease permitting regulations at 30 CFR 251, or as part of an approved exploration or development and production plan at 30 CFR 250, is subject to environmental and regulatory review by the MMS. The MMS has standard mitigating measures which are applied to these activities, and lessees are encouraged to review these measures before developing their applications for G&G permits. Copies of the non-proprietary portions of all G&G permit applications will be provided to the North Slope Borough (NSB), the Alaska Eskimo Whaling Commission (AEWC), and potentially affected subsistence communities for comment. The MMS may impose restrictions (including the timing of operations relative to open water) and other requirements (such as having a locally approved coordinator on board) on G&G surveys to minimize unreasonable conflicts between the G&G survey and subsistence whaling activities. The Industry Site-Specific Bowhead Whale Monitoring Program stipulation requires a peer reviewed monitoring program for G&G surveys conducted with marine vessels. Lessees will coordinate any proposed G&G activity with potentially affected subsistence communities, the NSB, and the AEWC to identify potential conflicts and develop plans to avoid these conflicts. Copies of the results of any required monitoring plans will be provided to the potentially affected subsistence communities, the NSB, and the AEWC for comment. In the event of no agreement a similar conflict resolution process as described in Stipulation No. 5 - *Subsistence Whaling and Other Subsistence Activities* will be implemented.

Information on Polar Bear Interaction

Lessees are advised that polar bears may be present in the area of operations, particularly during the solid-ice period. Lessees should conduct their activities in a manner which will limit potential encounters and interaction between lease operations and polar bears. The U.S. Fish and Wildlife Service (FWS) is responsible for the protection of polar bears under the provisions of the Marine Mammal Protection Act of 1972, as amended. Lessees are advised to contact the FWS regarding proposed operations and actions which might be taken to minimize interaction with polar bears. OCS Study MMS 93-0008 contains guidelines for oil and gas operations in polar bear habitats.

Lessees are advised that the FWS issued final regulations for incidental take of polar bears in the Beaufort Sea and adjacent northern coast of Alaska effective December 16, 1993 (50 CFR 18.111, et seq.). These regulations were in effect for an 18-month period and have been extended for an additional 40 months through December 15, 1998. The FWS must be in receipt of a petition for incidental take prior to initiating the regulatory process. Incidental takes of polar bears are allowed only if a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) is obtained from the FWS pursuant to the regulations in effect at the time. An LOA or IHA must be requested annually.

Lessees are reminded of the provisions of the 30 CFR 250.40 regulations which prohibit discharges of pollutants into offshore waters. Trash, waste, or other debris which might attract polar bears or be harmful to polar bears should be properly stored and disposed of to minimize attraction of, or encounters with, polar bears.

The lessees are advised to read and be familiar with the Guidelines for Oil and Gas Operations in Polar Bear Habitats, OCS Study MMS 93-0008. Copies of these guidelines are available for the lessees from Minerals Management Service, Alaska Regional Office.

Information on the Spectacled Eider and Steller's Eider

Lessees are advised that in 1993 the spectacled eider (*Somateria fischeri*) was listed as threatened by the U.S. Fish and Wildlife Service (FWS) and is protected by the Endangered Species Act (ESA) of 1973, as amended 16 U.S.C. 1531 et seq.). Lessees are further advised that the Steller's eider (*Polysticta stelleri*) is being considered by the FWS for listing as an endangered species under the ESA.

Lessees are advised that exploration and development and production plans submitted to Minerals Management Service will be reviewed by the FWS to ensure spectacled eider's and their habitats are protected. If the Steller's eider is listed as endangered under the ESA, it will be afforded similar protection.

Information on Sensitive Areas To Be Considered in the Oil-Spill Contingency Plans (OSCP)

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, or other biological resources or cultural resources and should be considered when developing OSCP's. Identified areas and time periods of special biological and cultural sensitivity include:

(1) the lead system off Point Barrow, April-June;
(2) the salt marshes from Kogru Inlet to Smith Bay, June-September;
(3) the Plover Islands, June-September;
(4) the Boulder Patch in Stefansson Sound, June-October;
(5) the Camden Bay area (especially the Nuvugag and Kaninniivik hunting sites), January, April-September, November;
(6) the Canning River Delta, January-December;
(7) the Barter Island - Demarcation Point Area, January-December;
(8) the Colville River Delta, January-December;
(9) the Cross, Pole, Egg, and Thetis Islands, June-September;
(10) the Flaxman Island waterfowl use and polar bear denning areas (Leffingwell Cabin, a National Historic Site, is located on Flaxman Island);
(11) the Jones Island Group (Pingok, Spy, and Leavitt Islands) and Pole Island are known polar bear denning areas, November-April; and
(12) the Sagavanirktok River delta.

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

Industry should consult with FWS or State personnel to identify specific environmentally sensitive areas within National Wildlife Refuges or State special areas which should be considered when developing a project-specific OSCP.

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 and cultural sensitivity. Lessees are advised that prior approval must be obtained before dispersants are used.

Information on Oil-Spill-Cleanup Capability

Exploratory drilling, testing, and other downhole activities will be prohibited in broken-ice conditions unless the lessee demonstrates to the Regional Supervisor, Field Operations (RS/FO), the capability to detect, contain, clean up, and dispose of spilled oil in broken ice. For production operations, spill response plans must include a thorough evaluation of the burnability and emulsification characteristics of the field's crude oil under Arctic open-water and broken-ice conditions. The adequacy of these plans will be determined by the RS/FO with full consideration of the comments and recommendations received through the public review process. Lessees may be required to conduct additional field tests to verify response capabilities in broken-ice conditions.

Information on Oil-Spill-Response Preparedness

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

Information on the Oil Pollution Act of 1990 (33 U.S.C. 2701 et seq.)

Lessees are advised that Section 1016(c)(1) of the Oil Pollution Act (OPA) of 1990 (33 U.S.C. 2716(c)(1)) requires that lessees establish and maintain evidence of financial responsibility of $150,000,000 for offshore facilities. This provision supersedes the $35,000,000 requirement under Title III of the OCS Lands Act, as amended (43 U.S.C. 1814). The authority to administer this provision has been transferred from the U.S. Coast Guard to the MMS. On April 16, 1993, MMS issued a Notice to Lessees, No. 93-1N to establish interim guidelines for certificates of oil spill financial responsibility. The interim guidelines retain the $35,000,000 oil spill financial responsibility requirement for offshore facilities until new superseding regulations are issued.

In addition, the MMS issued interim regulations at 30 CFR 254 pursuant to the Federal Water Pollution Control Act (33 U.S.C. 1321(j)), as amended by Section 4202(b)(4) of the OPA, addressing oil spill response plans for offshore facilities. The OCS lease activities will be subject to the provisions of this interim rule and subsequent final regulations in addition to existing oil spill contingency plan regulations at 30 CFR 250 issued under the Outer Continental Shelf Lands Act.

Information on Coastal Zone Management

The State of Alaska will review OCS plans and associated oil spill contingency plans through the review process for consistency with the Alaska Coastal Management Program (ACMP). The ACMP includes statewide standards found in 6 AAC 80 and enforceable policies found within approved coastal district programs. Contingency plans will be reviewed for compliance with state standards, the use of best available and safest technologies, and with state and regional contingency plans on a case-by-case basis.

Information on Navigational Safety

Operations on some of the blocks offered for lease may be restricted by designation of fairways, precautionary zones, anchorages, safety zones, or traffic separation schemes established by the U.S. Coast Guard (USCG) pursuant to the Ports and Waterways Safety Act (33 U.S.C. 1221 et seq.), as amended. Lessees are encouraged to contact the USCG regarding any identified restrictions. The U.S. Corps of Engineers permits are required for construction of any artificial islands, installations, and other devices permanently or temporarily attached to the seabed located on the Outer Continental Shelf (OCS) in accordance with Section 4(e) of the OCS Lands Act, as amended.

For additional information, prospective bidders should contact the U.S. Coast Guard, 17th Coast Guard District, P.O. Box 3-5000, Juneau, Alaska 99802, (907) 586-7355. For Corps of Engineers information, prospective bidders should contact U.S. Corps of Engineers, Alaska District, Regulatory Branch (1145b), P.O. Box 898, Anchorage, Alaska 99506-0898, (907) 753-2724.

Information on Offshore Pipelines

Lessees are advised that the Department of the Interior and the Department of Transportation have entered into a Memorandum of Understanding, dated May 6, 1976, concerning the design, installation, operation, and maintenance of offshore pipelines. Bidders should consult both departments for regulations applicable to offshore pipelines.

Information on Affirmative Action Requirements

Revision of Department of Labor regulations on affirmative action requirements for Government contractors (including lessees) has been deferred, pending review of those regulations (see *Federal Register* of August 25, 1981, at 46 FR 42865 and 42968). Should changes become effective at any time before the issuance of leases resulting from this sale, section 18 of the lease form (Form MMS-2005, March 1986) would be deleted from leases resulting from this sale. In addition, existing stocks of the affirmative action forms contain language that would be superseded by revised regulations at 41 CFR 60-1.5(a)(1) and 60-1.7(a)(1). Submission of Form MMS-2032 (June 1985) and Form MMS-2033 (June 1985) will not invalidate an otherwise acceptable bid, and the requirements of the revised regulations will be deemed to be part of the existing affirmative action forms.

Information on Nuiqsutmiut Paper

The people of Nuiqsut, the Nuiqsutmiut, have compiled a paper for people working in their country. The guide provides information that may promote a better understanding of their concerns. Lessees are encouraged to obtain copies of the guide and to incorporate it into their Orientation Program to assist in fostering sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which they will be operating.

F. COMPARISON OF BASE-CASE EFFECTS (ALTERNATIVE I) WITH THE BARTER ISLAND DEFERRAL ALTERNATIVE, THE NUIQSUT DEFERRAL ALTERNATIVE, AND THE HIGH-CASE EFFECTS (ALTERNATIVE I):

This section contains a comparative presentation and discussion of the base case of the proposed action with that of the high case of the proposed action , the Barter Island Deferral (Alternative III) and the Nuiqsut Deferral (Alternative IV). The comparative discussion is based on the conclusions reached for each resource topic. Following the comparisons of the base case, the high case and the deferral alternatives is the cumulative case conclusion. The reader can evaluate, at a glance, the conclusions of the base-case, the high case and the alternatives against that cumulative case. Not included in this analysis are the low case of the proposed action and the No Sale Alternative. The low case is not discussed due to the minimal effects engendered. In every resource topic, the effects of the low case are short term and of limited effect (effects of the low case are described in Sec. IV.F). The low-case field-development scenario (Sec. II.A.1) presents an exploration-only sequence with no production development. The no-sale alternative represents no action and no direct effects on area resources and, accordingly, is not evaluated; however, there could be effects related to alternative energy sources as discussed in Section IV.C.

Comparison of Oil Spills by Case and Alternative: The Oil-Spill-Risk Analysis estimates a mean number of two spills ≥1,000 bbl are likely to occur for Alternative I (base case). For Alternatives III and IV, the most likely number of spills ≥1,000 bbl is estimated to be one. For the cumulative case, the most likely number of spills (≥1,000-bbl) is estimated to be three. *It should be noted that the number of oil spills does not necessarily translate* to a difference in environmental effects. A number of statistical variables exist for analyzing effects of oil spills. The size of the spill is one important variable; but the potential effects of that spill also will depend on the the number of spills of that size that might occur; the chances of that number of spills of that size occurring (expressed in percentages), and the probability of those spills actually contacting shorlines and living resources. Spills, including large spills, are unlikely to occur in the same area twice and, therefore, the assumed large spills are not expected to contact the same resources over the 22-year life of the field. However, even if a subsequent spill were to contact some of the same areas, it generally is assumed that recovery, which ranges from a few days for phytoplankton to <7 years for some fishes, would have occurred, and the effects therefore would be very similar to a single-spill event. For additional information on oil-spill assumptions, the reader is directed to Section IV.A.2.

Effects on Water Quality

Base-Case Conclusion: Overall for the base case and over the life of the field, contaminants from oil spills may exceed sublethal but not acute (toxic) levels over up to 200 square kilometers (km^2) for a few weeks; and contaminants from construction, island abandonment, and permitted discharges could exceed sublethal levels over a few square kilometers for several years. Regional water quality would not be affected.

Alternative-III Conclusion: The areal extent of effects on water quality would be on the order of half that of the proposal because of the reduction in the number of major spills from two to one. The magnitude of effects for Alternative III, however, would be similar to that for the base case: concentrations of contaminates may locally exceed sublethal but not acute (toxic) levels.

Alternative-IV Conclusion: The areal extent of effects on water quality would be on the order of half that of the proposal because of the reduction in the number, from two to one, of major spills. The magnitude of effects for Alternative IV, however, would be similar to that for the base case: concentrations of contaminates may locally exceed sublethal but not acute (toxic) levels.

High-Case Conclusion: Contaminants from oil spills may exceed sublethal but not acute (toxic) levels over about 600 km^2 (174 square nautical miles [nmi^2]) for a few weeks; and contaminants from construction, island abandonment, and permitted discharges could exceed sublethal, but not acute (toxic), levels over 1 to a few 100 km^2 (0.3-ca. 100 nm^2) for several years.

Comparison: The water-quality effects for the base case and Alternative III and IV would be essentially similar except that the areal extent of effects for the alternatives, especially from large spills (see Table IV.A.3-1), would be only half of the base case. However, for the high case, water-quality effects would markedly exceed those of the base case in extent but not duration.

Cumulative-Case Conclusion: Cumulative effects on water quality—about half attributable to the proposed sale—are expected to result in exceeding sublethal but not acute (toxic) levels of contaminants over up to 300 km^2 (87 nmi^2) for a few weeks, with smaller areas affected up to several years. Cumulative effects of existing causeways could result in chronic degradation of water quality on a regional basis—over >1,000 km^2 (290 nmi^2)—over the lives of the fields.

Effects on Lower Trophic-Level Organisms

Base-Case Conclusion: Each of the two assumed 7,000-bbl oil spills is estimated to have lethal and sublethal effects on <1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. Each of the assumed spills also is estimated to have lethal and sublethal effects on <5 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

Alternative-III Conclusion: The assumed 7,000-bbl oil spill is estimated to have lethal and sublethal effects on up to 1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spill also is estimated to have lethal and sublethal effects on <3 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

Alternative-IV Conclusion: The assumed 7,000-bbl oil spill is estimated to have lethal and sublethal effects on up to 1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spill also is estimated to have lethal and sublethal effects on <3 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

High-Case Conclusion: The effects of high-case oil spills (6 are assumed) are estimated to be about three times those of the base case (2 are assumed). Each of the assumed high-case oil spills is estimated to have lethal and sublethal effects on <1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spills also are estimated to have lethal and sublethal effects on <5 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take <1 month.

Comparison: Alternatives III and IV assume one spill instead of two as in the base case, reducing effects by about 50 percent. It also removes about 24 percent of the sale area that could be oiled by the base case. Hence, the alternatives are expected to have about one fourth the effect of the base case. The high case assumes six independent spills instead of the two assumed for the base case. Because recovery is assumed prior to the onset of each spill, the high case is expected to have about three times the effect of the base case.

Cumulative-Case Conclusion: The effects of cumulative-case oil spills (3 are assumed) are estimated to be about twice that of the base case (2 are assumed). Two of these spills are assumed to be due to the cumulative proposal, and one is assumed to be due to State oil and gas lease sales; State oil and gas fields, oil transportation, and noncrude carriers. Each of the assumed 7,000-bbl oil spills is estimated to have lethal and sublethal effects on up to 1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. Each of the assumed spills also is estimated to have lethal and sublethal effects on <5 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

Effects on Fishes

Base-Case Conclusion: Overall, the two oil spills and other activities assumed for the base case would, at worst, be lethal to a very small portion of some nearshore anadromous fish populations, which would decrease population levels for one generation (<7 years).

Alternative-III Conclusion: Overall, the activities associated with Alternative III are expected to be the same as for the base case, because the major anadromous fish-overwintering habitats are still within the deferral alternative.

Alternative-IV Conclusions: Under Alternative IV, the effects due to seismic, drilling, oil spills, and construction would be only slightly less than the effects for the base case: at worst, the effects would be lethal to a very small portion of some nearshore anadromous fish populations, decreasing the population levels by perhaps several hundred thousand juvenile fish for one generation (<7 years).

High-Case Conclusion: Overall, the six spills and other activities assumed for the high case would, at worst, be lethal to a minor portion of some anadromous fish populations, decreasing population levels for <7 years.

Comparison: There is no appreciable difference in the effects between the base case and alternatives. The high-case analysis indicates some increase in effects to fishes in regards to numbers of fishes affected, over the base case, but no increase in the duration of effects.

Cumulative-Case Conclusion: Overall, the effect of the cumulative case on fishes in the Sale 144 area, is expected to be lethal to small portions of several generations. Because of the development of nearshore prospects, in State waters, using long causeways. Relative to the entire cumulative effect, the projected activities for proposed Sale 144 are expected to be lethal to a very small portion of fish populations containing several generations, as analyzed for the base case.

Effects on Marine and Coastal Birds

Base-Case Conclusion: The overall effect of potential oil spills, noise and disturbance, and habitat alteration on marine and coastal birds (waterfowl, seabirds, and shorebirds) is expected to include the loss of several thousand birds due to oil contamination. The overall effect from noise and disturbance and habitat alteration would be the short-term (a few minutes to <1 hour) displacement of nesting, feeding, and molting birds. Bird-population recovery is expected within one generation (about 2-3 years).

Alternative-III Conclusion: Under Alternative III, oil-spill effects on marine and coastal birds and their habitats east and offshore of Barter Island and Camden Bay could be avoided or reduced. However, the overall levels of effect on marine and coastal birds and their habitats west of Camden Bay, due primarily to spilled oil and noise disturbance, are expected to be the same as for the base case (a loss of several thousand birds with populations expecting to recover within 1 generation).

Alternative-IV Conclusions: Under Alternative IV, oil-spill effects on marine and coastal birds and their habitats east and offshore of Cape Halkett to Herschel Island could be reduced. However, the overall levels of effect on marine and coastal birds and their habitats in the sale area, due primarily to the assumed oil spill, noise and disturbance, and habitat alteration, are expected to be the same as for the base case (a loss of several thousand birds with populations expecting to recover within 1 generation).

High-Case Conclusion: The overall effect of the high case on marine and coastal birds is expected to include the loss of tens of thousands of birds (up to perhaps 100,000) from the assumed six oil spills, with recovery taking place within more than one generation (perhaps 3-5 years). Other effects (disturbance and habitat alteration) are expected to be local (within 1 km (0.62 mi) of the pipelines and other structures) and/or short-term (a few minutes to <1 hour from aircraft). Bird-population recovery from habitat alteration and other nonlethal disturbances is expected within one generation.

Comparison: Effects from Alternatives III and IV vary from the effects of the base case only in its reduced geographical area of effects, whereas the effects of the high case feature substantially larger numbers of affected birds and longer recovery times for affected bird species (2-3 years recovery versus 3-5 years).

Cumulative-Case Conclusion: Cumulative effects from activities within the arctic region combined with other activities within the range of migratory birds are expected to be long term (several generations or at least 10 years) on migratory waterfowl, migratory seabirds, and shorebirds and (probably <1 generation) on bald eagles. The contribution of the proposal to the cumulative effects is expected to be generally short-term (≥1 generation) effects representing about <50 percent of the total estimated mortality and <1 percent of the habitat loss.

Effects on Pinnipeds, Polar Bears, and Belukha Whales

Base-Case Conclusion: The effects from activities associated with the base case are expected to include the loss of small numbers of seals (200-300) walruses (no more than perhaps several hundred), polar bears (perhaps 20-30) and belukha whales (<10), with populations recovering (recovery meaning the replacement of individuals killed as a consequence of the proposal) within one generation or less (about 2-5 years).

Alternative-III Conclusion: Under Alternative III, oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats east and offshore of Barter Island and Camden Bay could be avoided or reduced. However, the overall levels of effect on seals, walruses, polar bears, and belukha whales and their habitats west of Camden Bay are expected to be the same as for the base case (losses of seals, walruses, polar bears, and belukha whales replaced within 1 generation).

Alternative-IV Conclusion: Under Alternative IV, oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats east and offshore of Cape Halkett to Herschel Island could be reduced. However, the overall levels of effect on pinnipeds, polar bears, and belukha whales and their habitats in the sale area, due primarily to the assumed oil spill, noise and disturbance, and habitat alteration, are expected to be about the same as for the base case (a loss of relatively small numbers of marine mammals with populations expecting to recover within 1 generation).

High-Case Conclusion: The overall effect of the high case is expected to include the loss of several hundred to perhaps a few thousand young pinnipeds, several polar bears (30-60), and a few belukhas (<20) due to the assumed six oil spills, with recovery taking place within about one generation (4-7 years). Noise and disturbance and habitat effects on seal, walrus, polar bear, and belukha whale behavior and distribution are expected to be short term (a few minutes to a few days) and local (within about 1-3 km of the traffic and platforms).

Comparison: Alternative III and Alternative IV vary from the effects of the base case only in their reduced geographical area of effects. The most salient difference in effects of the high case from that of the base case is of the much larger loss of pinnipeds and the longer recovery times for affected species (2-5 years recovery versus 4-7 years) for the high case.

Cumulative-Case Conclusion: Cumulative effects (loss of several thousand seals and sea otters; loss of <100 polar bears, and belukha whales; and loss of several hundred to several thousand walruses due to oil spills, commercial fishing, hunting, and other cumulative activities) are expected to be short term (<1 generation) on ice seals (ringed, bearded, and spotted seals), harbor seals, polar bears, and belukha whales and longer term (>1 generation to perhaps 3 generations) on northern fur seals, walruses, and sea otters. The contribution of the proposal is expected to include about 50 percent of the oil-spill mortality of ice seals, polar bears, walruses, and belukha whales; and <50 percent of the sea otter, fur seal, and harbor seal mortality.

Effects on Endangered and Threatened Species

Bowhead Whales:

Base-Case Conclusion: Overall, bowhead whales exposed to noise-producing activities and oil spills most likely would experience temporary, nonlethal effects. Bowheads may exhibit temporary avoidance behavior in response to vessels and to activities related to seismic surveys, drilling, and construction during exploration and development and production. Avoidance behavior usually begins at a distance of 1 to 4 km (0.62 to 2.5 mi) from a vessel, 0.2 to 5 km (0.12 to 3.1 mi) from a drillship, and 7.5 km (4.7 mi) or less from seismic operations. A few whales may avoid drilling noise at 20 km (12.4 mi) or more. Behavioral changes may last up to 60 minutes after the disturbance has left the area or the whales have passed. Although there is no indication from studies that the bowhead whale migration has been displaced (Ljungblad et al., 1988; Treacy, 1995), Inupiat subsistence whalers feel that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and is thereby interfering with the subsistence hunt at Barrow (Ahmaogak, 1989). Some bowhead whales could be exposed to spilled oil, resulting primarily in temporary, nonlethal effects. Some mortality might result if exposure to freshly spilled oil were prolonged; however, the population is expected to recover within 1 to 3 years.

Alternative-III Conclusion: The level of disturbance in the deferred area would be less with the alternative than without it; however, bowheads would be subject to the same level of disturbance in the area outside of the deferred area as they would be under the base case. Oil-spill effects would not be reduced substantially under this alternative, although fewer whales would be likely to be exposed to spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills most likely would experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals, with the population recovering within 1 to 3 years.

Alternative-IV Conclusion: The level of disturbance in the deferred area would be less with the alternative than without it; however, bowheads would be subject to the same level of disturbance in the area outside of the deferred area as they would be under the base case and would remain subject to some disturbance from activities on previously leased blocks within the deferred area. Oil-spill effects probably would not be reduced substantially under this alternative, although fewer whales would be likely to be exposed to spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills most likely would experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years.

High-Case Conclusion: Bowheads may exhibit avoidance behavior to vessels and activities related to seismic surveys, drilling, and construction during exploration and development and production. Some bowhead whales could be exposed to spilled oil, resulting in temporary, nonlethal effects, although some mortality may result if there was a prolonged exposure to freshly spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills most likely would experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals, with the population recovering recovering to prespill population levels within 1 to 3 years.

Comparison: Outside of the deferred areas, the level of disturbance to bowhead whales would be the same for Alternatives III and IV as that of the base case. Effects for the high case are perceived to be the same as for the base case.

Cumulative-Case Conclusions: Bowheads may exhibit avoidance behavior to vessels and activities related to seismic surveys, drilling, and construction during exploration and development and production. Some bowhead whales could be exposed to spilled oil, resulting in temporary, nonlethal effects, although some mortality might result if there were a prolonged exposure to freshly spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills associated with the proposal and other future and existing projects within the arctic-region area—combined with the other activities within the range of the migrating bowhead whale—most likely would experience temporary, nonlethal effects. However, exposure to oil spills could result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years. The contribution of the proposal to the cumulative effects is expected to be of short duration and to result in primarily temporary, nonlethal effects.

Arctic Peregrine Falcon

Base-Case Conclusion: The arctic peregrine falcon is a highly transient species within the proposed sale area and, therefore, there is a very low probability that a large oil spill would contact them while in their foraging areas. Because of this, the overall effect on arctic peregrine falcons from oil spills and disturbance is expected to be minimal, with <5 percent of the population exposed to potentially adverse factors; no mortality is expected to result from the proposed action.

Alternative-III Conclusion: As determined for the base case of the proposal, overall routine and spill-related effects of the Barter Island Deferral Alternative on the peregrine falcon are expected to be minimal, with <5 percent of the population exposed to potentially adverse factors. Because exposure of falcons to oiled prey is expected to be insignificant under both the base case and this alternative, reduction of adverse effects also is expected to be insignificant. No mortality is expected to result from this alternative.

Alternative-IV conclusion: As determined for the base case of the proposal, overall routine and spill-related effects of the Nuiqsut Deferral Alternative on the arctic peregrine falcon are expected to be minimal, with <5 percent of the population exposed to potentially adverse factors. Because exposure of falcons to oiled prey is expected to be insignificant under both the base case and this alternative, reduction of adverse effects also is expected to be insignificant. No mortality is expected to result from this alternative.

High-Case Conclusion: The overall effects on peregrine falcons from oil spills and disturbance are expected to be minimal, with <10 percent of the population exposed to potentially adverse factors resulting in only a few mortalities.

Comparison: Effects levels for the base case and it's alternatives are analyzed to be the same. For the high case, the exposed percentage of the peregrine falcon population is expected to double; however, mortality rates are expected to remain low.

Cumulative-Case Conclusion: The cumulative effect of all projects and activities within the range occupied by nesting, migrating, or wintering arctic peregrine falcons is expected to be minimal and short-term, with mortality and sublethal effects on <10 percent of the population, requiring no more than one generation (3 years) for recovery to original status. The contribution of activities associated with proposed Sale 144 to the cumulative effect is not expected to represent >10 to 15 percent of the cumulative effect on the arctic peregrine falcon population.

Spectacled Eider

Base-Case Conclusion: Overall routine effects on the spectacled eider are expected to be minimal, affecting <2 percent of the population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur, if population status is declining as at present.

Alternative-III Conclusion: As determined for the base case of the proposal, overall routine effects of the Barter Island Deferral Alternative on the spectacled eider are expected to be minimal, affecting <2 percent of the population. Likewise, no significant reduction of the oil spill mortality expected under the base case is anticipated because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur, if population status is declining as at present.

Alternative-IV conclusion: As determined for the base case of the proposal, overall routine effects of the Nuiqsut Deferral Alternative on the spectacled eider are expected to be minimal, affecting <2 percent of the population. Likewise, no significant reduction of the oil spill mortality expected under the base case is anticipated because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur, if population status is declining as at present.

High-Case Conclusion: Overall routine effects on the spectacled eider are expected to be minimal, affecting <10 percent of the population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur, if population status is declining as at present

Comparison: The effects of Alternatives III and IV are expected to be the same as for the base case. For the high case, while effects levels are still expected to be minimal, their duration and effect are greater then those of the base case.

Cumulative-Case Conclusion: Routine OCS cumulative effects on the Alaskan spectacled eider population are expected to be minimal, affecting <5 percent of the population; however, recovery from any substantial oil-spill mortality is not expected to occur if population status is declining as at present. Likewise, recovery from substantial overall cumulative effect is not expected to occur if population status is declining as at present. A relatively low level of cumulative mortality still may require more than six generations for recovery, although any estimate of severity is confounded by the uncertainty regarding the population decline. The contribution of activities associated with proposed Sale 144 to the cumulative effect is not expected to represent >5 to 10 percent of the cumulative effect on the spectacled eider population.

Steller's Eider

Base-Case Conclusion: Overall routine effects on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur, if population status is declining as at present.

Alternative-III Conclusion: As determined for the base case of the proposal, overall routine effects of the Barter Island Deferral Alternative on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population. Likewise, no significant reduction of the oil spill mortality expected under the base case is anticipated because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur, if population status is declining as at present.

Alternative-IV Conclusion: As determined for the base case of the proposal, overall routine effects of the Nuiqsut Deferral Alternative on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population. Likewise, no significant reduction of the oil spill mortality expected under the base case is anticipated because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur, if population status is declining as at present.

High-Case Conclusion: Overall routine effects on the Steller's eider are expected to be minimal, affecting <10 percent of the Alaska population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur ,if population status is declining as at present

Comparison: The effects of the alternatives are expected to be the same as for the base case. For the high case, while effects levels are still expected to be minimal, their duration and effect are greater then those of the base case.

Cumulative-Case Conclusion: Routine OCS cumulative effects on the Alaskan Steller's eider population are expected to be minimal, affecting <5 percent of the population; however, recovery from any substantial oil-spill mortality is not expected to occur if population status is declining as at present. Likewise, recovery from substantial overall cumulative effect is not expected to occur if population status is declining as at present. A relatively low level of cumulative mortality still may require more than six generations for recovery, although any estimate of severity is confounded by the uncertainty regarding the population decline. The contribution of activities associated with proposed Sale 144 to the cumulative effect is not expected to represent >5 to 10 percent of the cumulative effect on the Steller's eider population.

Effects on Caribou

Base-Case Conclusion: The effects of the base case on caribou are expected to include local displacement of cow-calf groups within about 1 to 2 km (0.62-1.2 mi) along the pipeline and roads, with this local effect persisting for more than one generation (and perhaps over the life of the proposal). Brief disturbances (a few minutes to a few days) of large groups of caribou are expected to occur along the road and pipeline corridor during periods of high traffic over the life of the project, but these disturbances are not expected to affect caribou migrations and overall distribution. The two assumed oil spills are likely to result in the loss of small numbers of caribou (a few hundred to perhaps a thousand), with recovery expected within 1 year or less.

Alternative-III Conclusion: This alternative is expected to have local (within 1-2 km, or 0.62-1.2 mi of roads and pipelines) but long-term (>1 generation) displacement effects on caribou (due to road-traffic disturbance)— about the same level of effect as under the base case.

Alternative-IV Conclusion: Under Alternative IV, oil-spill effects on caribou and their habitats from Point McIntyre east to Flaxman Island could be reduced. However, the overall levels of effect on caribou and their habitats in the sale area, due primarily to disturbance-displacement, and habitat alteration are expected to be the same as for the base case (local displacement of some caribou cows and calves during the calving season with effect persisting for >1 generation).

High-Case Conclusion: For the high case, the overall effect on caribou behavior and distribution is expected to be long term (>1 generation) but local (within about 1-2 km (0.62-1.2 mi) of the road-pipeline corridors), and mortality (as many as <1,000 animals) due to oil spills is expected to be replaced within 1 year.

Comparison: Effects levels are similar for all four cases.

Cumulative-Case Conclusion: Cumulative effects on caribou distribution are likely to be long-term (several generations over the life of the oil fields) but local (within 1-2 km [0.62-1.2 mi]) of some onshore facilities). However, the cumulative reduction in calving and summer habitat use by cows and calves of the arctic herds near some oil-field facilities (such as road-pipelines with high traffic levels) may not result in a long-term effect on caribou abundance nor to reduce herd productivity. The contribution of the base case of the proposal to the cumulative case is estimated to be <10 percent of the local but long-term displacement of caribou calving habitat and reduced habitat use.

Effects on the Economy of the North Slope Borough

Base-Case Conclusion: The base case of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 2 percent each year through the production period. A peak employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 by 2026. The number of jobs filled by permanent residents of the region is projected to be about 4 percent greater than existing-condition employment. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy of the base case is directly related to effects on the subsistence harvest. The effects on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. In Barrow (Atqasuk), effects are expected to affect subsistence resources for a period not exceeding 1 year and make no resource unavailable, undesirable for use, or greatly reduced in number. Overall effects on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities would render one or more important subsistence resources unavailable, undesirable for use, or reduced in available numbers for a period of 1 to 2 years.

Alternative-III Conclusion: For the Barter Island Deferral Alternative, the effects on revenues and expenditures and employment of the NSB are expected to be the same, overall, as for the base case of the proposal.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest.. Overall effects of the Barter Island Deferral Alternative on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities are expected to render one or more subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. The effects of this alternative on subsistence-harvest patterns in Barrow (Atqasuk), Nuiqsut, and especially the community of Kaktovik are expected to affect subsistence resources for a period not exceeding 1 year, but no resource would become unavailable, undesirable for use, or greatly reduced in available numbers.

Alternative-IV Conclusion: For the Nuiqsut Deferral Alternative, the effects on the economy of the NSB are expected to be different from the base case of the proposal in that OCS direct employment will be less. A peak employment of 2,480 is projected for 2006, declining to under 1,000 jobs by 2023. A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. Under the Nuiqsut Deferral Alternative, effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns on Barrow (Atqasuk), Kaktovik, and especially the community of Nuiqsut are expected to affect subsistence resources for a period up to 1 year but make no resource unavailable, undesirable for use, or greatly reduced in number.

High-Case Conclusion: The high case of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 8 percent each year through the production period. A peak employment estimate of 8,221 jobs is projected for 2011, declining to under 5,000 jobs by 2025. The number of jobs filled by permanent residents of the region is projected to be about 11 percent greater than existing-condition employment. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. The effects of the high case on subsistence-harvest patterns in Barrow are expected to cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. In Nuiqsut and Kaktovik, high-case effects would cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. High-case effects are expected to cause a significant portion of subsistence waterfowl to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years.

Comparison: Employment levels generated by Alternative IV are expected to be 30-40 percent less, then those of the Base Case, in the peak years of developmental activity and are expected to decline more rapidly. Effects for Alternative III are expected to be the same as the base case; however, the high-case effects levels are two to four times that of the base case. Employment levels, jobs created, and collected taxes all are expected to be much greater in the high case than in the base case. Subsistence income effects are expected to be somewhat similar for the base case and Alternatives III and IV. In the high case, however, North Slope communities would experience an increase in lost subsistence income over subsistence forecast for the base case.

Cumulative-Case Conclusion: Cumulative effects on the economy of the NSB from activities within the arctic region combined with other activities are expected to be similar to those estimated for the base case of the proposal *due to the construction schedule for new projects and the declining existing-condition* of total property taxes in the NSB and NSB revenues. The contribution of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1998 and averaging about 2 percent each year through the production period. A peak-employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 by 2026. The number of jobs filled by permanent residents of the region is projected to be about 4 percent greater than existing-condition employment. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. In the cumulative case, the effects on subsistence-harvest patterns are expected to cause one or more important subsistence resources to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years in Barrow, Atqasuk, Nuiqsut, and Kaktovik and also within the region. The contribution of the proposal to the cumulative effects would be effects to subsistence resources that would render them unavailable, undesirable for use, or reduced in available numbers for a period not exceeding 1 year.

Effects on Sociocultural Systems

Base-Case Conclusion: Proposed Sale 144 base-case effects from industrial activities, changes in population and employment, and effects on subsistence-harvest patterns are expected to disrupt sociocultural systems. Chronic disruptions to sociocultural systems are expected to occur for a period of 1 to 2 years, and possibly longer, but these disruptions are not expected to cause permanent displacement of ongoing community activities and traditional practices for harvesting, sharing, and processing subsistence resources.

Alternative-III Conclusion: Under this alternative, effects on sociocultural systems from industrial activities, changes in population and employment, and effects on subsistence-harvest patterns are expected to produce only a short-term disruption of sociocultural systems—< 1 year—without a tendency to displace existing institutions. Effects in the community of Kaktovik would be even less pronounced and of shorter duration.

Alternative-IV Conclusion: Under this alternative, effects on sociocultural systems from industrial activities, changes in population and employment, and effects on subsistence-harvest patterns are expected to produce only short-term disruptions to sociocultural systems in Barrow (Atqasuk) and Kaktovik; in the community of Nuiqsut, effects would be less pronounced and of shorter duration. These disruptions are expected to last up to 1 year but are not expected to cause displacement of ongoing community activities and the traditional practices for harvesting, sharing, and processing subsistence resources.

High-Case Conclusion: For the high case, the effects on sociocultural systems are expected to cause chronic disruption for a period of 1 to 2 years but without a tendency toward the displacement of existing institutions.

Comparison: The effects levels of Alternative III and IV are less of the base case and would only produce short term disruptions to sociocultural systems. Alternative III would cause even shorter term effects in Kaktovik while

Alternative IV would cause the same in Nuiqsut. However, the high case will nearly double the time period from that of the base case that various sociocultural institutions will experience chronic disruption.

Cumulative-Case Conclusion: Cumulative effects on sociocultural systems could cause chronic disruption of sociocultural systems in the communities of Barrow, Nuiqsut, and Kaktovik for a period of 2 to 5 years without a tendency toward displacing existing institutions or social organization. Lesser cumulative effects would occur in the community of Atqasuk, where disruption would be only periodic. The contribution of the proposal to the cumulative effects would be disruptions to sociocultural systems lasting for a period of < 1 year without a tendency to displace existing institutions.

Effects on Subsistence-Harvest Patterns

Base-Case Conclusion: The effects of the Sale 144 base case on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. In Barrow (Atqasuk), effects from the Sale 144 base case are expected to affect subsistence resources for a period not exceeding 1 year and make no resource unavailable, undesirable for use, or greatly reduced in number. Overall effects on subsistence-harvest patterns from the Sale 144 base case as a result of oil spills, noise and disturbance, and construction activities would render one or more important subsistence resources unavailable, undesirable for use, or reduced in available numbers for a period of 1 to 2 years.

Alternative-III Conclusion: Under Alternative III, effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns in Barrow (Atqasuk), Nuiqsut, and especially the community of Kaktovik are expected to affect subsistence resources for a period not exceeding 1 year, but no resource would become unavailable, undesirable for use, or greatly reduced in available numbers.

Alternative-IV Conclusion: Under Alternative IV effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns Barrow (Atqasuk), Kaktovik, and especially the community of Nuiqsut are expected to affect subsistence resources for a period up to 1 year but make no resource unavailable, undesirable for use, or greatly reduced in number.

High-Case Conclusion: The effects of the Sale 144 high case on subsistence-harvest patterns in Barrow are expected to cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. In Nuiqsut and Kaktovik, high-case effects would cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. High-case effects are expected to cause a significant portion of subsistence waterfowl to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years.

Comparison: Effects levels for Alternatives III and IV are expected to be lower then those of the base case in that subsistence resources, although affected, will be available. The base case assumes that at least one subsistence resource will become unavailable for 1 to 2 years. High-case effects levels are substantively greater: subsistence resources may become unavailable or unusable for up to 2 years for the communities of Kaktovik and Nuiqsut, and a significant portion of subsistence waterfowl could be unavailable for up to 5 years.

Cumulative-Case Conclusion: In the cumulative case, the effects on subsistence-harvest patterns are expected to cause one or more important subsistence resources to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years in Barrow, Atqasuk, Nuiqsut, and Kaktovik and also within the region. The contribution of the proposal to the cumulative effects would be effects to subsistence resources that would render them unavailable, undesirable for use, or reduced in available numbers for a period not exceeding 1 year.

Effects on Archaeological Resources

Base-Case Conclusion: There should be no effects on submerged prehistoric sites as a result of Sale 144, because it is unlikely that there are preserved prehistoric sites within the sale area. The expected effect on historic shipwrecks should be low because of the requirement for review of geophysical data prior to any lease activities.

Although oil-spill effects on onshore archaeological resources are uncertain, data from the *Exxon Valdez* oil spill indicate that few onshore archaeological resources (<3%) are likely to be significantly affected by an oil spill.

Alternative-III Conclusion: The effects from the Barter Island Deferral Alternative would be the same as for the base case of the proposal.

Alternative-IV Conclusion: The effects from the Nuiqsut Deferral Alternative would be the same as for the proposal.

High-Case Conclusion: The effects from the high case of the proposal likely would be the same as from the base case of the proposal. There should be no effects on submerged prehistoric sites as a result of Sale 144, because it is unlikely that there are preserved prehistoric sites within the sale area. The expected effect on historic shipwrecks should be low because of the requirement for review of geophysical data prior to any lease activities. Although oil-spill effects on onshore archaeological resources are uncertain, data from the *Exxon Valdez* oil spill indicate that few onshore archaeological resources (<3%) are likely to be significantly affected by an oil spill.

Comparison: The effects of Alternatives III, IV and the high case are expected to be the same as the base case.

Cumulative-Case Conclusion: Cumulative effects on archaeological sites are expected to be similar to those of the base case. The analysis completed for the base case indicates that there should be no preserved prehistoric archaeological sites within the sale area; therefore, there would be no effects on submerged prehistoric sites. The expected effect on historic shipwrecks remains low. In the event that an increased amount of bottom-disturbing activity takes place, in-place State and Federal laws and regulations should mitigate effects to archaeological resources. The expected effect on onshore archaeological resources from an oil spill is uncertain, but data from the EVOS indicate that <3 percent of the resources within a spill area would be significantly affected.

Effects on Air Quality

Base-Case Conclusion: The effects of these activities would not increase the concentrations of criteria pollutants in the onshore ambient air to the point that they would remain well within the air-quality standards. Therefore, effects from the base case would be low.

Alternative-III Conclusion: The effects of this alternative on air quality are expected to be low, the same level of effects as for base case.

Alternative-IV Conclusion: The effects of this alternative on air quality are expected to be low, the same level of effects as for the base case.

High-Case Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Effects on onshore air quality from high-case air emissions are expected to be 6 percent of the maximum allowable PSD Class II increments. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration and development and production activities or from accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

Comparison: The effects of Alternative III and the high case are expected to be similar to those of the base case.

Cumulative-Case Conclusions: The effects associated with the cumulative case essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Effects on onshore air quality from cumulative-case emissions are expected to be 6 percent of the maximum allowable PSD Class II increments. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration, development, and production activities or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

Effects on Land Use Plans and Coastal Management Programs

Base-Case Conclusion: For the base case of Alternative I, conflicts could occur with specific Statewide standards and NSB Coastal Management Plan policies related to the potential for user conflicts between development activities and the subsistence bowhead whale hunt. Conflicts are possible with the NSB Coastal Management Plan policy related to adverse effects on subsistence resources if spilled oil contacted the subsistence-hunting areas of Kaktovik and Nuiqsut.

Alternative-III Conclusion: For Alternative III, the effects of potential conflicts on land use plans and coastal management programs are expected to be almost the same as for the base case of Alternative I: conflicts could occur with specific Statewide standards and NSB Coastal Management Plan policies related to the potential for user conflict between development activities and the subsistence bowhead whale hunt, with the exception that the Barter Island Deferral Alternative would reduce the possibility of conflicts with the Kaktovik subsistence-harvest area by reducing the possibility of spilled oil and noise-related disturbances effecting the harvest area.

Alternative-IV Conclusion: For Alternative IV, the effects of potential conflicts on land use plans and coastal management programs overall are expected to be almost the same as for the base case of Alternative I: conflicts could occur with specific Statewide standards and NSB Coastal Management Plan policies related to the potential for user conflict between development activities and the subsistence bowhead whale hunt, with the exception that the Nuiqsut Deferral Alternative would reduce the possibility of conflicts with the Nuiqsut subsistence-harvest area by slightly reducing the possibility of spilled oil contacting that area and providing some mitigation from noise-related disturbances affecting the harvest area of Nuiqsut.

High-Case Conclusion: For the high case of Alternative I, conflicts could occur with specific Statewide standards and NSB coastal management policies related to the potential for user conflicts between development activities and the subsistence bowhead whale hunt. Conflicts also are possible with the NSB Coastal Management Plan policy related to adverse effects on subsistence resources if spilled oil contacted subsistence-hunting areas. In addition, the scenario potentially may conflict with Statewide standards related to water quality and habitats.

Comparison: The effects levels of Alternative III are the same as the base case, except for the reduced possibility of conflicts with the Kaktovik subsistence-harvest area. The same can be stated for Alternative IV, except the reduced possibility of effects is in the Nuiqsut subsistence-harvest area. In the high case, effects of the proposed action also may conflict with Statewide standards for water quality and habitats.

Cumulative-Case Conclusion: For the cumulative case, there is a potential for conflict with four policies of land use plans and coastal management programs: energy-facility siting, transportation and utilities, habitat, and subsistence.

SECTION III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. PHYSICAL CHARACTERISTICS OF THE BEAUFORT SEA PLANNING AREA:

AREA: The physical descriptions of the Beaufort Sea Planning Area in Sections III.A, B, and C of the Sales 87, 97, and 124 Final Environmental Impact Statements (FEIS's) (USDOI, MMS, 1984, 1987, and 1990, respectively) are incorporated by reference in the following Sections III.A, B, and C. The titles of these sections are III.A, Physical Environment; III.B, Biological Resources; and III.C, Social Systems. A summary of the previously published material, augmented by additional material, as cited, follows.

1. Geology:

a. Petroleum Geology: For information on the petroleum geology of the Sale 144 area and regional petroleum exploration history, see Appendix A.

b. Other Geological and Environmental Considerations:

(1) Physiography and Bathymetry: The Beaufort Sea Sale 144 area includes the continental shelf and upper part of the continental slope of the Alaskan Beaufort Sea. Water depths within the sale area range from about 1 meter (3 feet) (3 ft, 1 m) to slightly less than 1,000 m (3,000 ft) (Fig. III.A.1-1). The Alaskan Beaufort Sea continental shelf is a relatively narrow feature extending from the Alaska-Yukon border to the Barrow Sea Valley. The distance from the shore to the shelf break ranges from 60 to 120 kilometers (km) (37 to 75 miles [mi]). The major bathymetric features of the Beaufort shelf are the barrier islands and shoals. Some islands are migrating westward at rates of 19 to 30 meters per year (m/yr) (60-100 ft/yr) and landward 3 to 7 m/yr (10 to 23 ft/yr). Shoals that rise 5 to 10 m (16-33 ft) above the surrounding seafloor have been observed in water depths of 10 to 20 m (33-65 ft).

(2) Surficial Sediments: The surficial sediments of the Alaskan Beaufort Sea continental shelf consist predominantly of mud (clay- and silt-size particles). Sediment erosion is more dominant than deposition out to a depth of 30 m (Reimnitz, Graves, and Barnes, 1988). Coarse-grained sediments (sand- and gravel-size particles) are for the most part relict deposits found in the nearshore areas, in the vicinity of the offshore barrier islands, and on shoals and along the shelf break. Overconsolidated sediments are widespread on the Beaufort Sea shelf.

(3) Mudslides: Most of the Beaufort shelf seaward of the 50- to 65-m isobath and the upper part of the slope consists of a relatively thick mass of unconsolidated and poorly consolidated sediments that show a variety of features associated with the downslope movement of large, tabular sediment blocks (Grantz et al., 1982). The size of the blocks varies, but masses up to 38 km long and from 20 to 230 m thick have been observed. Estimates of the downslope movement range from 0.2 to 2.3 km. The sediments of the outer shelf and upper slope of the eastern Beaufort Sea appear to be relict deposits; and the mass-movement phenomenon may be related to processes that are not active today (Reimnitz, Barnes, and Phillips, 1982). However, if fine-grained sediments presently are accumulating along the outer shelf and upper slope, mass-movement processes that would include slumping and sliding may be active now and in the future.

(4) Coastal Erosion: The rates of coastal retreat vary from year to year and depend on the timing of the sea-ice breakup, variations in the size of the open-water areas (exposure to the sea), the timing of late summer and autumn storms, the composition of the coastal bluffs, beach width, and the morphology of the adjacent seafloor. Most of the erosion occurs in late summer and autumn. Data from the 344-km shoreline between Prudhoe Bay west to Drew Point indicate the coastline is eroding at an average annual rate of about 2.5 m/yr; this average excludes the Colville River Delta, which is advancing seaward at an average rate of 0.4 m/yr (Reimnitz, Graves, and Barnes, 1988). In the western third of this area, the coastal-plain deposits are fine-grained muds and the average erosion rates are about 5.4 m/yr; coastal deposits in the rest of the area consist of sandy to gravelly sediments, and the average erosion rate is about 1.4 m/yr. Long-term, local erosion rates may be as high as 18 m/yr in places; and near the active mouths of the Colville River, the shoreline may be advancing

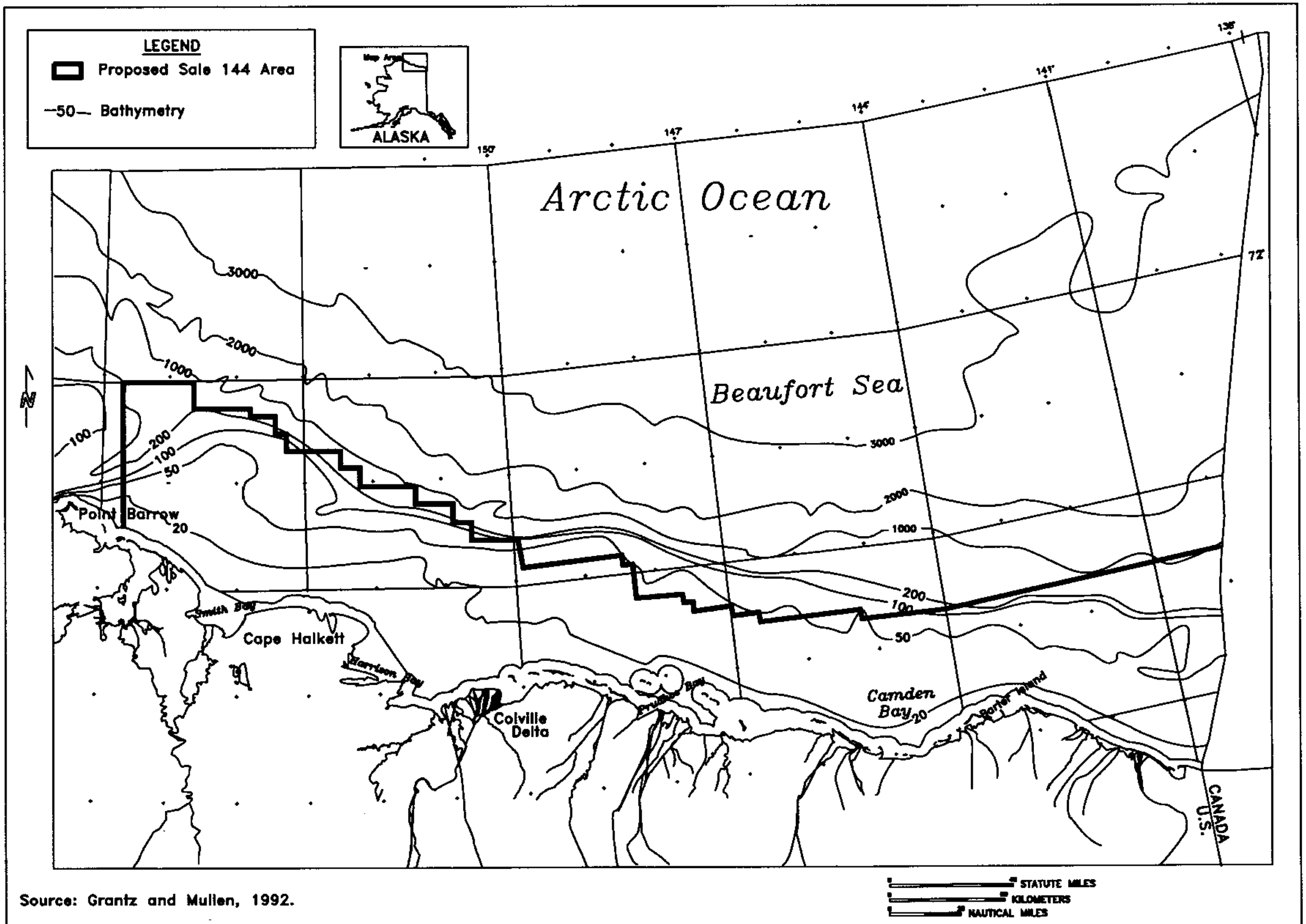


Figure III.A.1–1. Bathymetry map of the Alaskan Beaufort Sea.

seaward at rates as high as 20 m/yr. Coastal-erosion rates of other locations along the coast adjacent to the sale area are shown in Figure III.A.1-2.

(5) Faults and Earthquakes: Mapped subsurface faults are shown in Figure III.A.1-3. Generally, the faults in the Harrison Bay area and in the middle part of the western Beaufort shelf do not displace Pleistocene or Holocene sediments. Thus, differential movement along these faults may have ended prior to the beginning of the Quaternary Period. However, the faults may provide migration routes for gas from the lower Cretaceous beds or create traps for gas at shallow depths.

Movement along the faults of the outer shelf and upper slope of the western Beaufort may be as great as 1,055 m. However, these faults have not generated earthquakes of sufficient magnitude to be detected by regional and local seismograph networks in place since 1968. Thus, the age of the faults is unknown.

In the Sale 144 area, 73 earthquakes have been recorded from 1937 to 1992 area (Fig. III.A.1-3). These earthquakes range in magnitude from less than (<) 1.0 to 5.3 on the Richter scale; most of the earthquakes recorded since 1968 range in magnitude from 3.0 to 4.0 (U.S. Geological Survey, 1995). Earthquakes indicate active movement along the faults in the Camden Bay area and tend to occur along the axes of anticlines and synclines.

(6) Permafrost: The permafrost that underlies the present-day Beaufort Sea continental shelf shoreward of the 90-m isobath is, for the most part, a relict feature overlain by a layer of unconsolidated sediment.

Shallow zones of the bonded permafrost occur locally in the Beaufort Sea. A large area of permafrost occurs off the Sagavanirktok (Sag) River, where ice-bonded sediments are commonly found <10 m below the surface. Also, seismic data indicate that some nearshore areas in Harrison Bay may be underlain by ice-bonded permafrost. Other areas of ice-bonded permafrost occur (1) in adjacent zones landward of the 2-m isobath that are overlain by bottomfast ice in the winter, (2) at highly variable depths up to several hundred meters beneath the seafloor, (3) in areas between the barrier islands and the shore, and (4) onshore and on some of the barrier islands. Based on seismic studies, permafrost also may exist on the Beaufort Shelf at depths that range from 100 to 1,900 m.

(7) Natural Gas Hydrates: The presence of natural gas hydrates is favored by the pressure and temperature conditions found in or below the permafrost layer. The presence of hydrates has been inferred from seismic profiles in the Alaskan Beaufort Sea. Where water depths in the planning area exceed 400 m, the upper 300 to 700 m of the sediments lie in the temperature-pressure range for the formation and stability of natural gas hydrates. Inferred locations of natural gas hydrates are shown in Figure III.A.1-4.

(8) Shallow Gas: On the inner and middle continental shelf, the shallow-gas accumulations are most commonly associated with buried Pleistocene delta and channel systems and with active faults overlying natural gas sources (Fig. III.A.1-4). In the eastern part of Harrison Bay, the acoustic anomalies of the seismic-reflection profiles indicate that shallow gas may be present in a region where there also are numerous faults.

(9) Overpressured Shale: The Kaktovik Basin contains numerous diapirs that disturb the Tertiary sediments along the continental shelf east of 146° W. longitude. These structures are interpreted to have shale cores on the basis that they appear to be a westward extension of the western Canadian Beaufort shelf shale-diapir province. Shale diapirism is the result of lower density in the shale section than in the overlying strata because of incomplete dewatering of the shale and is an indication of overpressuring within the shale section. The occurrence of abnormal pressure probably is confined to areas of thick Cenozoic strata as in the Kaktovik, Camden, and Nuwuk Basins.

2. Meteorology: The Sale 144 area is in the Arctic climate zone. Mean annual temperature is about -12 °C. Figure III.A.2-1 shows general meteorologic conditions for areas adjacent to and within the Sale 144 area. Precipitation ranges from 13 centimeters (cm) at Barrow to 18 cm at Barter Island and

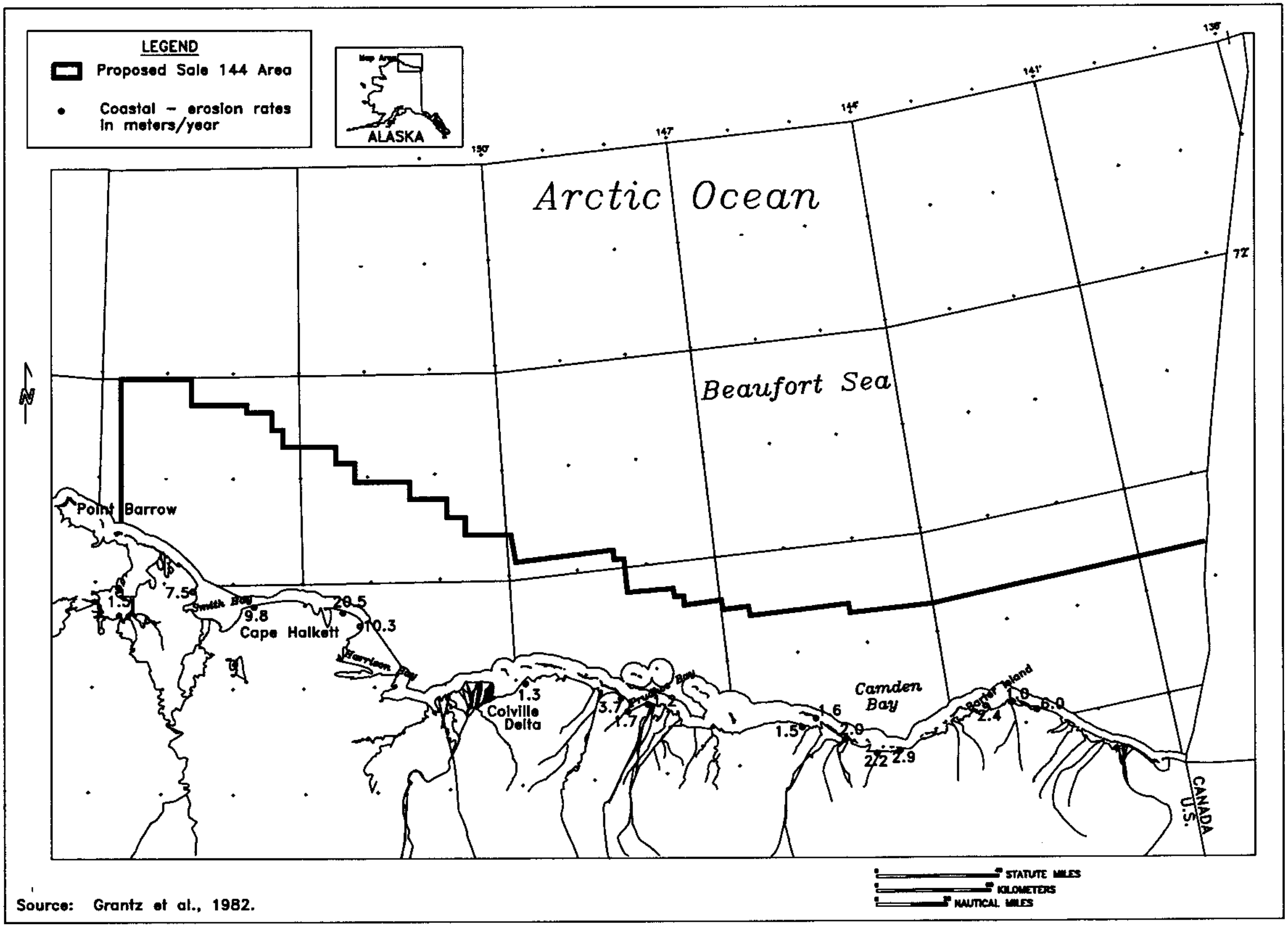


Figure III.A.1-2. Coastal Erosion Along the Alaskan Beaufort Sea Adjacent to the Sale 144 Area

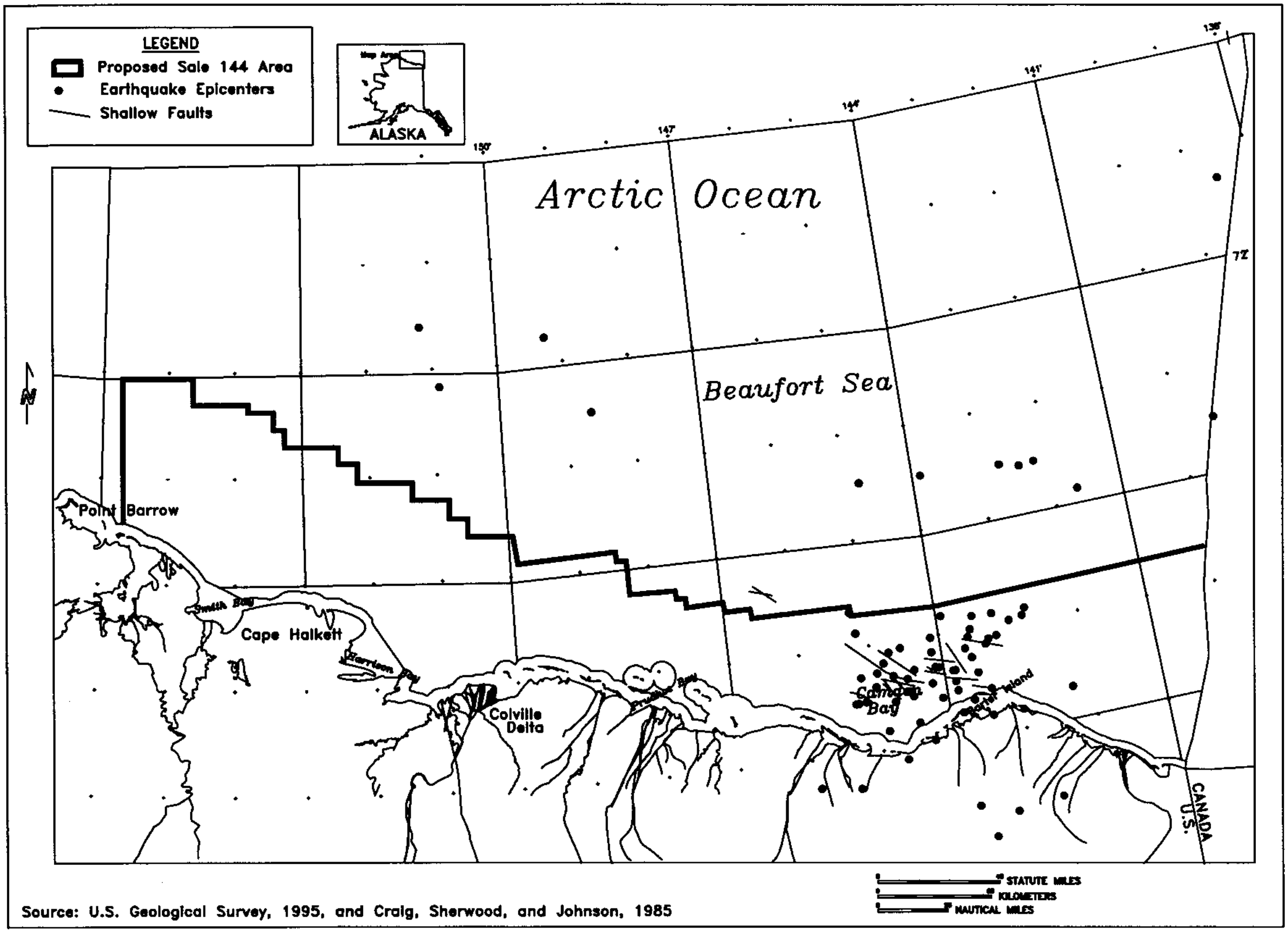


Figure III.A.1-3. Location of Shallow Faults and Earthquake Epicenters In and Near the Sale 144 Area

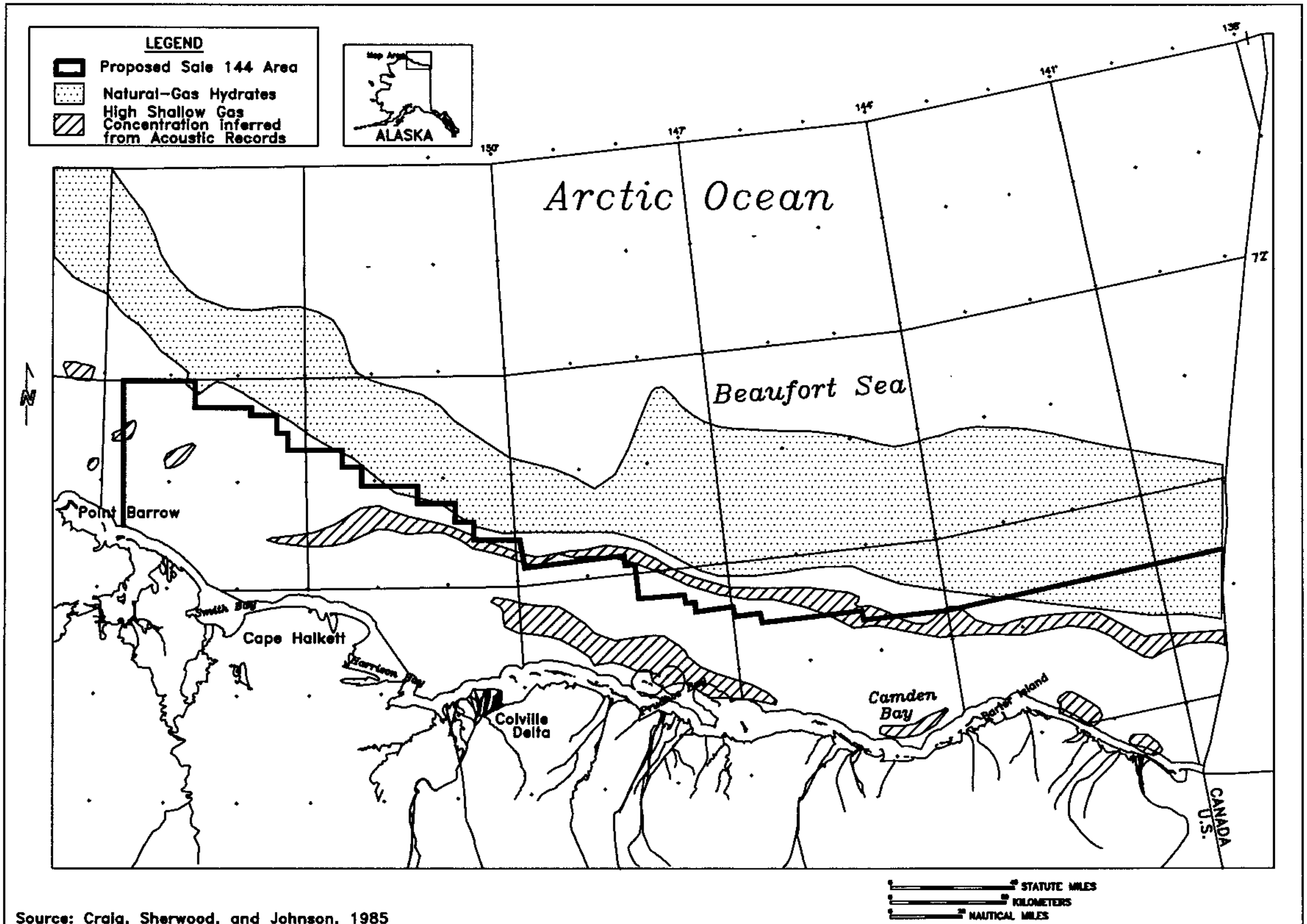


Figure III.A.1-4. Inferred Location of Natural Gas Hydrates and Shallow Gas

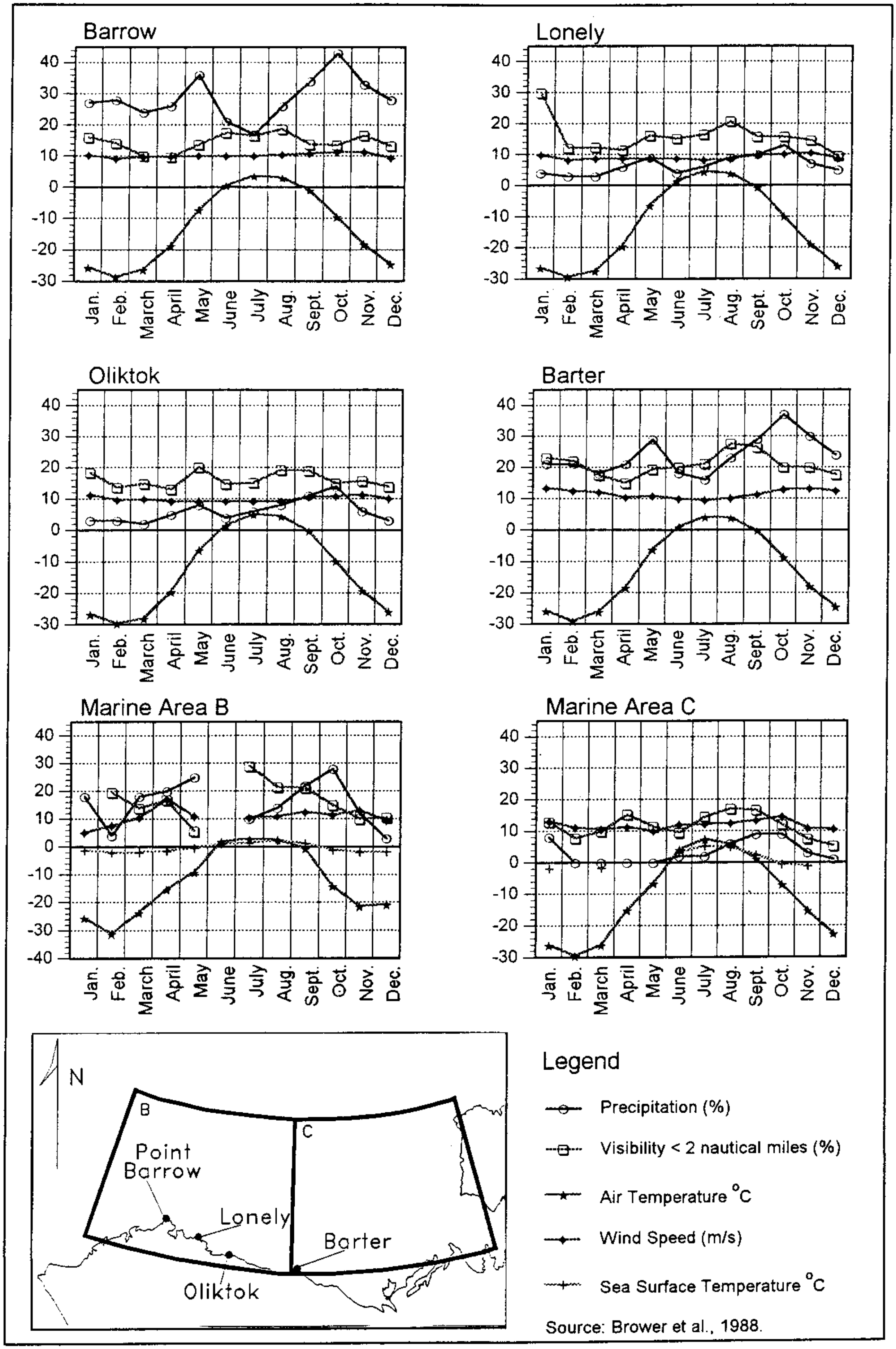


Figure III.A.2-1. General Meterorological Characteristics for Areas In and Adjacent to the Sale 144 Area occurs mostly as summer rain. Fog frequently reduces visibility along the coast in the open-water season. Winds are persistent in direction and speed. Mean annual wind speed is 5 m per second at Barrow and 6 m per second at Barter Island. Winds usually are easterly but shift to westerly from January through April. Part of this shift in winter, particularly along the eastern shores of the proposed sale area, is caused by air piling up against the Brooks Range. Sea breezes occur during about 25 percent of the summer and extend to at least 20 km offshore.

3. Beaufort Shelf Water Characteristics, Circulation, and Mixing: Substantially different circulation regimes exist on the inner and outer continental shelf and are discussed below.

a. Outer Continental Shelf (Water Depths Greater than 40 Meters) and Continental Slope: Within the Beaufort Sea Planning Area, large-scale shelf and slope surface-water circulation (<40 m) is dominated by the Beaufort Gyre, which moves water to the west at a mean rate of about 5 to 10 cm/sec (Fig. III.A.3-1). The subsurface waters (>40-50 m), called the Beaufort Undercurrent, move to the east with frequent reversals to the west (Aagaard et al., 1989). Long-term mean speeds of the undercurrent are about 5 to 10 cm/sec, but daily mean values may be 10 times greater.

The subsurface water extends from near the surface to the bottom between the 40- to 50- and 2,500-m isobaths and contains two watermasses from the Bering Sea (Mountain, 1974). The Alaska Coastal Water forms in the Bering and Chukchi seas' nearshore environments from warm, low-salinity runoff and warmed Bering Sea Water. The Bering Sea Water is colder and more saline than the Alaska Coastal Water. Near Barrow, the Alaska Coastal Water has temperatures of 5 to 10 °C and salinities that generally are <31.5 parts per thousand ($^{o}/_{oo}$); the Bering Sea Water temperatures are near 0 °C and have salinities of 32.2 to 33$^{o}/_{oo}$ (Lewbel and Gallaway, 1984). These watermasses move into the Beaufort Sea through the Barrow Canyon with mean speeds of 13 to 16 cm/sec; the Bering Sea Water flows beneath the Alaska Coastal Water (Aagaard, 1989; Aagaard and Roach, 1990). Flow reversals occur in Barrow Canyon with upwelling. These reversals are tied to the pressure gradient associated with the variable longshore current (Aagaard and Roach, 1990). The Alaska Coastal Water mixes rapidly with the surface water in the Beaufort Sea and is not clearly identifiable east of Prudhoe Bay. The Bering Sea Water has been traced as far east as Barter Island.

b. Inner Shelf (Water Depths Less than 40 Meters): The inner-shelf environment lies in waters shallower than 40 m and includes the barrier islands, open bays, lagoons, and river deltas. The inner shelf is strongly wind driven and undergoes large seasonal changes. The generalized circulation of the inner shelf is illustrated in Figures III.A.3-2a through III.A.3-2c. Wind accounts for approximately 40 to 50 percent of the nearshore-current variance in water <6 m (Hanzlick, Short, and Hachmeister, 1990).

(1) General Characteristics and Considerations:

(a) Water Temperature and Salinity Characteristics: The inner-shelf water is composed of freshwater, marine water, or a mixture of both (Hachmeister and Vinelli, 1984). The water characteristics vary with the year, season, location (bays, lagoons, deltas, and open shelf), winds (direction, speed, and persistence), river discharge, solar heating, and coastal geomorphology (Envirosphere, 1988a,b). The spatial and temporal variations are reflected in the water's thermal and saline properties. Because of the many factors affecting the water characteristics, the temperature and salinity changes are described in terms that represent a general range of values (Table III.A.3-1) or relative differences between watermasses.

The temperature and salinity noted in Table III.A.3-1 are based on the extensively studied area near the West Dock and Endicott Causeways (Envirosphere, 1988a,b) and include Gwydyr Bay and the Kuparuk River Delta, West Dock Causeway, Prudhoe Bay and the Putuligayuk River Delta, the Sag River Delta and the Endicott Causeway, and Foggy Island Bay. The temperature and salinity range is similar to other areas along the Beaufort Sea coast and indicates differences in the degree of mixing between river-plume, delta, coastal, and marine watermasses. The mixing amount depends primarily on the forces associated with the winds; strong, sustained winds are more effective in mixing than are light, variable winds.

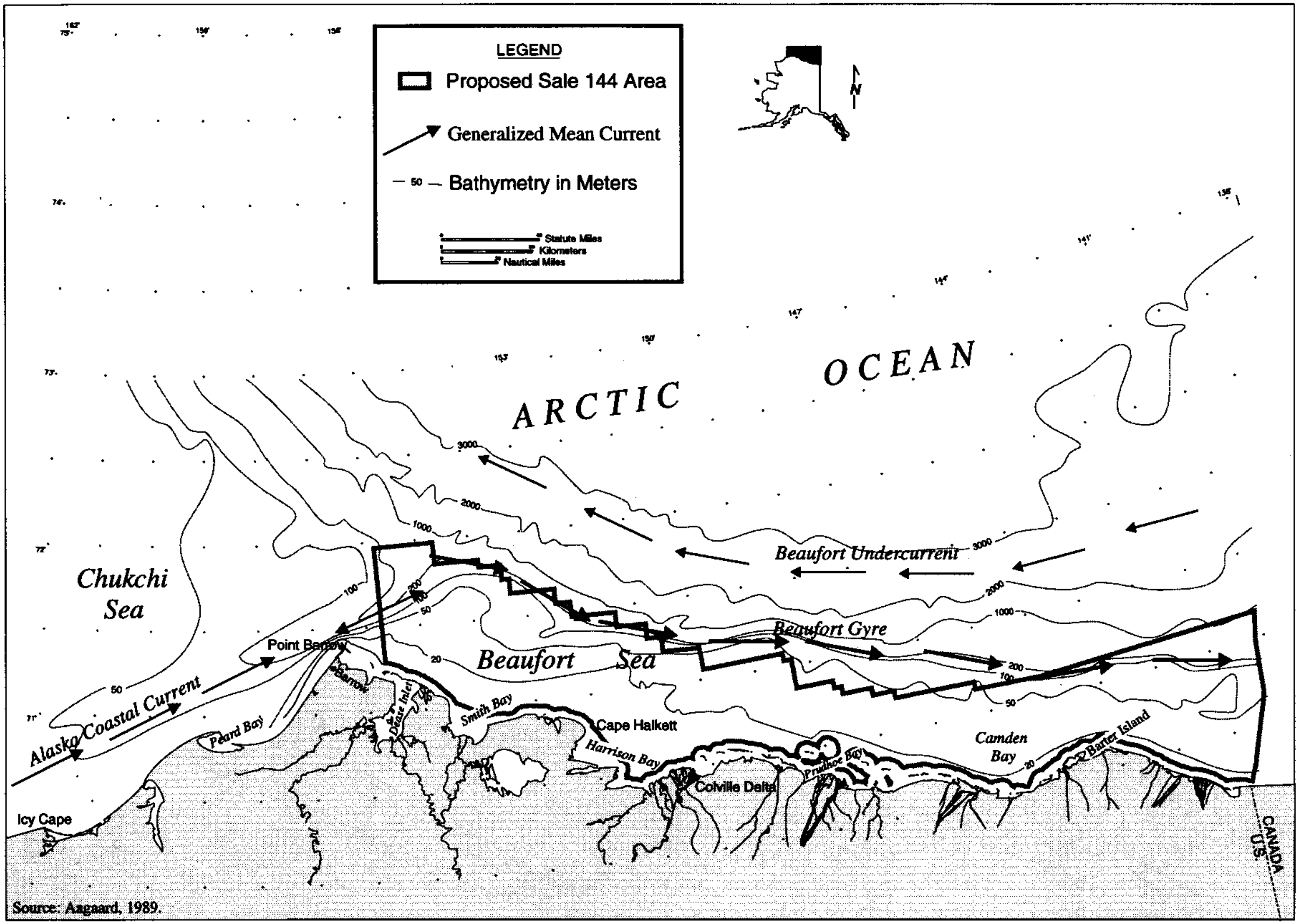
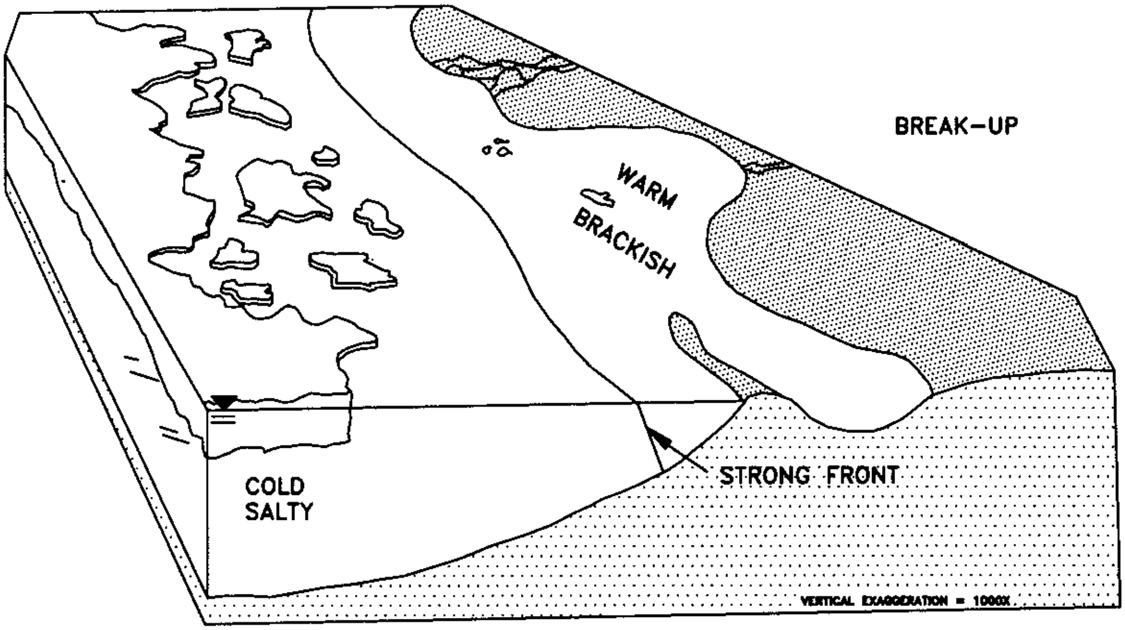
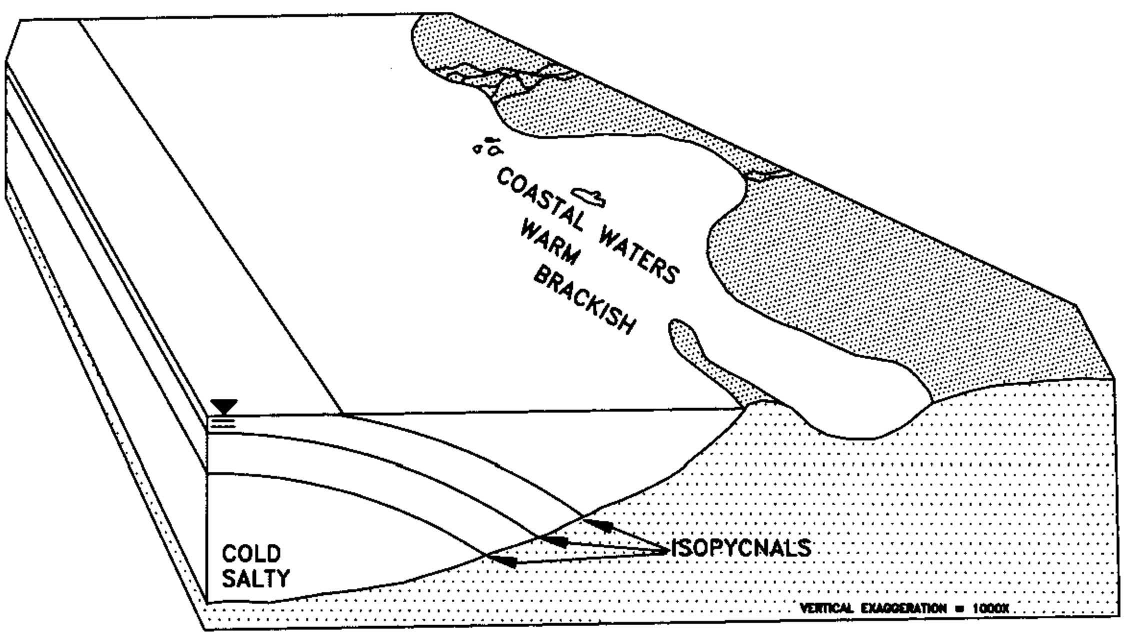


Figure III.A.3-1. Generalized Schematic of the Offshore Circulation in the Beaufort Sea

OCEANOGRAPHIC CONDITIONS FOLLOWING BREAK-UP



EARLY PHASE ONE OPEN WATER SEASON OCEANOGRAPHIC CONDITIONS
MODERATE STORMS MIX WATER MASSES AND WEAKEN THE FRONT

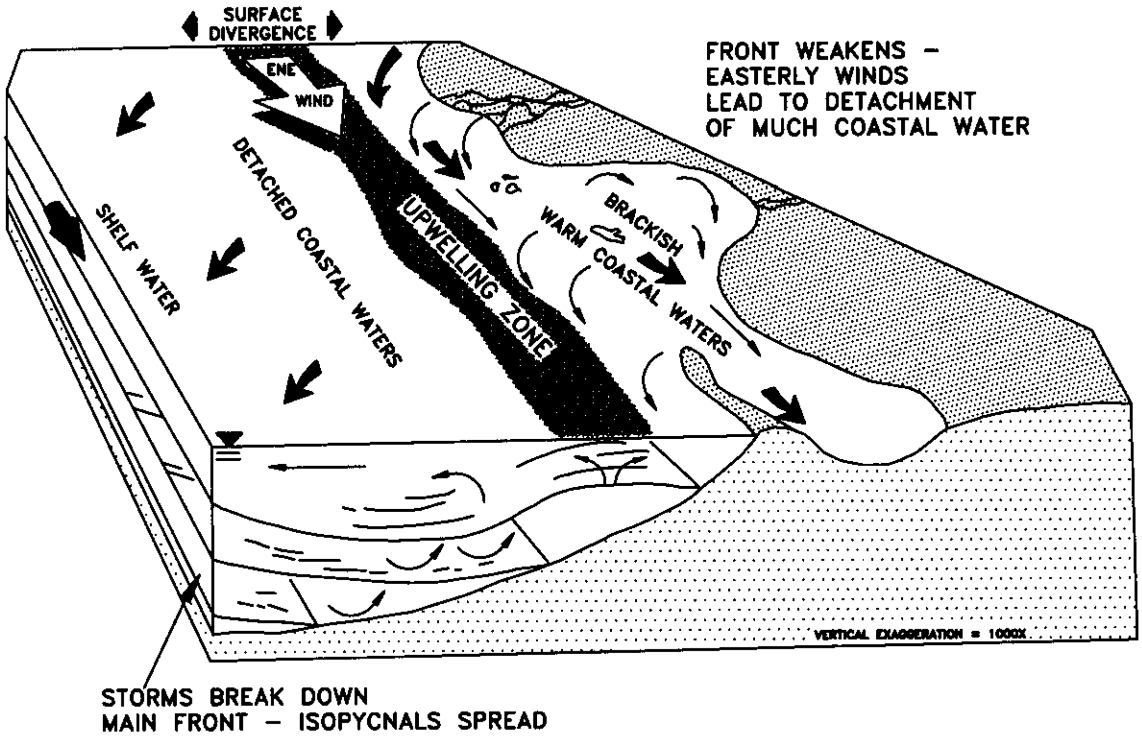


STRONG STORMS DESTROY STRATIFICATION AND RESTORE STEEP FRONT

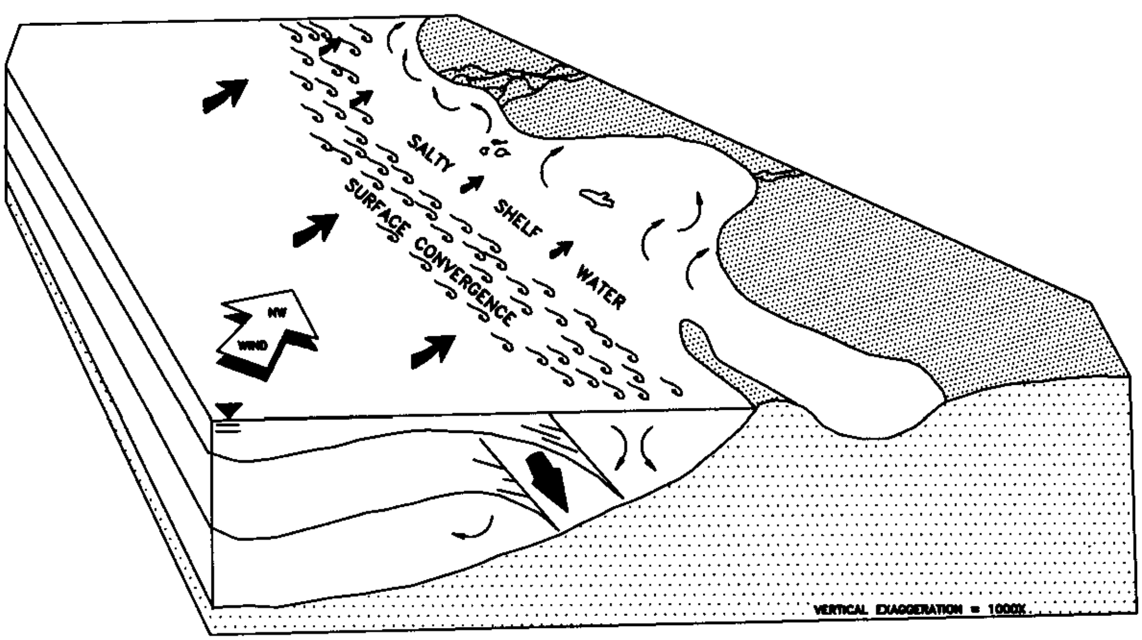
Source: Niedoroda and Colonell, 1990.

Figure III.A.3-2a Schematic of Nearshore Circulation

LATE PHASE ONE OPEN WATER SEASON OCEANOGRAPHIC CONDITIONS



END OF PHASE ONE STEP INTRUSION OF SHELF WATER ONTO COASTAL REGION



Source: Niedoroda and Colonell, 1990.

Figure III.A.3–2b Schematic of Nearshore Circulation

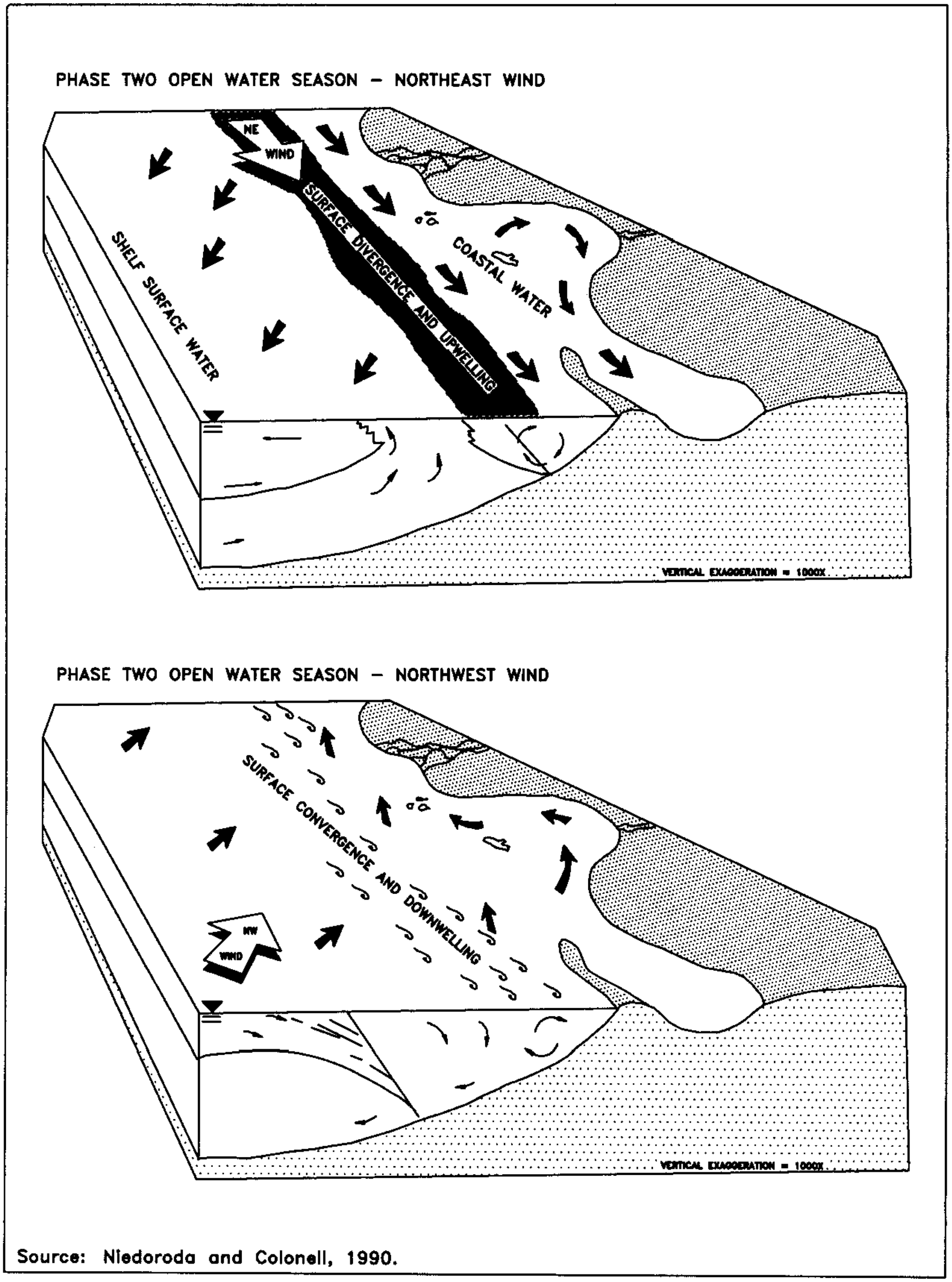


Figure III.A.3–2c Schematic of Nearshore Circulation

Table III.A.3-1
Temperatures and Salinities of
Inner-Shelf Water Types

Water Type	Temperature (°C)	Salinity (Parts per Thousand [°/₀₀])
River Discharge (Freshwater	8 - 15	<5
River Plume	2 - 5	<10
East Channel Sag River Plume		10 - 16
West Channel Sag River Plume		10 - 15
Put River Plume		10 - 15
Delta	<8 to <5	
Ice Melt	<8	
Coastal, Intermediate, Mixed Offshore		15 - 25
Coastal	0 - 9	5 - 15
Marine	0 - 2	>25 to >30
		>30
Relative Temperature Related		
Cold	<2	
Cool	2 - 5	
Moderate	5 - 9	
Warm	8 - 12	
Relative Salinity Related		
Fresh		<5
Low		10 - 15
Moderate		15 - 25
High		25 - 30

Source: Hachmeister and Vinelli, 1984; Envirosphere, 1988a; and Envirosphere, 1988b.

(b) ***Seasonal Generalizations:*** For descriptive purposes, summer (the period between the breakup and freezeup of sea ice) can be divided into three intervals: early, mid, and late.

Early Summer (Mid-June to Mid-July): Early summer is when the ice begins to melt, rivers break up and begin to overflow the sea ice, and open-water areas form in the river deltas and adjacent bays and lagoons (Envirosphere, 1988b). Open-water areas adjacent to the deltas are dominated largely by river water and offshore by ice-melt water that forms a 3- to 4-m-thick surface layer (Niedoroda and Colonell, 1991). Cold, high-salinity marine water lies below the surface layer. Due to the large density difference between the layers and the >50 percent extent of the ice cover, mixing of the fresh- and marine-water layers by wind forces during early summer is negligible (Colonell and Niedoroda, 1988; Envirosphere, 1988b; LaBelle et al., 1983).

Both the Endicott and West Dock Causeways retain fast ice and packed floes along their margins (Envirosphere, 1988b). The heat energy lost from the water due to ice melting reduces the amount of warm water near the causeways.

Midsummer (Mid-July to Mid-August): The midsummer regime begins as the open-water areas become large enough for the winds to affect mixing and circulation. The lagoons from the Colville River Delta to the Sag River Delta are dominated by warm, low-salinity water (Niedoroda and Colonell, 1991; Envirosphere, 1988b). The increase in open-water areas is the result of the ice continuing to melt and being blown farther offshore. With the increase in open-water areas, the freshwater surface layer spreads along the shore and offshore; spreading reduces the thickness of the surface layer and also increases the potential for winds to mix the surface layer of freshwater with the lower layer of marine water. Mixing produces intermediate, delta, or coastal watermasses with a range of intermediate temperatures (0-9 °C) and salinity values (5-15°/$_{oo}$) whose distribution is determined by naturally occurring physical processes and the causeways (Envirosphere, 1988b).

The early- to midsummer transition often occurs after strong easterly or westerly winds that have sufficient force to mix the surface layer of fresh river and ice-melt water with the underlying marine water (Colonell and Niedoroda, 1988; Envirosphere, 1988b).

Late Summer (Mid-August to Mid-September): Late summer is the time of falling air temperatures and decreasing freshwater discharge (Envirosphere, 1988b). The decrease in air temperature and freshwater discharge tends to reduce the temperature and salinity gradients throughout the water column (Envirosphere, 1988a); as the waters become more homogeneous, the effects of mixing different watermasses are reduced. Sometime in mid- to late August, the water temperature on the river deltas consistently remains below about 8 °C; later, the temperature of the river waters becomes colder than the coastal water temperatures. Water temperatures in the upper 3 to 4 m of the water column tend to become uniform, about 2 to 3 °C; salinities, however, remain distinguishable (Hale et al., 1989).

If a major storm affects all or part of the Beaufort Sea coast, the transition to the late-summer regime can occur rapidly in the affected areas; such storms tend to occur from the end of July to mid-August (Niedoroda and Colonell, 1990; Envirosphere, 1988b). As a result of late-summer-storm conditions, water temperatures along the coast can decrease from 8 to12 °C to 3 to 5 °C, and salinities can increase 10 or more parts per thousand within 24 hours. Following a storm, the warmer, lower salinity watermass regimes may be reestablished, especially in the river deltas and adjacent bays and lagoons.

(2) ***Circulation:*** Inner-shelf circulation primarily is wind driven (Hanzlick, Short, and Hachmeister, 1990); other factors controlling water movement include river discharge, ice melt, bathymetry, and coastal geomorphology. The current speed is approximately 3 to 4 percent of the wind speed (Hanzlick, Short, and Hachmeister, 1990). Wind direction and frequency influence the surface-current direction, watermass-residence time, and the mixing between different watermasses. The nearshore surface water responds quickly, within 1 to 3 hours, to changes in the wind direction from sustained easterly (or westerly) to sustained westerly (or easterly) (Hanzlick, Short, and Hachmeister, 1990; Segar, 1990). Natural shelf circulation exhibits a strong continuity in the direction parallel to the shelf and large zonal variations across the shelf (Hachmeister and Vinelli, 1984). The water circulation below the mixed layer appears to be driven primarily by ocean circulation rather than the winds (Aagaard, Pease and Salo, 1988).

During the open-water period, the prevailing winds along the Beaufort Sea coast are easterly (from the east-northeast) (Hachmeister and Vinelli, 1984). Westerly winds (from the west-northwest) are more common in the fall and winter and occur more frequently at Barter Island than at Point Barrow. Sustained easterly winds transport water along the shore to the west while westerly winds move the water to the east; the main flow direction generally is orientated parallel to the bathymetric contours. Along the Beaufort Sea coast, from Point Barrow to Barter Island, the year-round mean surface-current direction is to the west. East of Barter Island, there is a mean westward flow in the summer and eastward flow in the winter.

In addition to the east or west components, the alongshore-water transport also has a slight offshore or onshore component. Upper-surface water that is being transported to the west under the influence of easterly winds has a slight offshore-transport component. The transport of the nearshore, warm, less saline surface waters offshore causes a horizontal divergence and a decrease in the sea level that is balanced by the onshore transport of cooler, more saline marine waters flowing onshore beneath and toward the surface layer. During westerly winds, the upper-surface water is transported to the east and slightly shoreward. The shoreward transport of surface water results in the elevation of the sea surface along the shore, and this causes the water in the lower layer to move offshore. A change from easterly winds to westerly generally results in warmer water replacing the cooler, more saline marine water that encroaches along the coast during easterly winds. During westerly winds, when the dominant flow direction is to the east, the water column tends to become more vertically homogeneous (Segar, 1990).

The residence time of fresh- or low-salinity water in the nearshore environments largely depends on the frequency and direction of the easterly and westerly winds (Envirosphere, 1988a). During the years dominated by persistent easterly winds, the residence time of freshwater is relatively short because the coastal watermasses are transported offshore. However, in the years when westerly winds predominate, the freshwater-residence time is relatively long because coastal watermasses are kept nearshore.

In addition to the wind-driven circulation, there also are several naturally occurring phenomena that induce transverse (cross-shelf) water-transport patterns (Hachmeister and Vinelli, 1984). In the spring and summer, warm, freshwater runoff accumulates in the surface layer on and adjacent to the deltas. As part of this water spreads seaward across the shelf, there is an accompanying onshore flow of cooler, more saline marine water in a subsurface layer (similar to estuarine flow except it occurs along the entire coastline; estuarine flow is characterized by a strong vertical stratification of the water column and a seaward flow of the surface layer and shoreward flow of the subsurface layer). This estuarine-type circulation probably is most important during the period of high runoff in late spring-early summer and continues to a lesser extent throughout the summer.

The discharge from large rivers such as the Colville and Sag modifies the coastal current patterns and influences mixing and temperature and salinity-distribution patterns (Envirosphere, 1988a). The surface plumes from these rivers have a strong offshore component that contributes to onshore flow of subsurface water, especially during easterly winds.

Transverse flow also occurs in the winter. As seawater freezes, dense brine forms and flows offshore in the lower layer; this offshore flow probably is accompanied by an onshore flow in the upper layer (Hachmeister and Vinelli, 1984). Brine flow is most important during the early freezeup, especially in the shallow, nearshore water, and probably continues throughout the winter.

(a) Lagoon Circulation Patterns and Water Exchanges with the Nearshore Environment: The circulation and water-exchange patterns of lagoons along the Beaufort Sea coast may be classified as (1) open—lagoons are open to alongshore transport as well as cross-shelf exchange through the multiple large openings between the barrier islands, (2) pulsing—exchange with the nearshore waters primarily occurs via tidal currents through a single major entrance, and (3) limited exchange—the flow of alongshore currents through several large entrances to the lagoon is limited (Hachmeister and Vinelli, 1984).

Open-Type Lagoons (Simpson Lagoon): The lagoons between Point Barrow and Barter Island are open types (Hachmeister and Vinelli, 1984). Simpson Lagoon has been the most extensively studied of these lagoons. The following discussion of lagoon circulation pertains to Simpson Lagoon and generally applies to other open-type lagoons.

Easterly Winds: During easterly winds, the warmer (4 °C or warmer), lower salinity (≤24°/₀₀) water, formed by the mixing of lagoon water with freshwater runoff, is transported westward through the lagoon and exits through the passes in the western part of the lagoon. The transport through the lagoon is similar to the wind-driven, alongshore transport seaward of the barrier islands (Hachmeister and Vinelli, 1984). Wind-driven water seaward of the barrier islands generally enters in the eastern and central parts of the lagoon through the passes and is transported westward through the lagoon. The westward wind-driven transport through the lagoon also is accompanied by some offshore transport of the surface water. Wind-driven surface water transported seaward of the lagoon is replaced by colder (0 °C), more saline (30°/₀₀) marine water that flows into the lagoons through the passes.

In addition to the easterly wind-driven transport are the effects of the tidal cycle. During floodtides, tidal currents at each entrance transport colder, more saline marine water into the lagoon where it partially mixes with lagoon water and is transported to the west. On ebb tides, the net westward flow through the lagoon is reduced, and lagoon water collects near the eastern entrances to the lagoon and forms pools of warmer, fresher water. Inside the lagoon, the tidal cycles result in the formation of alternating pools of cooler, more saline nearshore water (formed during the flood) and warmer, less saline lagoon water (formed by the mixing of nearshore water from the previous flood with freshwater from river runoff) that are transported westward through the lagoon.

Westerly Winds: Westerly winds cause the waters to flow easterly through Simpson Lagoon. Warm, fresh water from the Colville River enters the Lagoon, and Kuparuk River water flows into the eastern part (Gwydyr Bay). Also, alongshore transport of nearshore water seaward of the barrier islands is toward the east and shoreward; some of the nearshore waters are transported into the lagoon. As a result of this transport, the temperature and salinity characteristics of the nearshore and lagoon waters become similar. The formation of alternating pools of lagoon and nearshore water does not occur inside the lagoon during westerly winds.

Pulsing-Type Lagoons: Pulsing-type lagoons comprise about 15 percent of the coast east of Barter Island. This type of lagoon is characterized by one major entrance through the barrier islands, and the exchange with the nearshore water occurs primarily via tidal currents through this entrance. There also may be other entrances; but these usually are shallow, and the amount of exchange through them is small. One or more small rivers or streams may empty into this type of lagoon, providing a source of freshwater, particularly in the spring. Angun Lagoon and Pokok Bay are examples of pulsing-type lagoons.

As a result of the water transport associated with easterly winds, the nearshore water that is available for exchange with Angun Lagoon and Pokok Bay has somewhat lower temperatures and higher salinities than waters in these lagoons. During a tidal cycle, cooler, higher salinity nearshore water enters the lagoon on the flood tide. Inside the lagoon, this water mixes with the lagoon water and, during the ebb tide, mixed lagoon water flows out. Because the waters entering the lagoon do not flow through in a manner similar to the open-type lagoon (Simpson Lagoon), the circulation in a pulsing lagoon does not consist of alternating pools of lagoon and nearshore water. The flushing efficiency (percent water exchange per tidal cycle) for Pokok Bay is estimated to be between 15 and 20 percent and for Angun Lagoon between 7 and 10 percent. During westerly winds, the characteristics of the nearshore water become similar to those of the lagoon water.

Limited-Exchange-Type Lagoons: Limited-exchange lagoons comprise about 75 percent of the coast east of Barter Island; Beaufort Lagoon is an example of this type of lagoon. Although there are several large openings in the barrier islands that enclose the seaward side of this lagoon, the flow of alongshore currents through the lagoon is limited. Water exchange between the nearshore and lagoon environment may or may not be affected by tidal action.

(b) Gwydyr Bay to Foggy Island Bay: The coastal area between Gwydyr Bay and Foggy Island Bay, includes Gwydyr Bay and the Kuparuk River Delta, the West Dock Causeway, Prudhoe Bay and the Put River Delta, the Sag River Delta and the Endicott Causeway, and Foggy Island Bay. West Dock Causeway and the Endicott Causeway are manmade structures that act as geomorphological features affecting the circulation and mixing of watermasses (Envirosphere, 1988b). Both causeways generally are orientated perpendicular to the bathymetry. This orientation deflects the east-west transport of water along the inner shelf offshore and causes changes in the hydrographic conditions downstream from the causeways; these changes are indicated by temperature and salinity gradients between the areas east and west of the causeways.

West Dock Causeway is a 13,100-ft-long, solid-fill, gravel causeway located northwest of Prudhoe Bay (Envirosphere, 1988a). The causeway provides road and pipeline access to docks and the Seawater Treatment Plant. Construction of the causeway occurred in three stages: 4,440 ft in 1974 to 1975; 5,000 ft in 1975 to 1976; and 3,700 ft in 1981 to 1983; until 1995, the only breach in the causeway was a 50-ft opening near the juncture of the second and third segments. In the summer of 1995, a 650-ft breach was added. Water depths around the causeway average about 2 to 3 m. The effects of the West Dock Causeway are largely based on data obtained from 1985 through 1987 (Envirosphere, 1988a). Estimates of precauseway conditions are based on limited data available before the construction of the causeway and knowledge of coastal processes.

The Endicott Causeway is located on the delta of the Sag River and provides road and pipeline access from the mainland to two petroleum-production islands located approximately 2.5 mi offshore (Envirosphere, 1988b). The gravel causeway consists of a mainland-to-interisland segment and an interisland segment and is about 5 mi long. The causeway contains two breaches, both located along the mainland-to-interisland segment and spanned by bridges. An inner breach, 500 ft long, spans a natural channel of the Sag River Delta near the mainland. The outer breach is located about a mile north of the inner breach and is about 200 ft long. A 650-ft breach was added in 1994. The causeway separates the discharge from the west and east channels of the Sag River.

The effects of the Endicott Causeway on inner-shelf circulation and the characteristics of the watermasses are based on data obtained during 1985 through 1990 (Envirosphere, 1988b; Niedoroda and Colonell, 1990; Science Applications International Corporation, 1992; 1993). Conditions prior to the causeway are hypothesized from a review and analysis of the 1985 and 1986 data, precauseway historical data, and existing knowledge and theory of coastal hydrodynamics.

Easterly Winds:

Endicott Causeway: The warm (8-12 °C), low-salinity (0-15‰) coastal water from Foggy Island Bay and river-plume water from the east channel of the Sag River that are transported to the west during easterly winds are blocked by the Endicott Causeway and diverted offshore (Envirosphere, 1988b). This offshore transport produces a divergence in the flow field of the surface water and a lowering of the sea level, which cause cold (0-2 °C), high-salinity (30‰) marine water to upwell onto the Sag River Delta platform on both sides of the causeway (Envirosphere, 1988a, Niedoroda and Colonell, 1990); upwelling reaches to about the 0.5- to 1-m-contour interval across the delta. The offshore diversion and upwelling enhance the mixing of the river water from the east channel of the Sag River with the marine water; and the mixing changes part of the warm, less saline river water into cooler, more saline coastal water. This decay of part of the river plume reduces the size of the amount of warm, less saline water transported westward. The marine water also decays as it mixes with adjacent and overlying river-plume water. Water from the west channel of the Sag River also mixes with the marine water upwelled along the delta front and in the lee of the causeway. Mixing of the surface water with cold, high-salinity marine water is enhanced if an eddy develops in the lee of the causeway during easterly winds (Segar, 1990).

Mixing of the waters from the east and west channels of the Sag River with cooler, more saline, upwelled water reduces the amount of warm, low-salinity, river-plume water transported to the west toward Prudhoe Bay, Gwydyr Bay, and Simpson Lagoon. The westward flow of water is across the mouth of Prudhoe Bay; circulation in the Bay is clockwise.

Upwelling and mixing of the delta water and upwelled water in the lee of the causeway also forms pools of water that are colder and more saline than the water from the west channel of the Sag River that overlies the western part of the delta (Envirosphere, 1988b); the pools cause discontinuities—breaks—in the alongshore continuity of the delta water. However, the temperature and salinity differences between water in the discontinuities and delta water may be relatively small because of the inflow of warm, freshwater from the west channel. In the shallow areas where upwelled marine water does not penetrate, the temperature of the water is influenced by the temperature of the river water and solar heating.

West Dock Causeway: The general effects of the West Dock Causeway on the westerly transport of water during easterly winds are similar to those of Endicott. Waters being transported westward from the Sag River Delta and Prudhoe Bay are diverted offshore by the West Dock Causeway (Envirosphere, 1988a). This offshore transport enhances upwelling of marine water on both sides of the dock. Mixing of the cold, high-salinity marine water with the surface water is enhanced if an eddy develops in the lee of the causeway during easterly winds (Segar, 1990). The effects of mixing are greater at West Dock than at Endicott because of the lack of warm, freshwater input.

Upwelled water on the east side of West Dock is transported into the passage between the dock and Stump Island and westward past the barrier islands off Gwydyr Bay and Simpson Lagoon. This water is cooler and more saline than would be the water of alongshore flow before the causeway (Hale et al., 1989) and would enter Gwydyr Bay and Simpson Lagoon through the channels between the barrier islands. A discontinuity in the Sag River plume occurs between Prudhoe Bay and Simpson Lagoon as the plume decays within a few kilometers of the end of West Dock.

In the later part of the open-water season, the temperatures in the upper 3 to 4 m of the water column become more uniform, and the effects of West Dock on temperature distributions is reduced (Hale et al., 1989, Niedoroda and Colonell, 1990). However, river discharge and upwelling continue to affect the salinity of the nearshore water, and the effects of West Dock on salinity distributions is about the same as it was during midseason.

Cumulative Effects of Endicott and West Dock Causeways: During easterly winds, the Endicott and West Dock Causeways enhance the offshore transport of warm, brackish water and upwelling of marine water along the coast (Envirosphere, 1988b). Under sustained easterly winds, cool, moderate- to high-salinity water dominates the area from Foggy Island Bay to Gwydyr Bay except for areas within the Sag River Delta directly influenced by the river plume. This reduces the amount of warm, low-salinity water on the Sag River Delta, in Prudhoe and Gwydyr Bays, and in Simpson Lagoon.

Precauseway: It is estimated that prior to the construction of the causeways, the main part of the westerly alongshore transport of water would be orientated parallel to the bathymetry (Envirosphere, 1988b). There also would be some offshore transport of coastal and river-plume waters and upwelling of marine waters. In the absence of the causeways, this offshore transport and upwelling would be less than it is with the causeways; upwelling would extend only to about the 2- to 3-m isobath.

In the absence of the Endicott Causeway, river-plume water from the east channel of the Sag River would be transported across the delta during easterly winds and diverted offshore (Envirosphere, 1988b). The nearshore water between the Sag River Delta and Gwydyr Bay would be warmer and less saline and would form a continuous alongshore band of brackish water during easterly winds. During midsummer, it is estimated that the water overlying the Sag River Delta typically would be composed of water in which the temperature at the surface decreased from >6 or 7 °C nearshore to 3 or 4 °C offshore, and the salinity increased from about 5 to 25-30‰; the bottom-water temperatures would be decreased from values ranging from 3 to 7 °C nearshore (the lower temperatures indicate a greater influence of marine waters and the higher temperatures indicate a greater influence of river or nearshore water) to 0 to -1 °C offshore. Temperature and salinity gradients generally would be parallel to the bathymetry.

The amount of Sag River plume water moving westward would be large and would incorporate a larger amount of lower salinity coastal water into the outer part of its flow pattern (Envirosphere, 1988a). At West Dock, this water would be diverted offshore, and the offshore transport of a large plume would create a larger surface divergence and enhance upwelling over the pre-Endicott regime.

In the absence of West Dock, there would be less low-temperature, high-salinity water entering Gwydyr Bay and Simpson Lagoon; upwelled water would extend only to depths of about 2 or 3 m west of West Dock (Envirosphere, 1988a).

Westerly Winds: The change from easterly winds to westerly winds slows or stops the movement of warm, low-salinity waters offshore (Envirosphere, 1988b). Cool, moderate-salinity offshore water and marine water that has upwelled in the vicinity of the causeways are transported eastward and slightly onshore and replace any warm, low-salinity water that might exist in areas east of the causeways.

If west winds persist for several days or more, the areas west of the causeways are flushed with warm, low-salinity water (Envirosphere, 1988b). Under sustained westerly winds, part of the Colville River plume, consisting of warm, low- to moderate-salinity water, flows through Simpson Lagoon and Gwydyr Bay; and the other part flows seaward of the barrier islands and directly into Stefansson Sound. If west winds persist for more than several days, the Colville River plume may extend to the Sag River Delta.

West Dock Causeway: Coastal water flowing eastward offshore of the Simpson Lagoon-Gwydyr Bay barrier islands is diverted offshore by the West Dock Causeway and continues toward the Sag River Delta following bathymetric contours (Envirosphere, 1988a).

Surface water flowing out of Gwydyr Bay is diverted northward by the dock. When the surface water from the west side of West Dock encounters the eastward-flowing coastal waters, it turns and flows eastward along the bathymetric contours. During its eastward transport, this warm, brackish water does not enter Prudhoe Bay but remains seaward of the 4-m isobath. Cold, high-salinity marine water that has upwelled on the west side of West Dock during easterly winds also is diverted around West Dock during westerly winds. Following the change from easterly to westerly winds, this marine water enters Prudhoe Bay.

Endicott Causeway: Upwelled waters in the northeastern part of Prudhoe Bay and on the western part of the Sag River Delta are transported toward the Endicott Causeway (Envirosphere, 1988b). These waters meet and mix with river water from the west channel of the Sag River before passing around the end of the causeway or through the breaches. The water of the western part of the Sag River Delta is affected by residual marine water upwelled during previous easterly winds and by mixing of water along the west side of the causeway. Part of the water that is deflected past the causeway mixes with underlying marine water. The westward transport of cooler, high-salinity water and mixing reduces the amount of warm, low-salinity water on the western part of the Sag River Delta. The causeway also shelters the east-channel plume from the direct driving force of the westerly winds. As a result of this sheltering effect, the water from the east channel flows offshore and mixes with higher salinity water (Envirosphere, 1988b).

The effects of the Endicott Causeway are to reduce the amount of warm, low-salinity water that flows into Foggy Island Bay during westerly winds.

Precauseway Effects: In the absence of the West Dock and Endicott Causeways, there would be a natural distribution of the water in the area from Gwydyr Bay to Foggy Island Bay—the water-characteristics pattern basically would show a continuum along the shelf and offshore gradients. The residual effects of upwelling and mixing that happened during easterly winds would not occur. The waters along the coast would be warmer and less saline than are the waters affected by the presence of the causeways. Thus warmer, less saline waters would be transported into areas east of the present causeway sites during westerly winds.

c. Waves and Swells: The entire coastline adjacent to the planning area is a low-wave-energy environment. Waves, which generally are from the northeast and east, are limited to the open-water season. The ice pack limits fetch even during this season. Because of the pack ice, significant wave heights are reduced by a factor of four from heights that otherwise would be expected in summer. Wave heights >0.5 m occur in <20 percent of the observations summarized by Brower et al. (1988); wave heights >5.5 m are not reported within the limited Beaufort Sea database of 5,968 observations.

d. Storm Surges: Summer and fall storms frequently generate storm surges along the Beaufort and Chukchi Sea coasts. Sea-level increases of 1 to 3 m have been observed along the Beaufort Sea coast; the largest increases have occurred on westward-facing shores. Storm surges also occur during the period from December through February, but changes in sea-level elevation generally are less than in summer and fall. Decreases in sea-level elevation also occur and appear to be more frequent in the winter months.

e. Tides: Tides in the eastern Chukchi and Beaufort seas are very small and generally are mixed semidiurnal with mean ranges from 10 to 30 cm. The tide appears to approach the shelf from the north. Tide height increases slightly west to east along stations on the Beaufort Sea coast.

f. ***River Discharge:*** The Colville River is the major river entering the Alaskan Beaufort Sea. Annual discharge of the Colville River is 2 cubic kilometers (km^3) this is about 73 percent of the total discharge of all rivers between the Colville and the Canning Rivers. During spring thaw in June, the Colville River discharges 50 percent of its annual flow. The Colville and other large rivers along the coast discharge as late as January, with no further measurable discharge until late April or early May. Seawater intrusions into river deltas occur from mid-autumn through winter. Spring and summer discharge of the Colville River and lesser rivers greatly affects the salinity, nutrient regimes, and turbidity of the nearshore Beaufort Sea.

4. Sea Ice:

a. ***Winter Conditions:*** Beaufort Sea wintertime conditions begin with freezeup and an increase in the sea-ice concentration. Although there are considerable spatial and temporal variations, the September arctic pack-ice edge of an "average year" ranges from 20 to 110 km offshore (LaBelle et al., 1983). In October, the edge moves south of Barrow, and more than 50 percent of the planning area is covered with ice; from November through May, the ice covers more than 90 percent of the planning area. The planning area's winter sea-ice regime is divided into the landfast-ice zone, the stamukhi (or shear) zone, and the pack-ice zone (Fig. III.A.4-1).

(1) ***Landfast-Ice Zone:*** The landfast-ice zone extends from the shore out to the zone of grounded ridges. These ridges first form in about 8 to 15 m of water but by late winter may extend beyond the 20-m isobath. Wind and water stresses on floating fast-ice sheets may result in displacements and deformations. Displacements in later winter usually are on the order of tens of meters, but larger displacements up to several hundred meters have been observed. Deformations take the form of pileups and rideups on the coastal and island beaches and rubble fields and small ridges offshore. As the winter progresses,

extensive deformation within the landfast-ice zone generally decreases as the ice in the landfast zone thickens and strengthens and becomes more resistant to deformation.

By late winter, first-year sea ice in the Beaufort Sea landfast-ice zone generally is about 2 m thick; out to a depth of about 2 m, it is frozen to the bottom, forming the bottomfast-ice subzone. The remaining ice in the landfast zone is floating—forming the floating fast-ice subzone. In the Chukchi Sea, the landfast ice usually thickens to about 1.3 to 2.0 m before breakup.

The onshore movement of sea ice in the landfast-ice zone is a relatively common event that generates pileups and rideups along the coast and on offshore and barrier islands. The onshore pileups frequently extend up to 20 m inland from the shoreline over both gently sloping terrain and up onto steep coastal bluffs. Ice rideups, where the whole ice sheet slides in a relatively unbroken manner over the ground surface for more than 50 m, are not very frequent; rideups that extend more than 100 m are relatively infrequent.

In addition to their effects on circulation, as discussed in Section III.A.3.b(2)(b), causeways also affect the local breakup of ice. Observations in 1985 and 1986 indicated that the Endicott Causeway contributed to the early draining of floodwaters from the Sag River and breakup of the floating ice along the delta front (Envirosphere, 1988b). However, pack-ice floes were retained along the north and east side of the causeway after breakup of the fast ice along the delta front. The West Dock Causeway prohibits the spreading of the Kuparuk River floodwater southeastward along the shore into Prudhoe Bay and delays the melting and breakup of ice along the western shore of Prudhoe Bay (Envirosphere, 1988a). The causeway also delays the melting and breakup of ice in the more sheltered areas to the west.

(2) ***Stamukhi Zone:*** Seaward of the landfast-ice zone is the stamukhi, or shear, zone. This 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 and leads. In the Beaufort Sea, the region of most intense ridging occurs in waters that are 15 to 45 m deep.

As shown in Figure III.A.4-1, one of the characteristics of the stamukhi zone is that some portions of the ice are grounded on the seafloor. The outer edge of the stamukhi zone appears to advance seaward during the ice season.

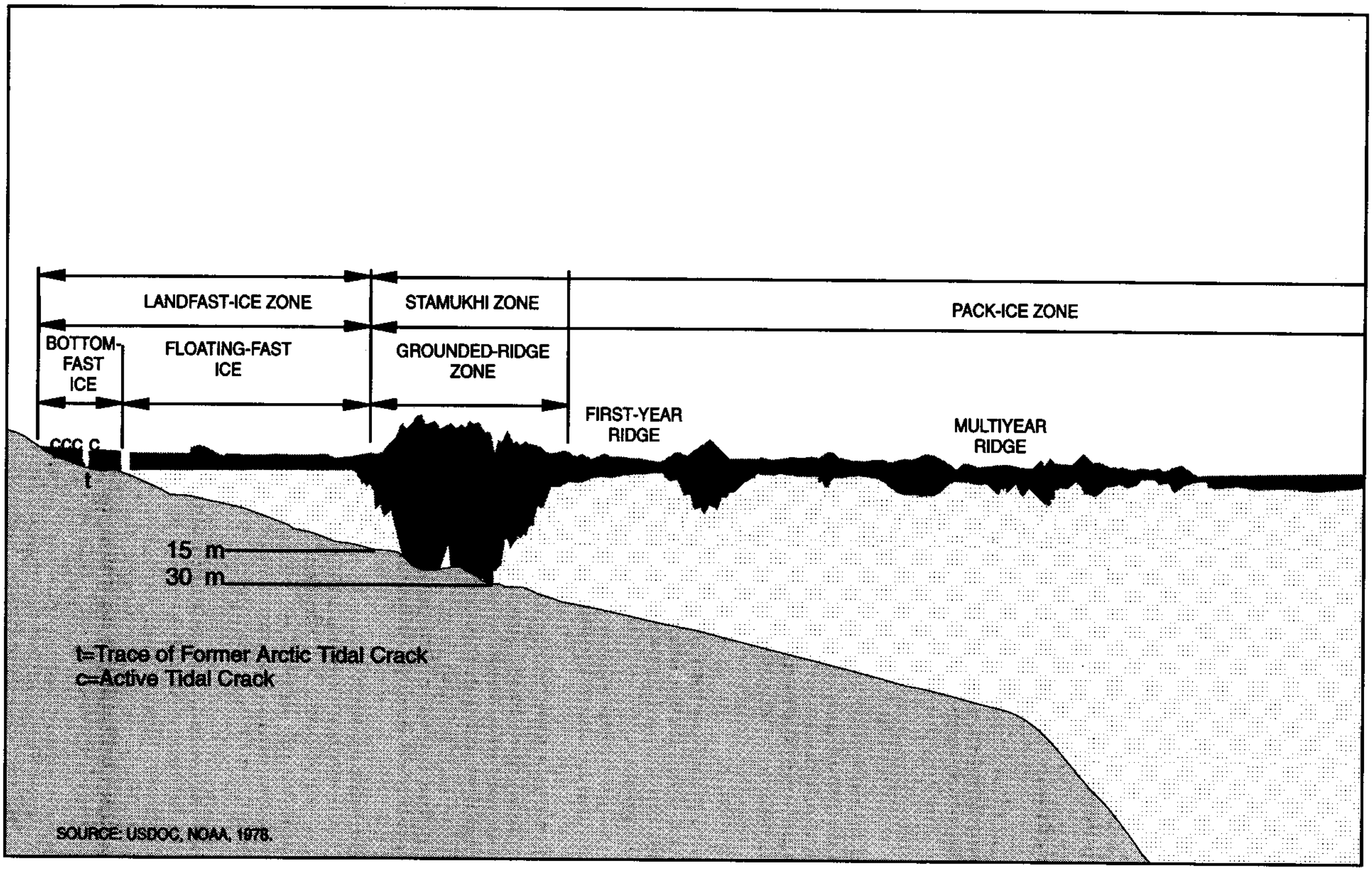


Figure III.A.4-1. Winter-Ice Zonation of the Beaufort Sea Coast

Shoreward of the 60-m isobath, long, linear depressions have been cut into the sediments of the Beaufort Sea continental shelf by the plowing action of drifting ice masses. The dominant orientation of these ice gouges in waters 10 to 50 m deep generally is parallel to the coast. The highest average (mean) values of those features—such as individual gouge density, depth, and width—usually occur within the stamukhi zone.

Gouge densities of >100 gouges/km^2 are found in waters 20 to 40 m deep. Dense gouging also occurs on the seaward side of the shoals. The lowest gouge densities are located in waters that are <5 m deep and greater than 45 m deep.

Gouges with average depths of >1 m generally are found in waters between 20 and 55 m deep. However, the maximum measured draft of sea ice in the Arctic Ocean is only 47 m. Thus, the gouges observed seaward of about 47 m may be cut by deeper keels with a return period of a few hundred years or less, or they may be relict features cut during the lower sea-level period of many thousands of years in age.

In the Chukchi Sea portion of the Beaufort Sea Planning Area, ice gouging of the seafloor sediments appears to be more intense shoreward of the Barrow Sea Valley and in the vicinity of Hanna Shoal. Densities in excess of 50 gouges/km in water depths of 20 to 35 m are reported as being widespread from Point Barrow to Point Hope. Ice gouging is relatively dense on the north and southeast side of Hanna Shoal.

(3) Pack-Ice Zone: The pack-ice zone lies seaward of the stamukhi zone and includes first-year ice, multiyear undeformed and deformed ice, and ice islands. The first-year ice that forms in the fractures, leads, and polynyas (large areas of open water) within the pack-ice zone varies in thickness from a few centimeters to more than a meter. Multiyear ice is simply defined as ice that has survived one or more melt seasons; undeformed multiyear ice is believed to reach a steady-state thickness of 3 to 5 m. Undeformed ice floes with diameters >500 m occupy about 60 percent of the pack-ice zone; some floes may have diameters up to 10 km.

Ridges are a prominent indicator of deformed ice. The height of most ridges appears to be about 1 to 2 m; ridge heights up to 6.4 m have been observed. The relationship between ridge sail height and keel depths suggests a sail-to-keel ratio of about 1:4.5 for first-year ice ridges and 1:3.3 for multiyear ridges. Multiyear composite maps of major ridges indicate that (1) in the nearshore region, there is a pronounced increase in ridge density in the vicinity of shoals and large promontories; (2) massive ridges occur shoreward of the 20-m isobath; and (3) in the eastern Beaufort Sea 30 to 40 km from the coast, there is an increase in ridging from east to west.

Ice islands are large, tabular icebergs that calve (break away) 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. The size of the ice islands may be up to 1,000 or more square miles and their thicknesses up to 60 m. During the observation period from 1963 through 1986, 1,053 km^2 of ice were lost from the Ellesmere and Axel Heiberg ice shelves. The amount of ice lost in any year varied from 0 to 569 km^2. The ice-shelf observations and ice-island sightings indicate that it may take 10 or more years for ice islands to reach locations within the Beaufort Sea Planning Area.

During the winter, movement in the pack-ice zone of the Beaufort Sea generally is small and tends to occur as discrete events associated with strong winds of several days' duration. The long-term direction of ice movement is from east to west in response to the Beaufort Gyre; however, there may be short-term perturbations from the general trend due to the passage of low- and high-pressure weather systems across the Arctic. The velocity of the pack ice has been variously reported as having (1) a mean annual net drift of 1.4 to 4.8 km per day and (2) an actual rate of 2.2 to 7.4 km per day, with extreme events up to 32 km per day.

During the winter, the pack ice in the northern part of the Chukchi Sea generally moves in a westerly direction in response to the Beaufort Gyre. The pack ice in the southern part of the Chukchi Sea usually is transported to the north or northwest. However, strong driving forces associated with northerly winds and southerly currents acting over a long period of time will force the ice in a band that is ≥100 km wide and extends from the Bering Strait northward along the Alaskan coast past Point Barrow to move southward.

Hanna Shoal is a site for the accumulation of ice features, such as ice-island fragments or ridges, that have drafts >25 m. Recurrent groundings of ice islands or ridges with progressively deeper drafts result in the seasonal growth of this field.

(4) Leads and Open-Water Areas: Data obtained from aerial and satellite remote sensing show that leads and open-water areas form within the pack-ice zone. Southwesterly storms cause leads to form in the Beaufort Sea.

Along the western Alaskan coast between Point Hope and Point Barrow, there is often a band of open water seaward of the landfast-ice zone during winter and spring. This opening is at some times a well-defined lead and at other times a series of openings in the sea ice or polynyas. The northern part of this open-water system extends into the Chukchi Sea portion of the Beaufort Sea Planning Area. Between February and April, the average width is <1 km (the extreme widths range from a few km in February to 20 km in April) and is open about 50 percent of the time. The Chukchi open-water system appears to be the result of the general westward motion seen in the Beaufort Gyre. Also, there appears to be a positive correlation between the average ice motion away from the coast and the mean wind direction, which is from the northeast for all months except July.

b. Summer Conditions: By the middle of July, much of the lagoonal and open-shelf fast ice inside the 10-m isobath has melted; and there has been some movement of the ice. After the first openings and ice movement in late June to early July, the areas of open water with few ice floes expand along the coast and away from the shore, and there is a seaward migration of the pack-ice zone. The concentration of ice floes generally increases seaward and, as the pack retreats, the width of the bands that define percentage of sea-ice cover also increases. During the summer, winds from the east and northeast are the most common along the Alaskan Beaufort Sea coast. These winds drive the ice offshore; westerly winds move the ice onshore.

5. Water Quality: Due to little or no industrial activity, most contaminants occur at low levels in the Beaufort Sea Planning Area. However, turbidity, trace metals, and hydrocarbons are introduced into the marine environment through river runoff, coastal erosion, atmospheric deposition, and natural seeps. The rivers (Colville, Kuparuk, Sagavanirktok, and Canning) that flow into the Alaskan Beaufort Sea remain relatively unpolluted by man's activities.

a. Turbidity: Satellite imagery and suspended-particulate-matter data suggest that, in general, turbid waters are confined to depths within the 5-m isobath and do not extend seaward of the barrier islands.

Water samples obtained in August 1978 from the continental shelf between Harrison Bay and the Canning River and seaward of the 20-m isobath had suspended-sediment concentrations that ranged from 0.3 to 2.1 parts per million (ppm). The water samples for these measurements were taken at the surface and at various depths; at one of the stations, the water at 90 m also was sampled.

In mid-June through early July, the shallow inshore waters generally carry more suspended material because runoff from the rivers produces very high turbidity adjacent to the river mouths. During the June flood, the Colville River discharges approximately 6 million metric tons of sediment into Harrison Bay; this is about 70 percent of its annual load. The resulting turbidity from the floods, along with other factors, blocks light and measurably reduces primary productivity of waters inshore of about the 13-m isobath.

Because of the absence of major rivers along the Chukchi coast, waters are clearer in the Chukchi portion of the planning area than in the Beaufort portion. Similar inputs occur elsewhere along the coast. Wave action resulting from prevailing winds and storms during the open-water season resuspends unconsolidated river delta sediments, which increases the turbidity in shallow inshore areas. Coastal erosion annually contributes about 0.3 million metric tons of sediment to Simpson Lagoon. Any ice cover in summer limits wave action and decreases turbidity.

b. Dissolved Oxygen: Dissolved oxygen levels in the Beaufort Sea Planning Area are usually high, about 8 milliliters (ml) of oxygen per liter. In deeper waters, there is an oxygen minimum of 6 ml per liter at about 150-200-m depth (Kinney, Arhleger, and Burrell, 1970). Under winter ice cover, respiration of oxygen continues, but atmospheric exchange and photosynthetic production of oxygen cease. Some oxygen is excluded into underlying water from thickening ice. Over the ice-covered period, areas with unrestricted circulation seldom drop below 6 ml of oxygen per liter. In areas of reduced circulation or high respiration, further depletion occurs. Schell (1975) found only 2 ml of oxygen per liter underneath the ice in a basin of the Colville River Delta containing overwintering fish. Such basins sometimes turn anoxic before spring breakup.

c. Trace Metals: Chukchi and Beaufort Sea trace-metal levels are elevated relative to the eastern Arctic Ocean due to high trace-metal levels in Bering Sea waters entering the Arctic Ocean through Bering Strait (Moore, 1981; Yeats, 1988). Beaufort Sea Planning Area trace-metal concentrations generally are considerably lower than U.S. Environmental Protection Agency (USEPA) criteria and show no indication of pollution (Table III.A.5-1). A few mercury values above the USEPA chronic criterion are reported, but these likely represent sample contamination (Gill and Fitzgerald, 1985).

Neither the Minerals Management Service (MMS) nor other industry and academic studies have found evidence of trace-metal contamination of sediments (Presley, 1993; Crecelius et al., 1991; Boehm et al., 1987). Observed geographic variation in the trace-metal concentration (chromium, lead, zinc, cadmium, barium, copper, and vanadium) were attribute to grain-size distribution and organic content, with higher trace-metal concentrations in finer sediments (Crecelius et al., 1991; Sweeny and Naidu, 1989). Mercury does demonstrate a geographic variation with 2- to 3-fold higher mercury concentrations in the inshore and offshore sediments of the western than eastern Beaufort Sea (Weiss et al., 1974). The major rivers—Canning (except for mercury), Sagavanirktok, Kuparuk, and Colville Rivers—are thought to be major sources for the trace metals in the Beaufort Sea coastal sediments (Weiss et al., 1974; Boehm et al., 1987).

d. Hydrocarbons: Background water hydrocarbon concentrations are low, generally ≤ 1 parts per billion (ppb) (ppb $\approx$ nanogram/gram) and appear to be biogenic.

Table III.A.5-2 shows the background aliphatic and aromatic hydrocarbon levels for the Alaskan and Canadian Beaufort Sea sediments. Sediment aliphatic and aromatic hydrocarbon levels are relatively high in comparison with other undeveloped OCS areas (Steinhauer and Boehm, 1992). The hydrocarbon composition differs from most other areas because they are largely fossil-derived. The hydrocarbon sources primarily are the onshore coal and shale outcrops and natural petroleum seeps that are drained by rivers into the Beaufort Sea (Boehm et al., 1987; Steinhauer and Boehm, 1992).

The aliphatic hydrocarbons range between 5 and 41 ppm dry weight; the highest levels were consistently found in Harrison Bay (Boehm et al., 1987; Steinhauer and Boehm, 1992). Most of these aliphatic hydrocarbons—80 to 85 percent—are higher molecular-weight alkanes (n-C21 to n-C34) characterized by odd-carbon dominance, indicating a biogenic source from terrestrial plant materials. The presence of significant quantities of lower molecular-weight alkanes, 0.3 to 1.2 ppm (15-20% of the total aliphatic hydrocarbons), also suggests widespread presence of petroleum hydrocarbons in the sediments. The highest concentrations were found offshore of the Colville River (Harrison Bay) and offshore of the Kuparuk River. Aliphatic-hydrocarbon composition suggestive of petroleum hydrocarbons also has been reported in sediments of the Canadian Beaufort Sea and was attributed to inflow from the MacKenzie River (Wong et al., 1976); Levy (1986), however, has contended that the data are insufficient to make this latter attribution.

The total aromatic hydrocarbons (TAH) range between 8 and 16 ppm and appear to derived mostly from nonindustrial, abiotic source materials. The subportion of TAH constituting two-to-five-ring polynuclear aromatic hydrocarbons (PAH) range from 0.2 ppm in Camden Bay and the Endicott Field area to 0.65 in the Kuparuk River Delta and to 1.0 ppm in Harrison Bay (Steinhauer and Boehm, 1992). The predominance of two-to-three-ring PAH over most four-to-five-ring PAH (with the exception of perylene) indicates that the PAH is derived from petrogenic (e.g., crude oil or coal) rather than pyrolytic sources. This derivation requires local marine or local terrestrial sources rather than a long-distance, atmospheric source. The rivers, particularly the Colville and Kuparuk rivers, appear to be important sources of PAH; however, marine-sediment concentrations range higher than riverine-sediment concentrations, suggesting the possibility of additional contributions from marine seeps.

There is no evidence that the hydrocarbon concentrations in Beaufort Sea sediments are derived from oil-industry activities.

Table III.A.5-1
Trace-Metal Concentrations in the Beaufort Sea

	Trace Metals (Symbols Defined Below)									
	As	Cr	Hg	Pb	Zn	Cd	Ba	Cu	Ni	V
SEDIMENTS (ppm)										
Nearshore, Lagoons, and Bays [1]	---[2]	17-19	0.02-0.09[3]	3.9-20	19-116	0.04-0.31	185-745	4.9-37	33[4]	33-153
Shelf[5]	16-23[6]	85[4]	0.03-0.16[7]	3[8]	98	0.2[7]	---	57	47	140[4]
Slope and Abyssal[8]	55[6] 2[9]	99[9]	0.07-0.17[7]	---	82	---	---	59	56	19
Average World Coastal Ocean[8]	---	10-100	0.01-0.07[10]	2-20	5-200	0.2-3.0	60-1500[11]	5-40	16-47[11]	130[9]
SUSPENDED SEDIMENTS (ppm of dry weight)[12]	---	21-140	---	---	8-232	---	---	5-83	10-100	2-307
WATER (ppb)										
Total[12]	---	0.1-2.1	0.005-0.57[7]	---	0.4-3.7[13]	---	---	0.4-2.1	---	---
Dissolved[8]	---	0.02-0.3	0.008-0.032[14]	0.02-1.7	0.2-3.4	0.02-0.11	---	0.3-1.8	---	---
Typical Worldwide Marine Total[15]	1.35-2.5[16]	0.3	0.001[17]	0.01	1	0.04	---	0.3	0.3	---
EPA Total Saltwater Criteria[18]	36[19]	50[20]	0.025	5.6	86	9.3	None	2.9[21]	8.3	None

Source: As indicated in the footnotes below.

Symbol Definitions: As = Arsenic; Cr = Chromium; Hg = Mercury; Pb = Lead; Zn = Zinc; Cd = Cadmium; Ba = Barium; Co = Copper; Ni = Nickel; V = Vanadium.

1 Boehm et al., 1987.
2 No data.
3 Northern Technical Services, 1981b; Weiss et al., 1974.
4 Naidu, 1982.
5 Naidu, 1974.
6 Robertson and Abel, 1979.
7 Weiss et al., 1974.
8 Thomas, 1978.
9 Naidu et al., 1980.
10 Nelson et al., 1975, for Central Bering Shelf and Chukchi Sea.
11 Chester, 1965.
12 OCSEAP data , NODC/NOAA data bank.
13 Burrell et al., 1970.
14 Guttman, Weiss, and Burrell, 1978 (for Chukchi and Beaufort Seas).
15 Berhard and Andreae, 1984.
16 Burton and Statham (1982) in Langston (1990).
17 Gill and Fitzgerald, 1985.
18 EPA, 1986; 52 FR (40)6213; 51 FR (232)43665; (chronic) 4-day average, total-recoverable concentration not to be exceeded more than once in 3 years.
19 As Arsenic^{+3}.
20 As Chromium^{+6}.
21 1-hour average, not to be exceeded more than once in 3 years.

Table III.A.5-2
Summary of Background Aliphatic and Aromatic Hydrocarbon Concentrations
in the Alaskan and Canadian Beaufort Sea

Compounds	Location	Year	Depth	Concentration Range ng /g dry weight	Number of Samples	Reference
B[a]P	Canadian Beaufort Sea, Hershel Island to Shingle Point	1979	0 - 5 cm	0.6 - 10.1	8	Stitch and Dunn, 1980
	Mackenzie Delta	1979	0 - 5 cm	2.2 - 33.1	8	Stitch and Dunn, 1980
	Kittigazuit Bay	1979	0 - 5 cm	0.7 - 24.3	8	Stitch and Dunn, 1980
	Smoking Hills Area	1979	0 - 5 cm	1.6 - 13.4	8	Stitch and Dunn, 1980
	Devon Island, Thomas Lee Inlet	1979	0 - 5 cm	0.4	2	Stitch and Dunn, 1980
	Issungnak 0-61	1981-82		6 - 134	11	Erickson et al., 1983
∑PAH[1]	Tuktoyaktuk Harbor	1982	0 - 5 cm	94 - 8,222	14	Thomas et al., 1982
	McKinley Bay	1982	0 - 5 cm	6.7 - 933	18	Thomas et al., 1982
	Canadian Beaufort Coast (Tuft Point)	1982	0 - 5 cm	50 - 4,094	7	Thomas et al., 1982
	Yukon Coast/Tuktoyaktuk	1984	0 - 5 cm	20 - 1,358	58	Can Test, 1985
	Hutchinson Bay	1982	0 - 5 cm	16.8 - 1,119	16	Thomas et al., 1992
	Amauligak F-24 (Canadian Beaufort Sea)	1978	0 - 1 cm	866	1	Thomas, 1988
∑PAH[2]	S. Canadian Beaufort Sea Marine Sites	1975	Surface	97 - 1,341	22	Wong et al., 1976
∑PAH[3]	S. Canadian Beaufort Sea Nearshore	1975	Surface	0.4 - 20	10	Wong et al., 1976
∑PAH[1]	S. Canadian Beaufort Sea	1981	0 - 5 cm	68 - 1,856	12	Erickson et al., 1983
∑PAH[3]	S. Canadian Beaufort Sea (Artificial Islands)	1982	0 - 5 cm	23 - 6,785	3	Fowler and Hope 1984
∑PAH[4]	Alaskan Coastal Beaufort Sea	1984	Surface	10 - 1,120	27	Boehm et al., 1985
∑PAH[4]	Alaskan Coastal Beaufort Sea	1985	Surface	20 - 380	39	Boehm et al., 1986
∑PAH[4]	Alaskan Coastal Beaufort Sea	1984-85	Surface	10 - 640	105	Boehm et al., 1987
∑PAH[4]	Alaskan Coastal Beaufort Sea	1989	Surface	47 - 1,200	48	Boehm et al., 1990
∑PAH	Alaskan Beaufort Sea	1976	Surface	200 - 300	2	Kaplan and Venkatesan, 1981
∑Alkanes[5]	Tuktoyaktuk Harbor	1982	0 - 5 cm	813 - 28,775	14	Thomas et al., 1982
	Tuktoyaktuk Harbor	1983	0 - 5 cm	8,500 - 18,000	-	NAS, 1984; Arctic Labs Ltd., 1983
	Canadian S. Beaufort Sea (Minuk I-53)	1985-86	0 - 2 cm	14 - 19,903	69	Erickson et al., 1988
	Canadian S. Beaufort Sea (Kaulvik I-43)	1985-86	0 - 2 cm	219 - 22,750	29	Erickson et al., 1988
	McKinley Bay	1982	0 - 5 cm	132 - 17,000	18	Thomas et al., 1982
	McKinley Bay	1983		5,000 - 17,000		Arctic Labs Ltd, 1983
	Canadian Beaufort Sea Coast (Tuft Point)	1982	0 - 5 cm	730 - 11,546	6	Thomas et al., 1982
	Alaskan Coastal Beaufort Sea[6]	1984	Surface	680 - 22,800	27	Boehm et al., 1985
	Alaskan Coastal Beaufort Sea[6]	1985	Surface	640 - 21,150	39	Boehm et al., 1986
	Alaskan Coastal Beaufort Sea[6]	1984-86	Surface	780 - 19,000	105	Boehm et al., 1987
	Alaskan Coastal Beaufort Sea[6]	1989	Surface	120 - 15,100	48	Boehm et al., 1990
	Hutchinson Bay	1982	0 - 5 cm	116 - 15,324	16	Thomas et al., 1982
	Amauligak F-24	1982	0 - 1 cm	12,880	1	Thomas, 1988
∑n-paraffins	Canadian S. Beaufort Sea Marine Sites	1975	Surface	600 - 23,600	29	Wong et al., 1976
∑n-paraffins	Canadian S. Beaufort Sea	1971	Surface	123 - 9,400	10	Peake et al., 1972
∑ alkanes	Canadian S. Beaufort Sea (Artificial Islands)	1982	0 - 5 cm	295 - 14,263	3	Fowler and Hope, 1984
n-alkanes	Alaskan Beaufort Sea Coast	1976	Surface	1,440 - 5,080	11	Kaplan and Venkatesan 1981
n-alkanes	Alaskan S. Beaufort Sea Coast	1977	Surface	100 - 12,500	20	Shaw et al., 1979
Unsaturates[7]	Alaskan S. Beaufort Sea Coast	1977	Surface	<10 - 7,300	20	Shaw et al., 1979

Source: Adapted from Muir et al., 1992.

1 Sum of naphthalene, methyl naphthalene, fluorene, phenanthrene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzofluoranthenes, benzo[e]pyrene, benzo[a]pyrene, and perylene. Analysis by GC-MS (Arctic Labs Ltd., 1983, and Nuclear Activation Services (NAS), 1984, or by liquid chromatography (Can Test, 1985).

2 Sum of benzo[a]anthracene, chrysene, pyrene, perylene, and other isomers with same molecular weights analyzed by GC-MS.

3 Sum of pyrene, benzo[a]pyrene, perylene, and coronene by UV absorption.

4 Sum of fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzofluoranthene, benzo[a]pyrene, benzo[e]pyrene, and perylene.

5 Sum of n-C12 to n-C33 as recalculated by Wainwright and Humphrey, 1988. Analysis by GC-FID except for results of NAS 1984, which were performed using GC-MS.

6 nC10-nC34.

7 *Mainly PAH. Estimated by GC-MS using selected ion monitoring of molecular ions.*

6. Air Quality: The existing onshore air quality for most areas adjacent to the Beaufort Sea sale area is considered to be relatively pristine, with concentrations of regulated air pollutants that are far less than the maxima allowed by the National Ambient Air Quality Standards (national standards) and State air-quality statutes and regulations (USEPA, 1978). These standards are designed to protect human health. Areas where national standards are attained are referred to as attainment areas; others are nonattainment areas. The entire North Slope of Alaska is an attainment area. Under provisions of the Prevention of Significant Deterioration Program (PSD) of the Clean Air Act, existing air quality superior to the national standards is protected by additional limitations on nitrogen dioxide, sulfur dioxide, and total-suspended-particulate matter. Areas in Alaska currently are designated as PSD Class I or II. Class I air-quality designation is the most restrictive and applies to certain national parks, monuments, and wilderness areas. There are no Class I areas in or near the proposed sale area. The entire onshore area adjacent to the sale area is designated Class II. The applicable standards and PSD Class II increments are listed in Table III.A.6-1.

Over most of the onshore area adjacent to the sale area, there are only a few small, scattered emissions from widely scattered sources, principally from diesel-electric generators in small villages. The only major local sources of industrial emissions near the sale area are in the Prudhoe Bay/Kuparuk/Endicott oil-production complex. This area was the subject of two monitoring programs during the 1986 to 1987 (ERT, 1987; Environmental Science and Engineering, Inc., 1987). In each case, two monitoring sites were selected, one deemed subject to maximum air-pollutant concentrations and one site to be more representative of the air quality of the general Prudhoe Bay area. The 1-hour maximum-value standard for ozone at site C (Table III.A.6-2) was apparently exceeded; however, it was determined that the high ozone level may have been caused by arc welding within 150 m of the monitoring site. However, the results demonstrate that, generally, most ambient-pollutant concentrations, even for sites deemed subject to maximum concentrations, meet the ambient-air-pollution standards. This is true even if the baseline PSD concentrations (which must be determined on a site-specific basis) are assumed to be zero, limiting the allowable increase in concentrations.

During the winter and spring, pollutants are transported to arctic Alaska across the Arctic Ocean, from industrial Europe and Asia (Rahn, 1982). These pollutants cause a phenomenon known as arctic haze. Pollutant sulfate due to arctic haze in the air in Barrow—that in excess of natural background—then averages 1.5 micrograms per cubic meter. The concentration of vanadium, a combustion product of fossil fuels, then averages up to 20 times the background levels in the air and snowpack. Recent observations of the chemistry of the snowpack in the Canadian Arctic also provide evidence of long-range transport of small concentrations of organochlorine pesticides (Gregor and Gummer, 1989). Concentrations of arctic haze during winter and spring at Barrow are similar to those over large portions of the continental U.S. (see Fig. III.A.6), but they are considerably higher than levels south of the Brooks Range of Alaska. Any ground-level effects of arctic haze on the concentrations of regulated air pollutants in the Prudhoe Bay area are included in the monitoring data given in Table III.A.6-2. Despite this seasonal, long-distance transport of pollutants into the Arctic, regional air quality still is far better than specified by standards.

Table III.A.6-1
Ambient-Air-Quality Standards Relevant to Beaufort Sea Lease Sale 144
(Measured in ug/m^3; an asterisk [*] indicates that no standards have been established.)

		Averaging Time			Criteria	
Pollutant[1]	Annual	24 hr	8 hr	3 hr	1 hr	30 min
Total-Suspended Particulates[2]	60[3]	150	*	*	*	*
Class II[4]	19[3]	37	*	*	*	*
Carbon Monoxide	*	*	10,000	*	40,000	*
Ozone[5]	*	*	*	*	235[6]	*
Nitrogen Dioxide	100[7]	*	*	*	*	
Class II[4]	25[7]	*	*	*	*	*
Inhalable Particulate Matter (PM10)[8]	50[9]	150[10]	*	*	*	*
Class II[4]	17	30	*	*	*	*
Lead		1.5[11]	*	*	*	*
Sulfer Dioxide	80[7]	365	*	1,300	*	*
Class II[4]	20[7]	91	*	512	*	*
Reduced Sulfer Compounds[2,11]	*	*	*	*	*	50

Source: State of Alaska, Dept. of Environmental Conservation, 1982, 80, 18, AAC, 50.010, 18 AAC 50.020; 40 CFR 52.21 (43 FR 26388); 40 CFR 50.6 (52 FR 24663); 40 CFR 51.166 (53 FR 40671).

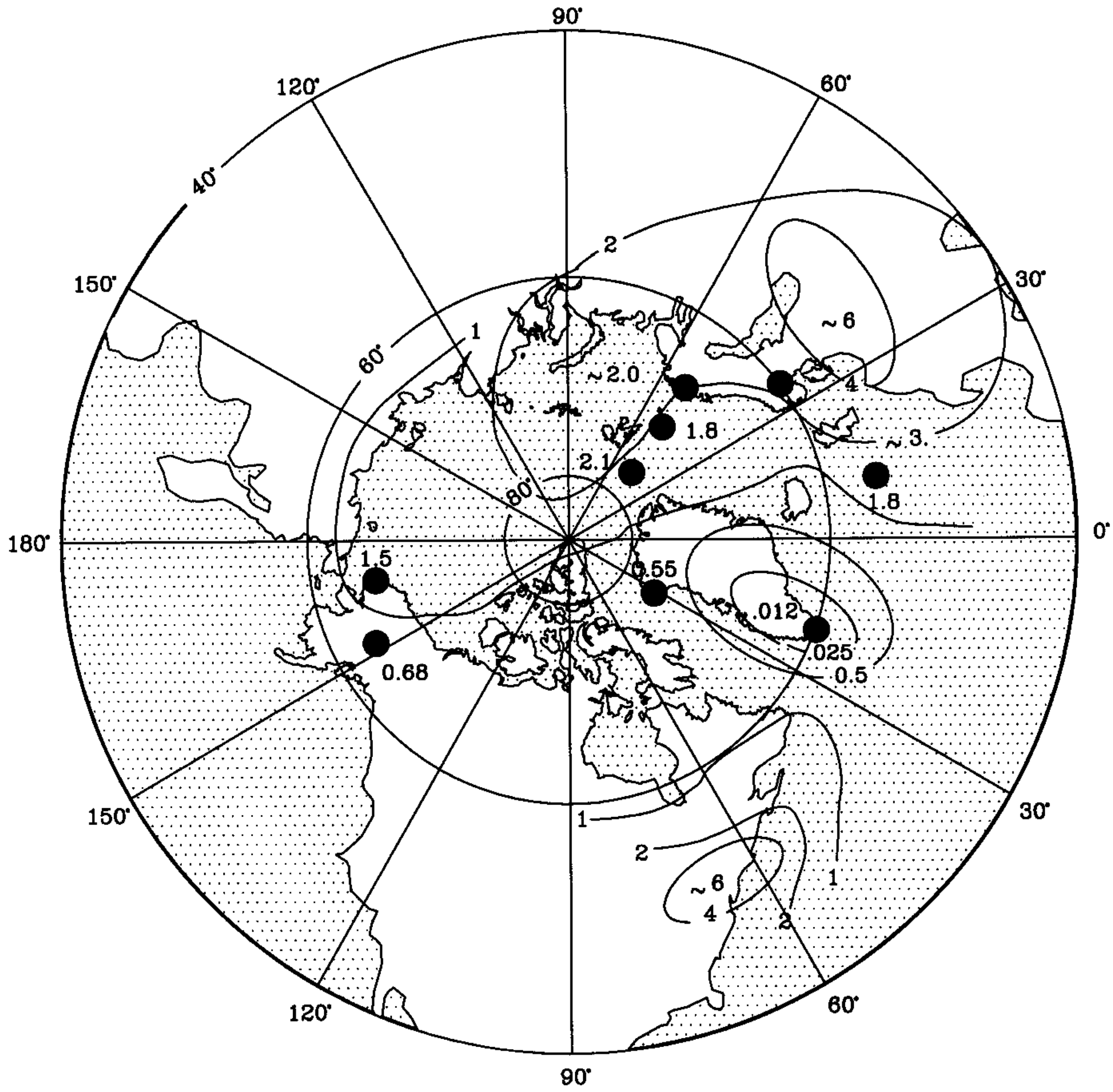
1 All-year-averaging times not to be exceeded more than once each year, except that annual means may not be exceeded.
2 State of Alaska air-quality standard (not national standard).
3 Annual geometric mean.
4 Class II standards refer to the PSD Program. The standards are the maximum increments in pollutants allowable above previously established baseline concentrations.
5 *The State ozone standard compares with national standards for photochemical oxidents; which are* measured as ozone.
6 The 1-hour standard for ozone is based on a statistical, rather than a deterministic, allowance for an "expected exceedance during a year."
7 Annual arithmetic mean.
8 PM10 is the particulate matter less than micrometers in aerodynamic diameter.
9 Attained when the expected annual arithmetic mean concentration, as determined in accordance with 40 CFR 50 subpart K, is equal to or less than 50 ug/m^3.
10 Attained when the expected number of days per calendar year with a 24-hour average concentration above 150 ug/m^3, as determined in accordance with 40 CFR 50, subpart K, is equal to or less than 1.
11 Measured as sulfur dioxide.

Table III.A.6-2
Measured-Air-Pollutant Concentrations at Prudhoe Bay, Alaska 1986-1987
(Measured in ug/m^3; absence of data is indicated by asterisks [**].)

Pollutant[1]	Monitor Sites A[2]	B[3]	C[4]	D[5]	Applicable National Ambient-Air-Quality Standards[6]	Class II PSD Standard Increments
Total-Suspended Particulates						
Annual	8.4	**	14.8	**	60	19
Annual Max. 24 hr	79.7	**	104[7]	**	150	37
Ozone						
Annual Max. 1 hr	92.1	170.5	265[8]	67	235	
Nitrogen Dioxide						
Annual	15.8	7.5	16	4	100	25
Inhalable Particulate Matter (PM10)						
Annual	**	**	10.5	**	50	17
Annual Max. 24 hr	**	**	25[7]	**	150	30
Sulfur Dioxide						
Annual	7.9	**	3	**	80	20
Annual Max. 24 hr	15.7	**	80.5[7]	**	365	91
Annual Max. 3 hr	21.0	**	**	**	1,300	512
Carbon Monoxide						
Annual Max. 8 hr	**	**	1,400	**	10,000	
Annual Max. 1 hr	**	**	2,500[7]	**	40,000	

Sources: ERT, 1987, and Environmental Science and Engineering, 1987.

[1] Lead was not monitored.
[2] Site CCP (Central Compressor Plant), Prudhoe Bay monitoring program, selected for maximum pollutant concentrations.
[3] Site Pad A (Drill Pad A), Prudhoe Bay monitoring program, site of previous monitoring, selected to be more representative of the general area or neighborhood.
[4] Site CPF-1 (Central Processing Facility), Kuparuk monitoring program, selected for maximum pollutant concentrations.
[5] Site DS-1F, Kuparuk monitoring program site selected to be representative of the general area or neighborhood.
[6] Please refer to Table III.A.6-1 for more specific definitions of air-quality standards.
[7] Second highest observed value (in accordance with approved procedures for determining ambient-air quality).
[8] The highest value for ozone at site A (CPF-1) may have been atypical due to field operations using arc welding within 150 m of the site. Otherwise, the highest value at the site was 174.7 ug/m^3.



Source: After Rahn, 1982

Figure III.A.6 Mean Winter Concentrations of Pollutant Sulphate ($\mu g/m^3$) in Surface Aerosol of Arctic and Environs

B. BIOLOGICAL RESOURCES:

1. ***Lower Trophic-Level Organisms:*** Lower-trophic-level organisms in the Beaufort Sea can be categorized as planktonic (living in the water column), epontic (living on the underside of sea ice), or benthic (living on or in the sea bottom), depending on their general location. The abundance and spatial and seasonal distribution of organisms in the Beaufort Sea are strongly influenced by environmental conditions. A primary example of this is the area traditionally referred to as the intertidal zone. Due to the annual predominance of shorefast ice, the intertidal zone of the Beaufort Sea (0-10 m in depth) is highly disturbed and supports no marine flora and few fauna. Hence, there is little or no intertidal zone in the Beaufort Sea, in the traditional sense. Rather, it is a disturbed shoreline area that is seasonally recolonized by a small number of fauna during the summer months. Principal invertebrates involved in these recolonizations include chironomid larvae, oligochaete worms, the isopod *Saduria entomon*, and the amphipods *Gammarus setosa* and *Onisiumus litoralis* (Thorsteinson, 1983). Marine flora and fauna found farther offshore are discussed under Benthic Communities, subparagraph c below.

a. *Planktonic Communities:* Annual primary production in the Alaskan Beaufort Sea is low compared to that of other oceans. Areas in the Beaufort Sea not covered permanently by ice, such as coastal areas, can be somewhat more productive. Recent estimates of annual primary production in these areas indicate that up to 30 grams of carbon per year per square meter can be produced in shelf and coastal environments. This is roughly the same as that produced in the central gyres of the Atlantic and Pacific oceans (Schell, 1988; Cooney, 1988). In the Beaufort Sea there is no real evidence of a major spring phytoplankton bloom occurring at all; instead, there is a small phytoplankton increase during and after ice breakup. The most productive areas of the Alaskan Beaufort Sea appear to be the areas near Barrow in the west and Barter Island in the east. Annual primary production in the area just east of Barrow could be as high as 50 grams of carbon per year per square meter (Schell, 1982). This enhanced production is thought to be due to the influx of nutrient rich Bering-Chukchi Sea water, as well as enriched brackish coastal water.

The abundance of phytoplankton appears to be greatest in nearshore waters with decreasing numbers farther offshore. Although observations of the vertical distribution of phytoplankton vary, most reports show that phytoplankton abundance is greatest at depths of <5 m (Alexander, 1974). Peak abundance occurs in late July and early August due to increased light intensity during this period. Sources of primary production include epontic algae, phytoplankton, benthic microalgae, benthic macroalgae, and peat entering into the system from terrestrial areas. The turbidity of ice and the pattern of ice breakup greatly influence the timing and degree of production by algae. The contribution of ice algae to annual productivity is small, but it provides a source of food in early spring when food is in short supply.

Horner (1984) found that the rate of primary production varies as much as two to three times between years. Highest production and standing-stock values occurred in the sampling year with the least amount of ice cover, while lowest production and standing stock occurred in the year with the most extensive ice cover. The presence or absence of a spring phytoplankton bloom also varies. A spring bloom may occur in the nearshore during and just after ice breakup when light levels increase and high nutrient concentrations exist (Horner, 1969). Concerning offshore areas, Horner (1984) states that "there are no data based on sufficiently intense sampling to indicate the occurrence of a spring bloom in the offshore Beaufort Sea." Schell et al. (1982), sampling in Simpson Lagoon, Harrison Bay, Prudhoe Bay, Stefansson Sound, and offshore, also did not find any evidence of a "spring" phytoplankton bloom. Benthic macroscopic algae, although limited in their occurrence in the Beaufort Sea, can provide as much as 56 percent of the annual primary production in an area (Dunton, 1984). Although terrestrially derived peat contributes substantially to the available carbon in the nearshore marine environment, it is little-used by strictly marine organisms and thus does not enter in large degree into marine food webs (Schell, 1983). Peat carbon is used seasonally by freshwater and anadromous arctic fishes and oldsquaw ducks utilizing insect larvae.

Due to small amount of primary production in the Alaskan Beaufort Sea, the zooplankton communities of this area also are impoverished and are characterized by low diversity, low biomass, and slow growth (Cooney, 1988). There are >100 species of zooplankton that have been identified in the Beaufort Sea. They are: (1) species that occur throughout the Arctic Basin; (2) species that are swept into the Beaufort Sea to varying extent from the

Bering and Chukchi Seas; (3) species characteristic of nearshore, less saline environments; and (4) species that are the larval forms of animals that live in the benthos (meroplankton) (USDOC, NOAA, 1978). Horner (1979, 1981), in a study of zooplankton along the Alaskan Beaufort Sea coast, reported that copepods comprised an average of 63 percent of the individuals in the zooplankton. Richardson (1986), in a study of the eastern Beaufort Sea, found copepods represented 87 percent of the individual zooplankters and 78 percent of the wet-weight zooplankton biomass. Richardson also found a decrease in zooplankton biomass from the nearshore area to the inner shelf to the outer shelf. Zooplankton biomass above the pycnocline (the depth zone within which seawater density changes maximally) was very low except in nearshore waters. The highest biomasses of zooplankton generally were found just below the pycnocline. Distribution of zooplankton in the eastern Beaufort Sea was patchy, with patches being very extensive in the horizontal plane (e.g., 100's-1,000's of m across), but usually only 5 to 10 m thick. Off of Kaktovik, patches of zooplankton were more abundant in nearshore and inner-shelf waters, and biomass was greater than in more offshore waters (Richardson, 1986). Most copepods primarily are herbivorous.

b. Epontic Communities: Epontic communities are composed of those plants and animals living on or in the undersurface of sea ice. Microalgae in the ice consist primarily of pennate diatoms and microflagellates, but centric diatoms and dinoflagellates also may be present, usually in low numbers (Horner and Schrader, 1982). Although approximately 200 diatom species have been identified from arctic sea ice, only a few species predominate. In samples taken by Horner and Schrader (1982), only 6 of the 58 species enumerated accounted for > 10 percent of the cells counted. Regional differences occur in which species predominates and changes in community structure have been noted during the development of the spring bloom (Horner and Schrader, 1982).

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). Light appears to be the major factor controlling the distribution, development, and production of the ice-algal assemblage. Although spring blooms of ice algae have been reported by multiple investigators, only recently has a fall bloom also been noted (Schell et al., 1982). Diatom concentrations in Schell's fall samples (taken in 1980) were comparable to the levels found by Horner and Schrader (1982) in the 1980 spring bloom. In Horner and Schrader's study (1982), primary production by ice algae during the May peak was twice as great as phytoplankton production in the water column. The total amount of epontic algal primary production was estimated by Schell and Horner (1981) to constitute about one-twentieth of the annual total primary production of the nearshore zone. Dunton (1984) found that ice algae beneath clear ice contributed about 25 percent of the carbon produced in the area of the Stefansson Sound Boulder Patch. Although the contribution of ice algae to annual productivity may be relatively small, its importance lies in its input during early spring.

c. Benthic Communities: The benthic communities in the Alaskan Beaufort contain macrophytic algae (large kelps), benthic microalgae and bacteria, and benthic invertebrates. Although most substrates in the Beaufort Sea consist of silty sediments that are unsuitable for the settlement and growth of macrophytes, hard substrates in the form of cobbles and boulders are suitable and are known to exist. Macrophytes also have been found in some areas where significant quantities of rock substrata were lacking (Dunton, Reimnitz, and Schonberg, 1982). Ice gouging also can prevent the establishment and growth of macrophytes. The largest kelp community thus far described occurs in Stefansson Sound (commonly known as "the Boulder Patch") (see Dunton and Schonberg, 1981; Dunton, Reimnitz, and Schonberg, 1982; and Dunton, 1984). Other beds occur near the Stockton Islands, Flaxman Island, and Demarcation Bay (Thorsteinson, 1983).

The Boulder Patch community, although predominated by the brown alga, *Laminaria solidungula*, also contains red algae and benthic invertebrates. Approximately 98 percent of the carbon produced annually in the Boulder Patch is derived from kelp and phytoplankton. *Laminaria* is estimated to contribute 50 to 56 percent of the annual production (134 grams of Carbon per square m/yr [g $C/m^2/yr$] to 211 g $C/m^2/yr$), depending on whether the plants are beneath clear or turbid ice (Dunton, 1984). Kelp are responsible for the release of approximately 60 percent of the particulate organic matter found in the environment (Dunton, 1984). Much of the linear growth of the kelp takes place in winter, with maximum growth occurring in late winter or early spring (Dunton, Reimnitz, and

Schonberg, 1982). The only herbivore that consumes kelp in the Boulder Patch is the chiton, *Amicula vestita*. Dunton (1984) estimates the annual ingestion of kelp by *A. vestita* is approximately 0.8 g C/m^2.

Benthic microalgal assemblages, consisting primarily of diatoms, have been studied in the nearshore area off Barrow (Matheke and Horner, 1974), off Narwhal Island (Horner and Schrader, 1982), and in Stefansson Sound (Horner and Schrader, 1982; Dunton, 1984). 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. Although Matheke and Horner (1974) reported high productivities for benthic microalgae over the summer, Horner and Schrader (1982) and Dunton (1984) reported that benthic microalgae do not contribute significantly to primary production. Dunton (1984) estimates that benthic microalgae contribute about 2 percent of the annual carbon produced in the Stefansson Sound Boulder Patch, with production in the absence of turbid ice figured at about 0.4 g $C/m^2/yr$.

Benthic invertebrates typically are divided into epifauna and infauna, based on their relationship with the bottom substrate. Infaunal organisms live within the substrate and, as a result, often are sedentary. Epifaunal organisms, on the other hand, generally live on or near the surface of the bottom substrate. The organisms comprising these groups, as well as the general patterns of their distribution and abundance, have been described in the FEIS's for Sales 87, 97, 109, and 124 (USDOI, MMS, 1984, 1987a, 1987b, and 1990, respectively) and (Thorsteinson, 1983). Patterns in the distribution and relative abundance of benthic species in the Beaufort Sea are correlated with physical factors. As mentioned earlier, in nearshore waters with depths $\leq$2 m, relatively few species are found. Biomass and diversity in the inshore zone generally increase with depth, except in the shear zone at approximately 15 to 25 m in depth. Intensive ice gouging occurs in this zone between the landfast ice and the moving polar pack ice, which generally disturbs the sediments where infaunal organisms live. Polychaetes, bivalves, and gammarid amphipods predominate in this area with 105, 31, and over 100 species reported, respectively (Carey et al., 1981, as cited in Thorsteinson, 1983). Ice gouging continues out to about 40 m with decreasing intensity. The diversity and biomass of infauna increases beyond this minimum-abundance zone with distance offshore (Carey, 1978), at least as far as the edge of the continental shelf (200 m).

The coastal lagoons of the Beaufort Sea (e.g., Simpson Lagoon, Stefansson Sound, and those lagoons landward of Stockton and Maguire Islands) support a nearshore benthic environment that is used as a feeding ground in the late summer by many vertebrate consumers (Thorsteinson, 1983). Predominant benthic invertebrates include amphipods, mysids, copepods, and other motile crustaceans. These invertebrates are fed on heavily by some fishes, birds, and marine mammals (Envirosphere, 1985). Other invertebrates, such as bivalves, snails, crabs, and shrimp, are fed on heavily by some marine mammals (e.g., walruses and bearded and ringed seals; see Frost and Lowry, 1983). In general, the food habits of marine invertebrates vary depending on habitat, season, preferences, etc.; but they typically rely on marine plants, other invertebrates, detritus, or carrion.

2. Fishes: This description summarizes and incorporates by reference the information on fishes contained in the FEIS's for Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). This section also summarizes and incorporates by reference three other more recent sources of information:

- ☐ The symposium on "Fisheries and Oil Development on the Continental Shelf" in Anchorage, Alaska, that was sponsored by the American Fisheries Society and MMS, the proceedings of which have been edited by Benner and Middleton (1991).
- ☐ The Fifth Information Transfer Meeting for the Alaska OCS Region, which included several presentations on fishes (USDOI, MMS, 1993).
- ☐ The symposium on "Fish Ecology in Arctic North America" at the University of Alaska Fairbanks that also was sponsored by the American Fisheries Society and MMS, the proceedings of which are being edited by Reynolds (in press).

The previous FEIS's describe the three basic categories of Beaufort Sea fishes: (1) freshwater species that make relatively short seaward excursions from coastal rivers, (2) anadromous species that spawn in freshwater and migrate seaward as juveniles and adults, and (3) marine species that complete their entire lifecycle in the marine environment. The following sections briefly summarize the species, distributions, and abundances of these three general types of fishes.

a. Freshwater Species: Freshwater fishes that venture into the coastal waters are found almost exclusively in association with fresh or brackish waters extending offshore from major river deltas. Their presence in the marine environment generally is sporadic and brief with a peak occurrence probably during or immediately following spring breakup. Such freshwater species include arctic grayling, round whitefish, and burbot.

b. Anadromous Species: This section incorporates by reference, in addition to the publications in the introductory section above, a report on nearshore fishes that was prepared by the National Oceanic and Atmospheric Administration for MMS (Thorsteinson, Jarvela, and Hale, 1991), and a series of review papers, Research Advances on Anadromous Fish in Arctic Alaska and Canada (Norton, 1989). The synthesis begins with an excellent overview, An Introduction to Anadromous Fishes in the Alaskan Arctic (Craig, 1989).

As described in these sources of information, anadromous species found in the nearshore waters of the Beaufort Sea include arctic, least, and Bering cisco; broad and humpback whitefish; arctic char; pink and chum salmon; and rainbow smelt. The two largest river drainage systems, the Mackenzie and the Colville rivers, contain the most anadromous species. Both rivers have spawning populations of ciscoes and whitefishes. Between these two drainage systems are many mountain streams containing perennial springs that are the spawning and overwintering grounds of arctic char (Craig, 1984).

With the first signs of spring breakup during early June, adult and juvenile fishes move into and disperse through these coastal waters where they feed extensively on an abundant food supply, consisting mainly of epibenthic invertebrates. During the 3- to 4-month open-water season, anadromous fishes accumulate energy reserves used for overwintering and spawning activities that occur later in fresh- or brackish-water habitats. During the winter, when nearshore waters freeze solid, major shifts in fish distributions take place. At that time, most anadromous species concentrate in the deep, unfrozen pockets of freshwater in North Slope rivers and lakes. However, a few species overwinter in brackish waters off or within the major rivers, such as the Mackenzie and Colville rivers.

The coastal distribution of anadromous species reflects major geographic differences in the locations of anadromous fish stocks in North Slope rivers (Fig. III.B.2-1). Brief summaries of the distributions of three major anadromous fishes in the Alaskan Beaufort Sea follow. Arctic cisco apparently originate from the Mackenzie River in Canada but range as far west as Point Barrow. Most young arctic cisco disperse along the coast in the nearshore band of relatively warm and fresh water; but they also are caught in offshore waters, indicating that they can temporarily tolerate marine conditions. Least cisco are common west of the Colville River but are absent in rivers of the central Beaufort Sea. Broad whitefish occur in association with the freshwater discharges of large rivers from Point Barrow east to Prudhoe Bay and Mikkelsen Bay (Fig. III.B.2-1).

c. Marine Species: This section summarizes and incorporates by reference, in addition to the publications in the introductory section above, the information in the final report of the MMS study, Fisheries Oceanography of the Northeast Chukchi Sea (Barber, Smith, and Weingartner, 1993). In general, marine species appear to be widely distributed but in fairly low densities. Forty-three marine species have been reported from the Alaskan Beaufort Sea, with some found primarily in the brackish, nearshore waters; others in the marine, offshore waters; and some in both environments (see Craig, 1984). The most widespread and abundant species are the arctic cod, the saffron cod, twohorn and fourhorn sculpins, the Canadian eelpout, and the arctic flounder.

Trawl surveys conducted by Frost and Lowry (1983) and Barber et al. (1993) in the northeastern Chukchi and western Beaufort Seas, at depths of 40 to 400 m, sampled at least 19 species of fishes. Three of these species (arctic cod, Canadian eelpout, and twohorn sculpin) accounted for 65 percent of the catch. In more-nearshore waters, the fourhorn sculpin, capelin, and nine-spine stickleback also are important numerically. Some marine species, such as arctic cod, sporadically enter the nearshore areas to feed on the abundant epibenthic fauna or to

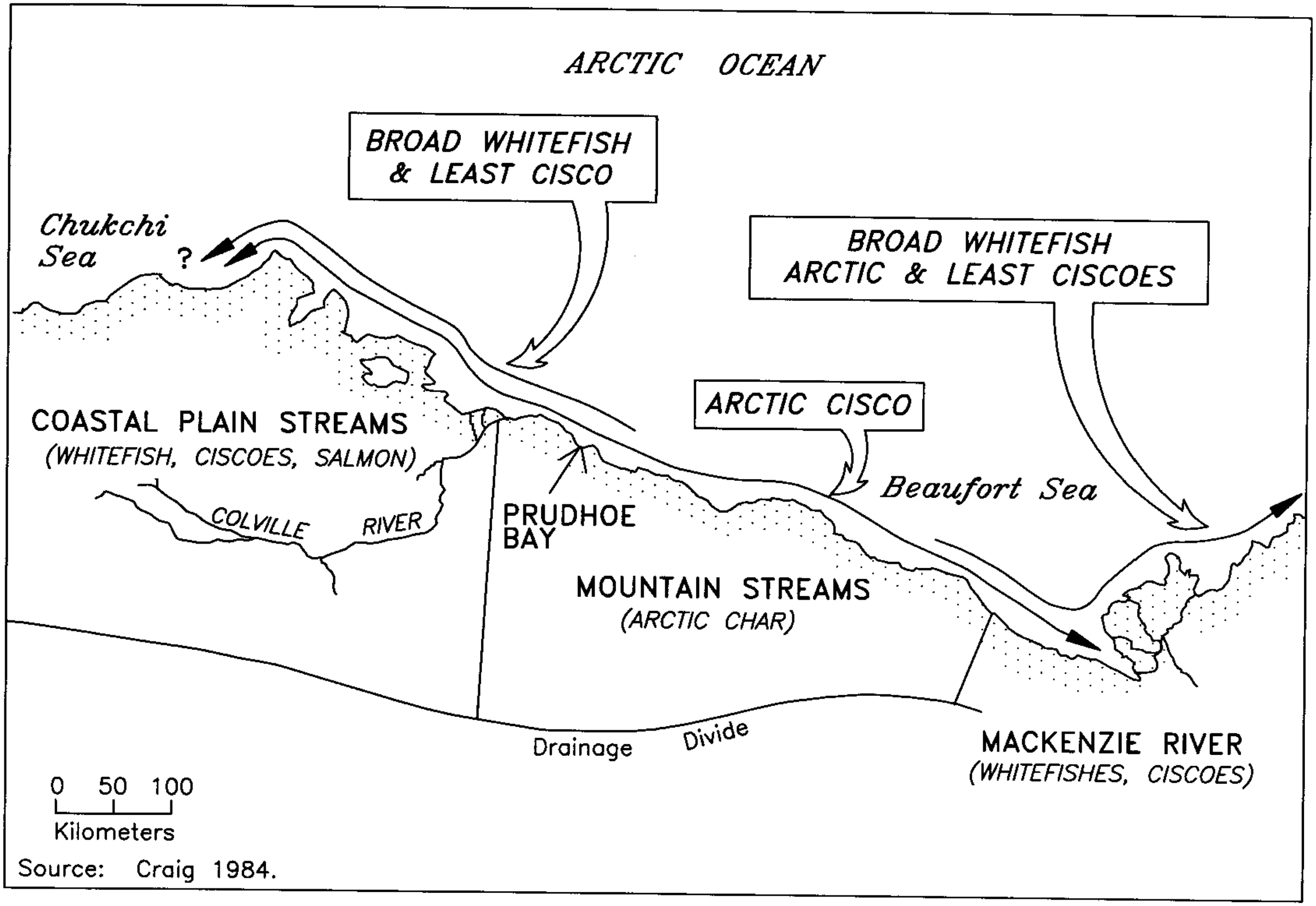


Figure III.B.2–1. Freshwater Sources and Coastal Dispersal Patterns of the Principal Anadromous Fishes Occuring Along the Beaufort Sea Coastline spawn. Others, such as fourhorn sculpin and flounder, remain in coastal waters throughout the ice-free period, then move farther offshore with the development of the shorefast ice during the winter.

Most marine species spawn during the winter period, some of them in the nearshore area under the landfast ice cover (Newbury, 1983). Craig and Haldorson (1981) suggest that arctic cod spawn under the ice between November and February, and spawning areas appear to occur both in shallow coastal areas as well as in offshore waters. Fourhorn sculpin spawn on the bottom in nearshore habitats during midwinter. A different spawning pattern is exhibited by two species—the kelp snailfish and leatherfin lumpsucker—which attach their adhesive eggs to solid substrates during the winter. Because of the spawning behavior, these adults are rare except in areas where there is solid substrate, such as near the rock and kelp in the Stefansson Sound Boulder Patch (Dunton, Reimnitz, and Schonberg, 1982).

Feeding habits of marine species are similar to those of anadromous species in nearshore waters, almost all of which rely heavily on epibenthic and planktonic invertebrates. The arctic cod has been described as a "key species in the ecosystem of the Arctic Ocean" due to its widespread distribution, abundance, and importance in the diets of other fishes, birds, and marine mammals (USDOI, MMS, 1990).

d. Fisheries and Population Levels: Anadromous fishes, particularly ciscoes and broad whitefishes, are harvested in several locations along the Alaskan Beaufort Sea coastline. Most of the fisheries are for subsistence, so are described also in Section III.C.3, Subsistence-Harvest Patterns.

There is a single commercial-fishing operation that has been operated by a family (the Helmericks) during the summer and fall months for over two and one-half decades in the Colville River Delta. Arctic and least cisco and broad whitefish are the main species that are harvested; they are sold for human consumption and dog food in Fairbanks and Barrow.

Data records on the fishery indicate that about 10 percent of the arctic ciscoes and 5 percent of the least ciscoes are caught in the commercial fisheries every year (State of Alaska, ADF&G, 1984). The changes in fishery yields from year to year provide a good indication of changes in overall population levels. The apparent recruitment of arctic cisco into the Colville River, as reflected by catch in the Helmericks' commercial fishery, has been followed closely for many years (Moulton and Field, 1988; Moulton, 1989). In order to accurately compare the yearly data, the yields from the Helmericks Colville River fishery have been adjusted through calculation of catch-per-unit-effort (CPUE) for standardized under-ice gillnets, as explained in Moulton (1989). Figure III.B.2-2 illustrates that the CPUE has varied greatly.

While the CPUE of arctic cisco has fluctuated widely, there has not been a trend in the CPUE. Specifically, the data indicate unusually high recruitment in 1979 and 1980, unusually low recruitment in 1981 to 1984, and good recruitment in 1985. The recruitment relates closely to the predominant wind direction, with the highest recruitment during years with predominately east winds (Fechhelm and Fissel, 1988; Fechhelm and Griffiths, 1990; Moulton, Field, and Kovalsky, 1991; Thorsteinson and Wilson, 1994). Because the maturation time and lifespan of arctic cisco is about 7 years, the unusually good recruitment in 1979 and 1980 probably is responsible for the good CPUE in 1986. Recruitment also may be influenced by temperature, salinity, prey abundance, and the size of the parent stock in a manner similar to classical density-dependent stock-recruitment relationships (Gallaway, Gazey, and Moulton, 1989; Moulton, 1989; English, 1991).

With regard to least cisco, there has been less variation, but there also are no obvious long-term trends with this species. Colonell and Gallaway (1990) and Thorsteinson and Wilson (1994) conclude that least cisco abundance has varied primarily with changes in natural mortality and fishing effects. Preliminary 1994 data indicate a reversal of the downward trend in the Colville River least cisco population after 1991 (Wilson, 1995a).

There are no similar fishery data for broad whitefish; however, there are population estimates for the Prudhoe Bay region. The population's size and age structure has been measured over the past decade, except for 1985 to 1987, as part of the Endicott Monitoring Program. Figure III.B.2-3 illustrates the seasonally adjusted abundance

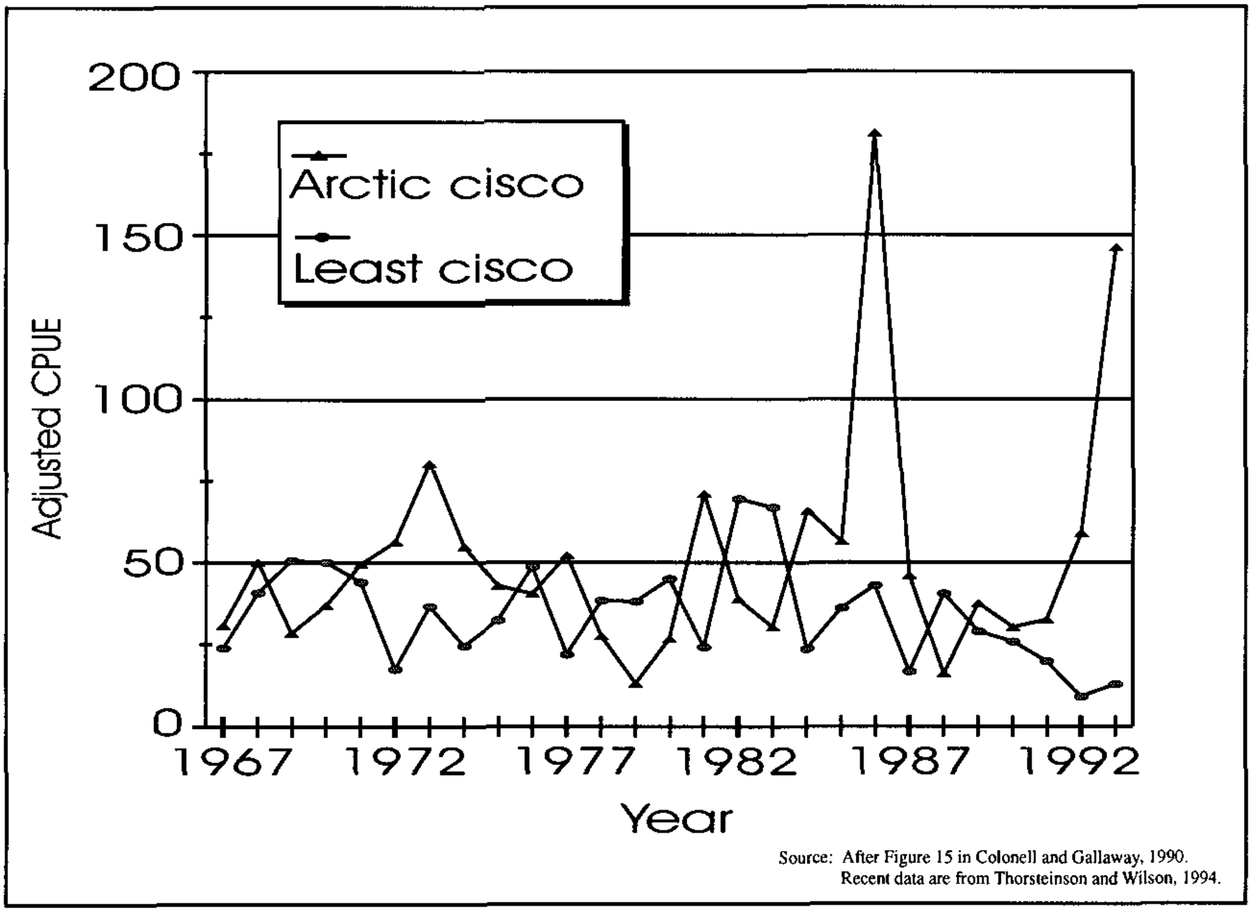


Figure III.B.2-2. Colville River Fishery Catch-per-unit-of-Effort (CPUE)

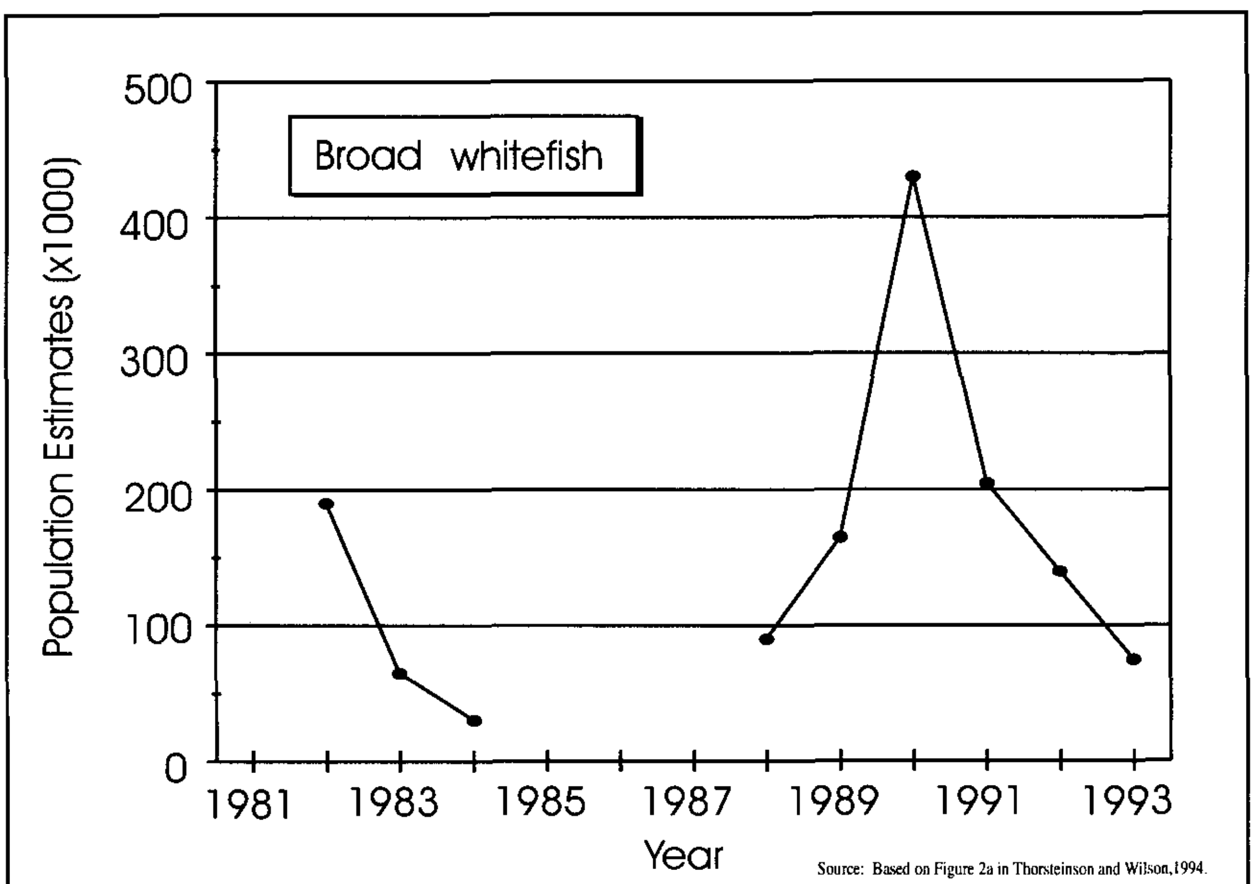


Figure III.B.2-3. Prudhoe Bay Broad Whitefish Population Estimates

estimates of broad whitefish cohorts I to IV. Their abundance has varied greatly, possibly due to a population cycle of about a decade's duration. Detailed analyses of each cohort indicate that the weak year classes may result from density-related adult displacement of juveniles from optimal overwintering habitats (Thorsteinson and Wilson, 1994).

The population density of the main marine species, arctic cod, was recently estimated for a coastal bay (Thorsteinson, 1996). During the summer of 1991, there was an unusually large number of young-of-the-year arctic cisco in Camden Bay. Thorsteinson estimated that there were up to 75 million young-of-the-year. So the total population level, including the older but relatively scarce year classes, would have been slightly higher. Even though the population estimate was unusually high, as noted by Thorsteinson, it provides a basis for quantification of effects in Chapter IV.

3. Marine and Coastal Birds: The description of marine and coastal birds in the Beaufort Sea Planning Area as contained in Section III.B.3 of the Sale 87 FEIS (USDOI, MMS, 1984) is incorporated by reference. A summary of this description, augmented by additional material, as cited, follows. Several million birds, consisting of about 150 species—including seabirds, waterfowl, shorebirds, passerines, and raptors—occur on the North Slope and/or within marine habitats within or adjacent to the area of Sale 144 in the Beaufort Sea. Nearly all of these species are migratory and are found in the Arctic seasonally, generally from May through September. The most abundant marine and coastal species include red phalarope, oldsquaw, glaucous gull, and common eider. During the fall—late September to mid-October—20,000 to 40,000 Ross' gulls, representing a large proportion of the world population of this species, occur within the sale area and adjacent coastal habitats. Within these areas, the greatest numbers are found offshore of Point Barrow and eastward to the Plover Islands (Divoky, Hatch, and Haney, 1988).

Within the proposed sale area, major concentrations of birds occur near shore (in waters <20 m in depth) and in coastal areas such as Plover Islands-Barrow Spit, Pitt Point-Cape Halkett, Fish Creek Delta, Colville River Delta, Simpson Lagoon, Beaufort Lagoon, and Demarcation Bay (Fig. III.B.3). In the far western part of the proposed sale area (Point Barrow area), high densities of birds occur offshore, apparently due to increased productivity caused by nutrient intrusion from the Bering Sea. Areas such as Elson Lagoon-Plover Islands, Pitt Point-Cape Halkett, and Simpson Lagoon support 50 to 100 birds per square kilometer (birds/km^2) in August, with feeding flocks of thousands of birds/km^2 occurring when abundant food sources are available. As many as 50,000 oldsquaw were recorded in Simpson Lagoon in late July (Johnson and Herter, 1989). However, pelagic areas (waters deeper than 20 m and out to the shelf break) offshore of Point Barrow-Plover Islands in the western Beaufort Sea support high average densities (38.1 birds/km^2) of predominant species during the open-water season. As many as 80,000 king eiders and 130,000 common eiders migrate past Point Barrow during the spring.

Shortly after spring migration, most shorebird and waterfowl populations disperse to nesting grounds primarily on moist tundra and marshlands of the arctic slope. The Teshekpuk Lake area, Colville River Delta, Mackenzie River Delta, Canning River Delta, and Herschel Island are very important nesting areas for waterfowl such as Pacific brants, yellow-billed loons, and snow geese, respectively. Other species, such as common eiders, arctic terns, glaucous gulls, and black guillemots, nest on barrier islands (Fig. III.B.3). Timing of breakup of ice surrounding a barrier island is critical for determining the island's importance as a nesting site for marine birds. For this reason, islands near large river deltas such as Thetis and Herschel Islands receive the heaviest use. Other barrier island nesting sites shown on Figure III.B.3 vary in their importance to nesting birds. In the Plover Islands, islands such as Cooper and Deadman Islands (in the western Beaufort Sea) are important for nesting black guillemots.

Beginning in mid-July, large concentrations of 10,000 or more oldsquaw and eider occur in coastal waters inshore of islands, such as those in Peard Bay (Gill, Handel, and Connors, 1985), and in Simpson and Beaufort Lagoons, where the birds intensively feed and molt before fall migration. In late July, large numbers of phalaropes and other shorebird species begin to concentrate along the coast. They feed intensively at coastal beach habitats of barrier islands and spits such as Barrow Spit-Plover Islands and along lagoon coastlines, marshlands, and mudflats. Use of lagoons and other coastal habitats peaks in August to late September before and during fall migration. During

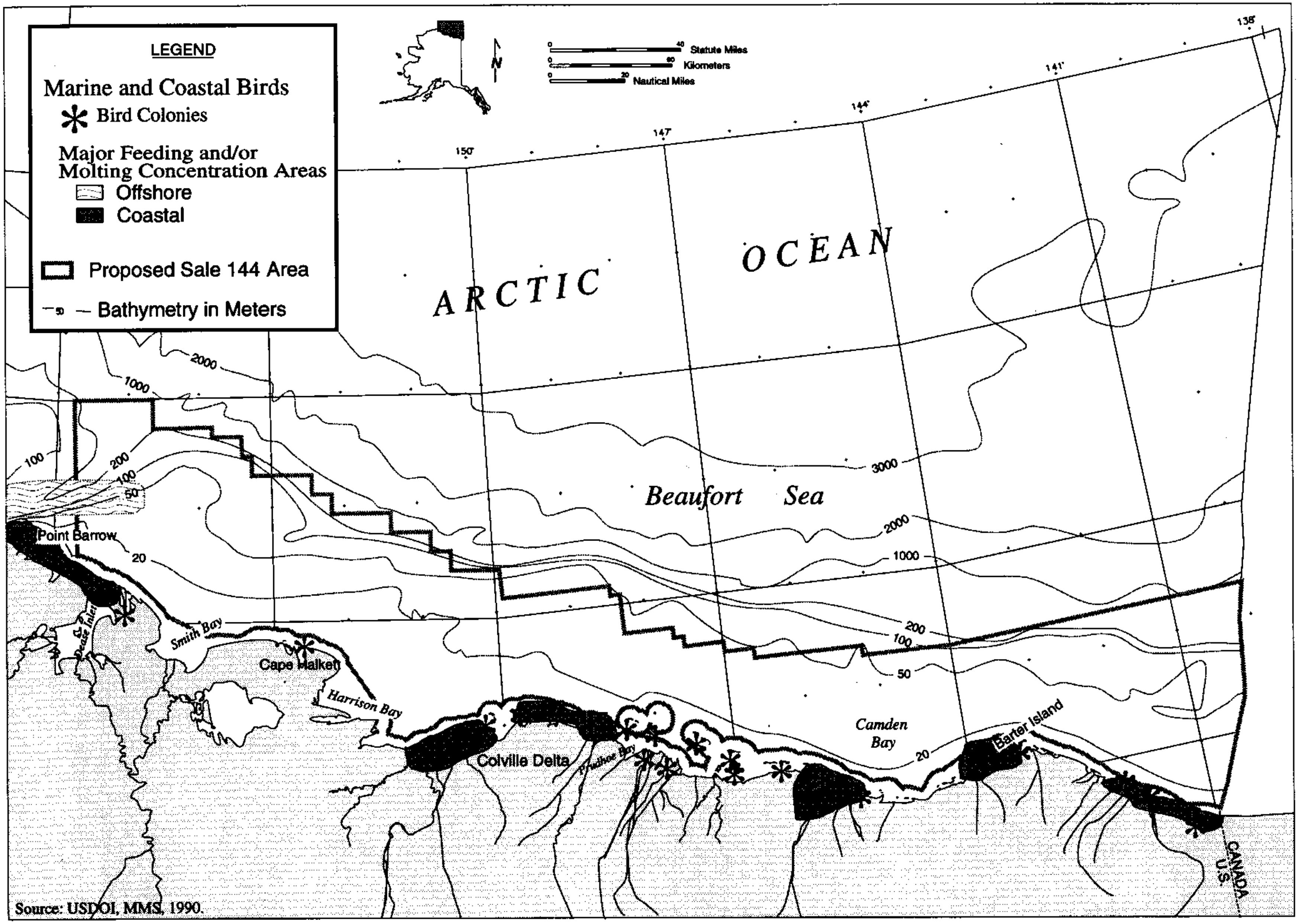


Figure III.B-3. Marine and Coastal Bird Habitats migration, tens of thousands of birds may use a local habitat area while passing through. In addition to the above habitats, coastal tundra lakes, ponds, and river deltas are very important for waterfowl and shorebird molting and staging before and during fall migration. Major areas are Teshekpuk Lake, Fish Creek Delta, Colville River Delta, Hulahula River Delta, and coastal tundra areas (for snow geese and tundra swans) on the Arctic National Wildlife Refuge (ANWR).

4. Pinnipeds, Polar Bears, and Belukha Whales:

The description of these nonendangered marine mammals in the Beaufort Sea Planning Area as contained in Section III.B.4 of the Sale 87 FEIS (USDOI, MMS, 1984) is incorporated by reference. A summary of this description, augmented by additional material, as cited, follows. This account emphasizes species of marine mammals, other than endangered whales, commonly occurring in the Alaskan Beaufort Sea habitats that may be affected by the proposed sale. Species covered include the ringed seal, bearded seal, spotted seal, walrus, polar bear, and belukha whale. Other species that are uncommon or rare in the sale area but that occasionally occur in small numbers (< 100 to < 10) include the gray whale, harbor porpoise, killer whale, narwhal, and hooded seal. The gray whale was discussed in detail in previous Beaufort Sea lease sale EIS's because these sales included tracts within the Chukchi Sea comprising part of the feeding area of this species. However, Sale 144 does not include any tracts west of Point Barrow in the Chukchi Sea (see Figure III.B.4), and therefore gray whales are not expected to be exposed to, or be affected by, any activities associated with the proposal. Due to the relative numerical insignificance of the latter species (including gray whales) in the Beaufort Sea (< 100-< 10 individuals of any of these species have been recorded in the Beaufort Sea), they are not expected to be exposed to or be affected by any activities associated with the proposal and therefore are not discussed further.

All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972 (MMPA). In the act, it was the declared intent of Congress 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 habitat areas of marine mammals are shown on Figure III.B.4.

a. Pinnipeds:

(1) Ringed Seals:

This species is the most abundant seal in the Beaufort Sea. It is widely distributed throughout the Arctic, with an estimated population of 80,000 seals during the summer and 40,000 seals during the winter in the Alaskan Beaufort Sea (Frost and Lowry, 1981). Ringed seal densities within the proposed sale area may depend on a variety of factors such as food availability, proximity to human disturbance, water depth, ice stability, etc. Densities of ringed seals in the floating shorefast-ice zone of the Beaufort Sea generally range from 1.5 to 2.4 seals per square nautical mile (seals/nmi^2) (Frost, Lowry, and Burns, 1988). 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.

Probably a polygamous species, ringed seals, when sexually mature, establish territories during the fall that they maintain during the pupping season. Pups are born in late March and April in lairs that are excavated in snowdrifts and pressure ridges. During the pupping and breeding season, adults on shorefast ice (floating fast-ice zone, see Fig. III.B.4) generally are less mobile than individuals in other habitats; they depend on a relatively small number of holes and cracks in the ice for breathing and foraging. During nursing (4-6 weeks), pups generally are confined to the birth lair. This species is a major subsistence resource composing as much as 58 percent of the total seals harvested by subsistence hunters in Alaska (see Sec. III.C.3, Subsistence-Harvest Patterns).

(2) Bearded Seals:

This species is found throughout the Arctic and generally prefers areas where seasonal broken sea ice occurs over waters <200 m 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. The bearded seal is primarily restricted to the moving ice in the Beaufort Sea. Densities of bearded seals in the western Beaufort Sea and throughout the sale area are greatest during the summer

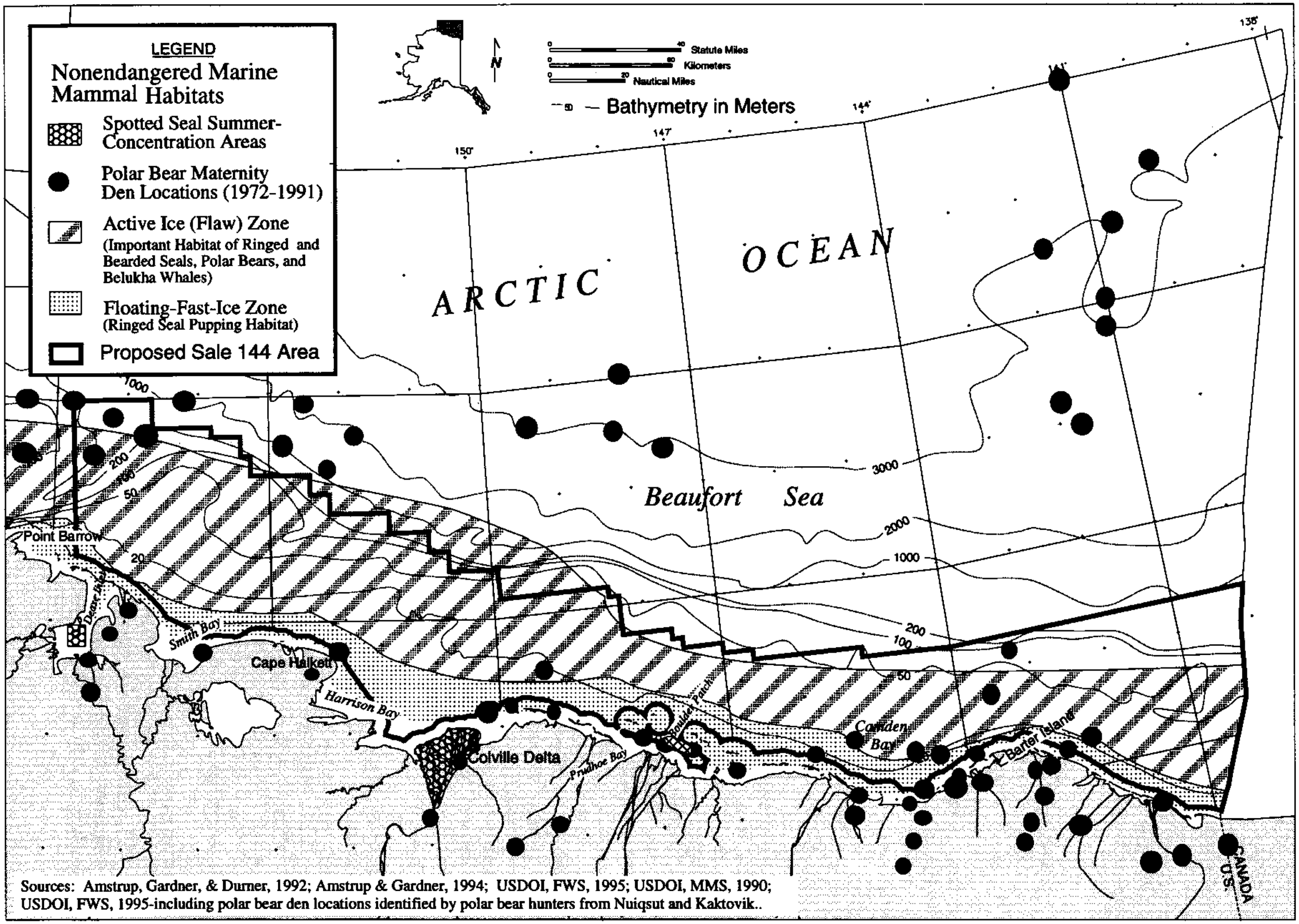


Figure III.B.4. Nonendangered Marine Mammal Habitats and lowest during the winter. The most important winter and spring habitat area is the active ice zone shown in Figure III.B.4.

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); most pups reach approximately 63 percent of their adult length when they are weaned. These seals do not form herds, although loose aggregations of animals do occur. The bearded seal is a relatively important subsistence species and is preferred by subsistence users.

(3) Spotted Seals: This species is a seasonal visitor to the Beaufort Sea. Spotted seals appear along the coast in July in low numbers (about 1,000 total for the Alaskan Beaufort Sea coast), hauling out on beaches, barrier islands, and remote sandbars on the river deltas. Beaufort Sea coastal haulout and concentration areas include the Colville River Delta, Peard Bay, and Oarlock Island in Dease Inlet/Admiralty Bay adjacent to the proposed sale area (Fig. III.B.4). Recently, these seals also have frequented Smith Bay at the mouth of the Piasuk River. Spotted seals frequently enter estuaries and sometimes ascend rivers, presumably to feed on anadromous fishes. Spotted seals migrate out of the Beaufort Sea in the fall (September to mid-October) as the shorefast ice re-forms and the pack ice advances southward. They spend the winter and spring periods along the ice front throughout the Bering Sea where pupping, breeding, and molting occur.

(4) Walruses: The North Pacific walrus population was estimated at about 201,000 animals in 1990 (Seagars, 1992; Gilbert et al., 1992), comprising about 80 percent of the world population. The 1990 estimate was less than the previous estimate (232,500 animals in Gilbert, 1989); however, the 1990 estimate was a minimal count and cannot be used to indicate a population trend due to the incompleteness of the aerial survey and the very broad spacial and temporal aggregation of the population in the Chukchi and Beaufort seas (Hills and Gilbert, 1994). By 1980, the walrus population was showing density-dependent signs of having reached the carrying capacity of its environment, with significant decline in productivity and calf survival occurring. At the same time, harvest rates by both the Soviet and American walrus hunters have more than doubled, with 10,000 to 15,000 animals (4-6% of the population) killed per year (Fay, Kelly, and Sease, 1989). The latter investigators believe that natural curtailment of the walrus population and the increase in human exploitation of this population may result in a dramatic population decline. An optimistic hypothetical model of the Pacific walrus population, based on recent data and assuming a 10-percent reduction in harvest rates per year, projects that the walrus population will decline to about 175,000 by the early 1990's (Fay, Kelly, and Sease, 1989). In general, most of this population is associated with the moving pack ice year-round. Walruses spend the winter in the Bering Sea; and the majority of the population summers throughout the Chukchi Sea, including the westernmost part of the proposed sale area (Fig. III.B.4). Although a few walruses may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open-water season, the majority of the Pacific population occurs west of 155° W. longitude north and west of Barrow, with the highest seasonal abundance along the pack-ice front.

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. Spring migration usually begins in April, and most of the walruses move north through the Bering Strait by late June. 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 Wrangell Island and along the northwest coast of Alaska from about Point Hope to north of Point Barrow. With the southern advance of the pack ice in the Chukchi Sea 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 in the eastern Beaufort Sea.

Walrus calves are born from mid-April to mid-June during the northward migration; mating takes place from January to March. The gross reproductive rate of walruses is considerably lower than that of seals. Prime reproductive females produce one calf every 2 years rather than one every year as do other pinnipeds. Walruses are a very important cultural and subsistence resource. Alaskan annual harvest catches ranged from 3,000 to about 6,000 animals from 1980 to 1985 (Fay, Kelly, and Sease, 1989).

b. Polar Bears: Polar bears are found throughout the Arctic. The Beaufort Sea population (from Point Barrow to Cape Bathurst, Northwest Territories) is estimated to be 1,300 to 2,500 bears, while the total Alaskan population is estimated at 3,000 to 5,000 bears (Amstrup, 1983; Amstrup, Stirling, and Lentfer, 1986). There is substantial annual variation in the seasonal distribution and local abundance of polar bears in the Alaskan Beaufort Sea. Average density appears to be one bear every 30 to 50 mi^2, with much lower densities occurring farther than 100 mi offshore and higher densities occurring near ice leads where seals are concentrated. The two most important natural factors affecting polar bear distributions are sea ice and food availability.

Drifting pack ice off the coast of the Alaskan Beaufort Sea probably supports greater numbers of polar bears than either shorefast ice or polar pack ice, probably due to the abundance and availability of subadult seals in this habitat. Polar bears prefer rough sea ice over smooth ice for hunting and resting (Martin and Jonkel, 1983). 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 are capable of swimming long distances and are very curious animals (Adams, 1986, pers. comm.).

Pregnant and lactating females and newborn cubs are the only polar bears that occupy winter dens for extended periods. Polar bears may concentrate such denning on offshore islands and certain portions of the mainland. Typically, dens are more sparsely distributed in the Alaskan coastal zone than areas receiving consistent use such as Wrangell Island, Hudson Bay, and James Bay. Pregnant females come to coastal areas in late October or early November to construct maternity dens. Most terrestrial dens are located close to the seacoast, usually not more than 8 to 10 km inland, but some dens have been located over 100 mi inland in Canada (Kolenosky and Prevett, 1983). Offspring are born from early December to late January, and females and cubs break out from dens in late March or early April. Polar bear dens have been located along river banks in northeast Alaska and on shorefast ice close to islands east of the mouth of the Colville River. Recently recorded denning areas have been found along the coast of ANWR. These and other recorded den locations from 1972 to 1985 are indicated on Figure III.B.4. Of the polar bears that den along the mainland coast of the Beaufort Sea in Alaska and Canada, 80 percent den between 137'00" W. and 146'59" W. longitudes (Amstrup and Gardner, 1994). This clumped distribution may in part be related to the greater topographic relief on the eastern part of the Arctic coastal plain (137'00"-146'59" W. longitude compared to the flat relief of the coastal plain west of 146'59" longitude). Topographic relief provides areas where snow will accumulate in drifts on the leeward side of banks and other topographic features adequate for den construction by the bears. Several of the coastal den sites shown in Figure III.B.4 from the Colville River Delta east to Barter Island were identified by polar hunters from Nuiqsut and Kaktovik (USDOI, FWS, 1995).

Female polar bears generally do not use the same den-site location (Ramsay and Stirling, 1990; Amstrup Garner, and Durner 1992). Polar bears repeatedly use the same geographic areas for maternity denning (Amstrup, Garner, and Durner 1992), but shifts in the distribution of den locations have been reported in Canada and might be related to changes in sea-ice conditions (Ramsay and Stirling, 1990).

Insufficient data exist to accurately quantify polar bear denning along the Alaskan Beaufort Sea coast. However, dens in this area appear to be less concentrated than in many denning areas in Canada and on Wrangell Island and elsewhere in the Arctic. Polar bears have been reported to bear young in maternity dens far offshore on the pack ice (Lentfer and Hensel, 1980; Amstrup, 1985). The majority of polar bear maternity dens located recently (1983-1991) in the Sale 144 area were found on sea ice scattered throughout the planning area (Amstrup, 1985; see Fig. III.B.4).

Besides being covered by the MMPA of 1972, polar bears and their habitats are protected by the International Agreement on the Conservation of Polar Bears of 1976 between Canada, Denmark, Norway, the Union of Soviet Socialist Republics, and the United States. This agreement addresses the protection of "habitat components such as denning and feeding sites and migration patterns."

c. Belukha Whales: The belukha whale, a subarctic and arctic species, is a summer seasonal visitor throughout offshore habitats of the Alaskan portion of the Beaufort Sea. The Bering-

Chukchi-Beaufort population may be in excess of 25,000, while an estimated 11,500 belukha whales migrate to the eastern Beaufort Sea (Frost, Lowry, and Burns, 1988b). 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 (Frost, 1985, pers. comm.). The spring-migration routes through ice leads are similar to those of the bowhead whale. A major portion of the Beaufort Sea population concentrates in the Mackenzie River estuary during July and August (Fig. III.B.4). An estimated 2,500 to 3,000 belukhas summer in the northwestern Beaufort and Chukchi Seas, with some utilizing coastal areas such as Peard Bay and Kasegaluk Lagoon (Frost, Lowry, and Burns, 1988b).

Fall migration through the western Beaufort Sea and the Sale 144 area is in September or October. Although small numbers of whales have been observed migrating along the coast (Johnson, 1979), surveys of fall distribution strongly indicate that most belukhas migrate offshore along the pack-ice front (Frost, Lowry and Burns, 1988). Belukha whales are an important subsistence resource of Inuit Natives in Canada and also are important locally to Inupiat Natives in Alaska (see Sec. III.C.3, Subsistence-Harvest Patterns).

5. Endangered and Threatened Species: The Endangered Species Act of 1973 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.

Gray whales and Arctic peregrine falcons recently were removed from the List of Endangered and Threatened Wildlife (59 *Federal Register* [*FR*] 31094, June 16, 1994, and 59 *FR*50796, October 5, 1994, respectively).

The endangered bowhead whale, the threatened spectacled eider, the proposed Steller's eider, and the recently delisted Arctic peregrine falcon (considered here as a candidate species) may occur year-round or seasonally in the Beaufort Sea Planning Area. General descriptions of the distribution, abundance, and biology of these species are summarized below. Additional information on these species may be found in previously issued Environmental Impact Statements (EIS's) for the Beaufort and Chukchi Seas, including Beaufort Sea Joint Federal/State Oil and Gas Lease Sale (Sale BF) FEIS (USDOI, BLM, 1979), Diaper Field Lease Sale 71 FEIS (USDOI, MMS, 1982), Diaper Field Lease Sale 87 FEIS (USDOI, MMS, 1984), Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1988), Beaufort Sea Sale 124 FEIS (USDOI, MMS, 1991), Chukchi Sea Sale 109 FEIS (USDOI, MMS, 1987), and Chukchi Sea Sale 126 FEIS (USDOI, MMS, 1991).

In addition to the species listed above, the Fish and Wildlife Service (FWS) referenced additional species that could be affected along transportation route south of the proposed sale area. During the consultation process for the Cook Inlet Planning Area Oil and Gas Lease Sale 149, the FWS expressed particular concern for the southern sea otter in California and the marbled murrelet in Washington, Oregon, and California. Both species are listed as threatened. Information on the distribution, abundance, and biology of these species and other endangered and threatened species along the southern transportation route can be found in the Cook Inlet Planning Area Oil and Gas Lease Sale 149 DEIS (USDOI, MMS, Alaska OCS Region, 1995) and the Biological Evaluation prepared for the Endangered Species Act Section 7 consultation, which are incorporated here by reference.

a. Bowhead Whale: The Bering Sea stock (western arctic stock) of bowhead whales migrates through the proposed sale area semiannually as the bowheads migrate between wintering areas in the Bering Sea and summer-feeding grounds located in the Canadian Beaufort Sea.

The bowhead whale population is estimated to number from 6,400 to 9,200 individuals, with 8,000 as the generally accepted best estimate of the population (IWC, 1995). Population estimates in the last 15 years have risen dramatically. There is evidence that the population was increasing during the 1980's at a rate of about 3 percent/year (Zeh et al., 1993). Following the 1993 spring census of bowhead whales, George et al. (1995a) suggested there may have been as much as a 4.5-percent annual growth in population size since 1978. This increase is likely due to a combination of improved data and better censusing techniques as well as an increasing population. The historic population has been estimated from 10,400 to 23,000 whales in 1848 prior to commercial exploitation (Woody and Botkin, 1993). The species presently appears to be much more abundant than at the close of the commercial whaling period, just after the turn of the century, when it was estimated that there probably were a minimum of 1,000 animals.

Bowhead whales have an affinity for ice and are associated with relatively heavy ice cover and shallow continental-shelf waters for much of the year. During the winter, they are associated with the marginal ice zone, regardless of where the zone is located, and with polynyas. Polynyas in the Bering Sea along the northern Gulf of Anadyr, south of St. Matthew Island, and near St. Lawrence Island, are important wintering areas for bowheads. Bowheads also congregate in these polynyas prior to the beginning of the spring migration.

The bowheads' northward spring migration appears to be timed with the ice breakup. They pass through the Bering Strait and eastern Chukchi Sea from late March to mid-June through newly opened leads in the shear zone between the shorefast ice and the offshore pack ice. Several studies of acoustical and visual comparisons of the bowhead spring migration off Barrow indicate that bowheads also may migrate under ice within several kilometers of the leads. Several observers' data indicate that bowheads migrate underneath ice and can break through ice from 14 to 18 cm (5.5-7.1 in) thick to breathe (George et al., 1989; Clark, Ellison, and Beeman, 1986). It is possible that bowheads use ambient-light cues and possibly echos from their calls to navigate under ice and to distinguish thin ice from multiyear floes (thick ice). After passing Barrow from April through mid-June, they move through or near offshore leads in an easterly direction. East of Point Barrow, the lead systems divide into numerous branches that vary in location and extent from year to year. Bowheads arrive on their summer-feeding grounds in the vicinity of Banks Island from mid-May through June and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September (Moore and Reeves, 1993).

Some biologists conclude that almost the entire Bering Sea bowhead population migrates to the Beaufort Sea each spring and that few, if any, whales summer in the Chukchi Sea. However, some Russian scientists maintain that some bowheads migrate through the Bering Sea in late spring, swim northwest along the Chukotka coast, and summer in the Chukchi Sea. Records of bowhead sightings from 1975 to 1991 suggest that bowheads may regularly occur along the northwestern Alaskan coast in late summer, but it is unclear whether these are "early autumn" migrants or whales that have summered nearby (Moore et al., 1995).

After summer feeding in the Canadian Beaufort Sea, bowheads begin moving westward into Alaskan waters in August and September. Generally, few bowheads are seen in Alaskan waters until the major portion of the migration occurs, typically between mid-September and mid-October. Conditions can vary during the fall migration from open water to over nine-tenths ice coverage, and the extent of ice cover may influence the timing or duration of the fall migration. The medium water depth over which the greatest number of whales appears to migrate is from 20 to 50 m (22-55 yard [yd]). An analysis of median water depths of bowheads sighted during fall aerial surveys from 1982 through 1993 provides an overall median depth of 37 m (40 yd) for all years combined. Greater median depths were observed for heavy ice years, especially for 1983, the heaviest ice year, which had a median depth of 347 m (380 yd) (Treacy, 1994).

Data on the bowhead fall migration through the Chukchi Sea before they move south into the Bering Sea is limited. Whales commonly are seen from the coast to about 150 km (93 mi) offshore between Point Barrow and Icy Cape, suggesting that most bowheads disperse southwest after passing Point Barrow and cross the central Chukchi Sea near Herald Shoal to the northern coast of the Chukotsk Peninsula. However, scattered sightings north of 72° N. latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. After moving south through the Chukchi Sea, bowheads pass through the Bering Strait in late October through early November on their way to overwintering areas in the Bering Sea.

Bowheads apparently feed throughout the water column, including bottom or near-bottom feeding as well as surface feeding, and have been observed feeding in or near the proposed sale area during their spring and fall migrations (Lowry, 1993). This report identifies two feeding areas north of Alaska, one extending from Barter Island to the U.S./Canada border and the second from Point Barrow east to approximately Pitt Point. Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods, with euphausiids and copepods being the primary prey species. Bowheads continue to feed intermittently as they migrate across the Alaskan Beaufort Sea. Areas to the east of Barter Island appear to be used by many bowheads for feeding briefly as they migrate slowly westward across the Beaufort Sea (Thomson and Richardson, 1987). Bowheads also have been observed feeding north of Flaxman Island and in some years, sizable groups of bowheads have been seen feeding east of Point Barrow between Smith Bay and Point Barrow. A study of the importance of the eastern Beaufort Sea to feeding bowhead whales indicated that, for the population as a whole, food resources consumed there did not contribute significantly to the whales' annual energy needs (Richardson, 1987). The North Slope Borough subsequently requested its Science Advisory Committee to review the study. The review committee did not accept the conclusion in the report that the study area is unimportant as a feeding area for bowhead whales (North Slope Borough Science Advisory Committee, 1987). The Committee believed there were problems in study design and that the duration of the study was too short. They believed that the estimates of bowhead whale use of the area in 1985 were unreliable due to unfavorable survey conditions and that one year's data was not adequate to judge the importance of the study area to the bowhead whale population. Carbon-isotope analysis of bowhead baleen has indicated that a significant amount of feeding may occur in wintering areas (Schell, Saupe, and Haubenstock, 1987). In some years, bowheads also have been observed feeding in the spring in the region just west of Point Barrow, indicating that bowheads will opportunistically feed in this area when food is available.

The mating season for bowhead whales is not known with certainty. Most bowhead mating and calving appear to occur from April through mid-June, coinciding with the spring migration. Mating may start as early as January and February, when most of the population is located in the Bering Sea, but has also been reported as late as September and early October (Koski et al., 1993). Calving occurs from March to early August, with the peak probably occurring between the beginning of April and the end of May.

b. Arctic Peregrine Falcon: The arctic peregrine falcon was removed from the list of endangered and threatened wildlife on October 5, 1994 (59 *FR* 50796); however, the FWS is required to monitor this species for 5 years, during which period it will have the same status as a candidate species. Based on 1993 surveys, the population of arctic peregrine falcons now stands at about 200-250 pairs and is increasing; productivity from 1980-1992 varied between 1.3-2.0 young/pair, sufficient to support annual recruitment into the breeding population of about 12 percent (Ambrose, 1995, pers. comm.).

Arctic peregrine falcons nest north of the Brooks Range and on the Seward Peninsula. On the North Slope, nesting sites nearest the coast occur about 32 km (20 mi) inland (Ambrose, 1995, pers. comm.). There are no known active nest sites along the coast between Barrow and Demarcation Point. The major nesting areas occur inland along the Colville and Sagavanirktok rivers with scattered nest sites along other North Slope rivers. Peregrine falcons usually are present in Alaska from about mid-April to mid-September. Egg laying begins in mid-May on the North Slope, and the young fledge from about the end of July to mid-August (USDOI, FWS, 1982). Immature arctic peregrines are known to use northern Alaskan coastal habitats east of the Colville River on a transient basis from mid-August to mid-September (USDOI, MMS, 1984b).

Data regarding the migration routes of Alaskan peregrine falcons are limited; however, it appears that falcons from the North Slope generally follow the central flyway. Peregrine falcons winter in Latin America from September to April (USDOI, FWS, 1982a).

c. Spectacled Eider: Spectacled eiders breed discontinuously, and in most areas sparingly, along the coast of Alaska from Bristol Bay north to Barrow and east almost to the Canadian border, and along the Siberian coast from the Chukotsk Peninsula to the Yana River Delta; apparently at least a few thousand pairs, and possibly double this number, may nest on the Alaskan arctic slope (Johnson and Herter, 1989; Larned, 1996; 58 FR 27474). An estimated 1,700-3,000 pairs of spectacled eiders have nested recently (1990-1992) on the Yukon-Kuskokwim (Y-K) Delta (Stehn et al., 1993); this represents a 94- to 98-percent decline from the early 1970's. A substantial decline also has been recorded at Prudhoe Bay (80% between 1981-1991 [Warnock and Troy, 1991], similar to that recorded on the Y-K Delta during the same period), and native elders from Wainwright and Barrow residents have observed evidence of local population declines elsewhere on the arctic slope (USDOI, FWS, 1994; Suydam, 1996, pers. comm.). Declines also have been reported on the Seward Peninsula and at St. Lawrence Island (Kessel, 1989). Surveys in Siberia in the 1960's indicated that numbers were dwindling at that time on the Indigirka Delta (Dau and Kistchinski, 1977).

Female spectacled eiders are present on the arctic slope from May to September; males also arrive in May but depart the nesting area in June or early July, soon after breeding. Individuals of both sexes stage in nearshore coastal waters for 1-2 weeks following their respective departure from the nesting grounds and prior to moving west and south to molting areas (Petersen, 1996, pers. comm.; Napageak, 1995, pers. comm.); birds in this phase of the annual cycle characteristically concentrate in a few relatively large flocks. In the arctic , spectacled eiders occasionally nest up to 96 km (60 mi) on the Alaska arctic slope and 120 km (75 mi) on the Indigirka River Delta (Dau and Kistchinski, 1977; Larned, 1996; Warnock and Troy, 1992). Nest sites are associated with pond areas containing emergent vegetation; the latter probably helps to reduce predation on ducklings (Petersen, 1995; Warnock and Troy, 1992). Nest densities of 0.20 and 0.13 pairs/km^2 have been observed in the Y-K Delta and Prudhoe Bay areas, respectively (Stehn, Wege, and Walters, 1992; Warnock and Troy, 1992); recent aerial surveys indicate 0.19 pairs/km^2 on the arctic slope east to the Canning River (Larned and Balogh, 1995, unpublished data). Nest success is relatively high both on the Y-K Delta and in the Prudhoe Bay area (40% in the latter), suggesting that the population decline is caused by factors operating outside the nesting period. Brood-rearing occurs in tundra-pond habitat.

Spectacled eider molting and wintering areas were mainly speculative until recent satellite tagging of individuals and winter aerial surveys occurred. Following coastal staging, satellite-tagged postbreeding males (June through October) have been located in coastal Beaufort Sea, at Icy Cape, and in Ledyard Bay, the primary molting area; other locations, some of which may be molting areas, include the Y-K Delta, Mechigmenan Bay on the Chukotsk Peninsula, the Indigirka River Delta in the Russian Far East, and scattered localities north and east of St. Lawrence Island (Petersen, Douglas, and Mulcahy, 1995; Petersen, 1996, pers. comm.). Tagged postbreeding females have been located in the Ledyard Bay molting area and in Norton Sound, along the Y-K Delta, and just southwest of St. Lawrence Island in December. A large proportion, perhaps most, of the world spectacled eider population was observed wintering in nearly closed pack ice about halfway between St. Matthew and St. Lawrence Islands in March 1995; this is assumed to be the previously undocumented wintering area (Larned and Balogh, 1995, unpublished data; Petersen, 1995, pers. comm.). Spring migration proceeds mainly along inland routes.

d. Steller's Eider: Holarctic population estimates for the Steller's eider range from 150,000-200,000; an estimated 50 percent decline in the population has occurred since the early 1970's (59 *FR* 35896). Most of the 70,000 to 100,000 Steller's eiders wintering in Alaska nest in northern Siberia (57 *FR* 19852; Kertell, 1991). Aerial surveys indicate as many as 1,000 pairs may nest in northwestern Alaska (Brackney and King, 1993); however, the only confirmed nesting area used currently is in the vicinity of Barrow (Johnson and Herter, 1989; Quakenbush and Cochrane, 1993). Recent population estimates for the arctic coastal plain (these include a substantial detection-factor error) range from 2,000-7,000 (Brackney and King, 1993); only small numbers have been observed between Barrow and the Colville River. Elsewhere, recent surveys along the entire western Alaskan coast and extensive research on the Y-K Delta have detected no Steller's eiders in suitable nesting habitat; this represents a substantial contraction of their former breeding range in Alaska (Kertell, 1991; Larned et al., 1993).

Males depart the nesting areas in late June, while females with broods remain until late August or early September. Reproductive success generally is low with occasional good years, suggesting that productivity is dependent primarily on adult survival. Brood-rearing takes place in tundra-pond habitat.

Alaskan Steller's eiders are coastal migrants through the western Beaufort, Chukchi, and Bering seas. Most of the population molts along the Alaskan coast from Nunivak Island to Cold Bay and winters from the eastern Aleutian Islands to lower Cook Inlet (Zwiefelhofer, 1993). Fall surveys along the Alaska Peninsula since 1983 have counted fewer than 65,000 individuals (USDOI, FWS, 1991).

Steller's eiders occupy nearshore marine habitats most of the year, feeding on crustaceans and mollusks (e.g., blue mussels) in protected bays.

6. Caribou: The description of caribou in the Beaufort Sea Planning Area as contained in Section III.B.6 of the Sale 87 FEIS (USDOI, MMS, 1984) is incorporated by reference. A summary of this description, augmented by additional material, as cited, follows. Among the terrestrial mammals that occur along the coast of the Beaufort Sea, barren-ground caribou is the species that could be affected most by proposed OCS oil and gas activities in the Sale 144 area.

Two large caribou herds and two smaller caribou herds use coastal habitats adjacent to the sale area: the Western Arctic, the Porcupine, the Central Arctic, and the Teshekpuk Lake herds (WAH, PCH, CAH, and TLH, respectively). The WAH, which was estimated by Machida (1994) to be 450,000 animals, 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. The PCH, estimated to be about 178,000 to 180,000 animals in 1989, had declined to 160,000 animals in 1992 and declined to 152,000 animals in 1994 (Whitten, 1992; Whitten, 1995 pers. comm.); the PCH ranges south from the Beaufort Sea coast, from the Canning River of Alaska in the west, eastward through the northern Yukon and portions of the Northwest Territories in Canada, and south to the Brooks Range (Fig. III.B.6). The CAH was estimated at about 23,000 animals (Abbott, 1993), but has declined to 18,100 animals in 1994 and continues to decline (personal communication, Whitten, ADF&G, 1995); the CAH ranges between the Canning and Itkillik rivers to the east and west, and from the Beaufort Sea in the north to the crest of the Brooks Range in the south.

The calving and wintering area for the TLH, comprising more than 27,000 animals (Machida 1994), is around Teshekpuk Lake and near Cape Halkett adjacent to Harrison Bay (see Fig. III.B.6). The WAH's major calving area is inland on the National Petroleum Reserve-Alaska (NPR-A). The PCH calving range encompasses an area along the Beaufort Sea coast from the Canning River in Alaska to the Babbage River in Canada and south to the northern foothills of the Brooks Range (Fig. III.B.6). Major concentrations of calving cows occur within this range between the Canning and Sadlerochit rivers on the west and east, respectively, and between Camden Bay on the north and the Sadlerochit Mountains on the south. Recently, most of the CAH have calved within 30 km of the Beaufort Sea, including the Prudhoe Bay area (see Fig. III.B.6). Calving generally takes place from late May to late June.

During the postcalving period in July through August, caribou generally attain their highest degree of aggregation with continuous masses of animals in herds such as the WAH or PCH in excess of tens of thousands. Cow/calf groups are most sensitive to human disturbance during this period. During the summer months, caribou use various coastal habitats of the Beaufort Sea in Alaska, such as sandbars, spits, river deltas, and some barrier islands, for relief from insect pests.

The need for caribou to migrate appears to be a behavioral adaptation that prevents destruction of forage habitat. If movements are greatly restricted, caribou are likely to overgraze their habitat, leading to perhaps a drastic, long-term population decline. Migrating caribou often follow well-defined routes between winter and summer ranges. 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; Eastland, Bowyer, and Fancy, 1989), 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 calving success.

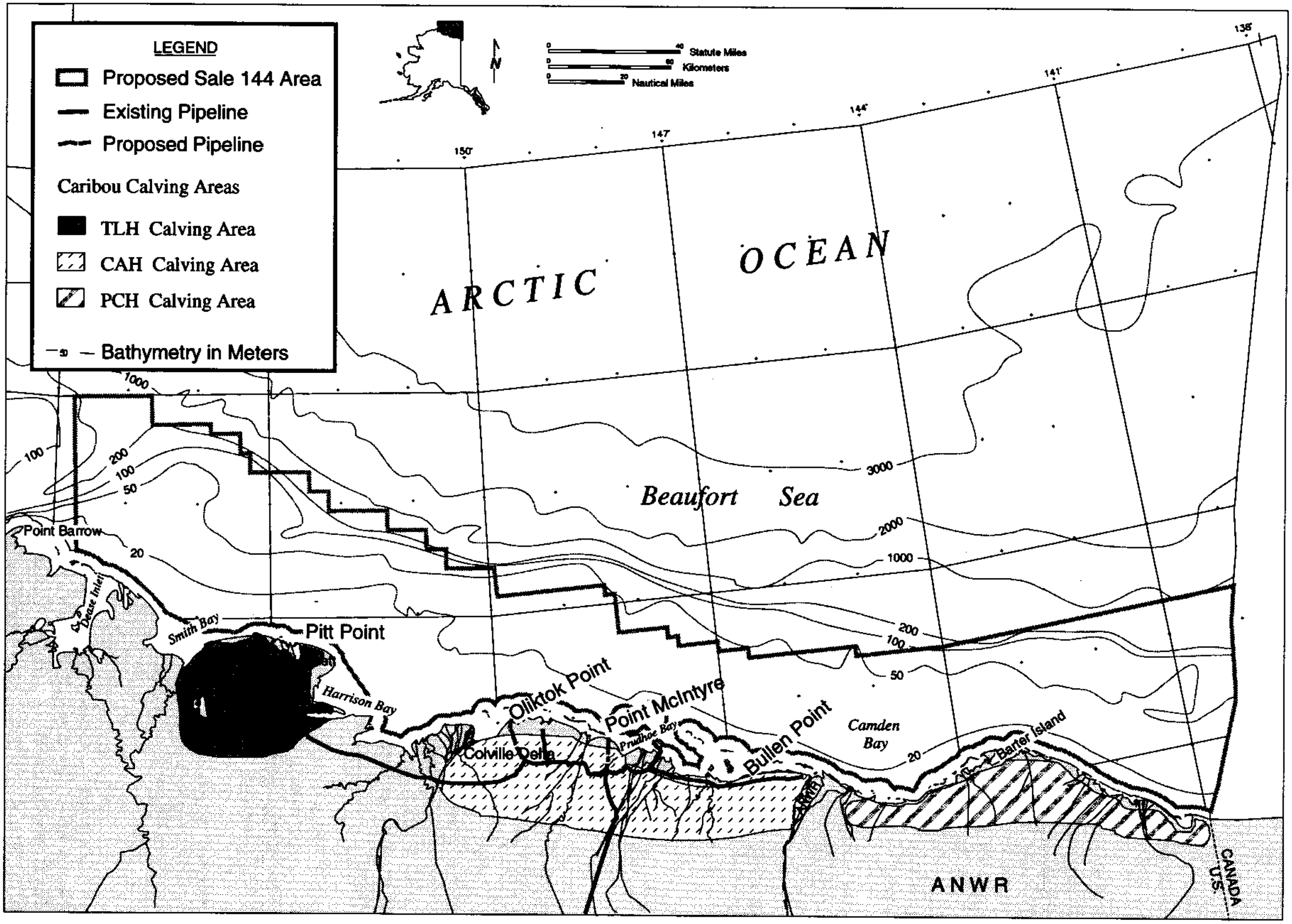


Figure III.B.6. Caribou Calving Areas

C. SOCIAL SYSTEMS:

1. *Economy of the North Slope Borough:*

The direct economic effects of proposed Sale 144 would be restricted almost entirely to the North Slope Borough (NSB). Because almost no direct economic effects are expected to occur outside this region, the economics discussion in the EIS does not describe the Statewide economy or the Statewide economic effects of the proposed sale.

The NSB includes the entire northern coast of Alaska and encompasses 88,281 mi^2 of territory, equal to 15 percent of the land area of Alaska. The predominately Inupiat residents have traditionally relied on subsistence activities. Sociocultural aspects and subsistence activities of the economy are discussed in Sections III.C.2 and III.C.3, respectively, of this EIS.

Located within the region is a vast petroleum-industry development centered at Prudhoe Bay. The most important economic linkage between petroleum activities and permanent residents of the region is the NSB government. The NSB is collecting very large property-tax revenues from petroleum-industry facilities. These revenues have funded greatly improved educational, health, and other government services and have financed an extensive Capital Improvements Program (CIP), which has created large numbers of construction jobs for permanent residents.

The following updates on NSB revenues and expenditures and employment in the North Slope region under existing conditions are from the Rural Alaska Model as developed by the Institute for Social and Economic Research (ISER) for MMS. There are four key groups of assumptions to which the model is most sensitive or for which there is greater uncertainty as to their true values. These assumptions are (1) future NSB revenues, (2) the relationship between Native migration and unemployment, (3) the share of jobs in each category of employment available to Natives, and (4) the percentage of workers unable to find other jobs in the villages who will seek work in the oil industry.

a. *NSB 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] 1995) of the enormously high-valued petroleum-industry-related property in the Prudhoe Bay area.

The NSB's total revenues in FY 1995 were estimated at $326 million. The largest source of these revenues was property taxes (71%). The general-fund revenues are roughly split (51% and 49%, respectively) to pay for previous expenditures, primarily the debt on general-obligation bonds that were sold to fund CIP projects, and for current operation and maintenance costs.

Property values could be higher or lower than those projected, depending on world-energy prices. However, property value is not considered to be the constraining factor for future NSB revenues. Future NSB revenues are likely to be constrained by a number of other factors, including (1) existing and potential State-imposed limits, (2) NSB residents' willingness to assume higher property-tax burdens, and (3) State and Federal revenue-sharing policies.

The FY 1994 mill rate applied by the NSB to assessed property is 18.5 mills. This rate is the sum of a rate of 4.78 mills for operations and 13.72 mills for debt service. Although the mill rate for operations is at the limit allowed by State statutes, the NSB's rate is well under the limit and, therefore, the NSB administration is not now facing any legal constraints to raising the rate.

Construction expenditures, primarily CIP, and operating expenditures are projected to decline significantly by the year 2000. These declines in expenditures will be the most important factors in the projected decline of resident employment discussed in the following section.

b. *Employment:*

Total North Slope (resident and commuter) employment in 1994 was estimated at around 7,000, down from a peak of over 10,300 in 1983. Over 5,000 (72%) of the jobs in 1994 were in the oil industry, down from a peak of almost 7,800 jobs in 1983. The NSB is the largest employer of North Slope residents in the region. To maintain its wide range of services and to staff its facilities, the Borough employs more than 45 percent of all working residents. When the NSB School District is included in employment figures, Borough employees account for more than 62 percent of the region's resident employed workforce. Most of the remaining resident workforce is employed by the Arctic Slope Regional Corporation, the other Alaska Native Claims Settlement Act (ANCSA) village corporations and their subsidiaries, and joint ventures. Almost all petroleum-industry jobs are held by workers who commute to permanent residences outside the region. The vast majority of these commuters are employed in isolated, self-sufficient industrial enclaves and have relatively minor direct economic interaction with the Eskimo communities.

Figure III.C.1-1 provides data on Native and non-Native resident employment since 1980. Total resident employment in the year 1993 was estimated to be about 1,943, with about 57 percent of jobs held by Natives. A primary goal of the NSB has been to create employment opportunities for Native residents, and they have been successful in hiring large numbers of Natives for NSB construction projects and operations. The NSB employment has been both high-paying and very flexible, permitting employees to take time off when they wish and allowing them to be rehired after quitting or being fired.

Only a small number of permanent residents hold jobs at the industrial enclaves at Prudhoe Bay. Residents seem to prefer the employment created by the NSB to jobs potentially available in industry. Pay scales offered by the NSB are equal to or better than those in the oil and gas industry, and the working conditions and flexibility offered by the NSB are considered by the Natives to be superior to those prevailing in the oil and gas industry.

Figure III.C.1-2 presents projections of unemployment in the region. The biggest reason for the projected decline in resident employment is the projected decline in NSB revenues and expenditures, which results in an expected decline in NSB-funded CIP employment. As CIP projects are completed, expenditures are shifted to operations. Even with an increased emphasis on operations, however, operating employment is expected to decline slightly. The 56-percent share of resident employment held by Natives since 1985 is expected to remain through 2010.

c. *Population:*

(1) Introduction: The population of the North Slope is divided among eight traditional Inupiat communities and various oil-related work camps. Traditional communities include Point Hope, Point Lay, and Wainwright on the Chukchi Sea; Barrow, Nuiqsut, and Kaktovik on the Beaufort Sea; and Atqasuk and Anaktuvuk Pass, both inland. The traditional communities are predominantly Inupiat, they are situated at long-used villages or subsistence sites, and subsistence resources continue to play an important role in their domestic economies. Although historically these settlements grow and contract, they contain a core of resident households united by long-standing kinship bonds.

Oil-related work camps are comprised primarily of male employees who, when not working, reside in Anchorage, Fairbanks, other parts of Alaska, or out of State. At present, these camps are concentrated in the Kuparuk-Prudhoe Bay area, but their location is tied to the necessities of oil exploration, construction, and production. The population of these camps is directly determined by the changes in oil development. Thus far, most North Slope work camps have been developed as industrial enclaves separated by rules and distance from the traditional communities.

(2) Traditional Communities: All villages grew in the early 1980's at a growth rate of 13.5 percent per annum. Wainwright's population increased the least—7.7 percent. The "new" villages of Atqasuk, Nuiqsut, and Point Lay grew most rapidly—96.3, 38.0, and 54.4 percent, respectively. Barrow, the largest NSB village and the regional center, represents about 60 percent of the North Slope total.

The future of the 1980's population explosion must be viewed against long-term trends. Until the early 1970's, North Slope trends conformed roughly to those found generally in Native rural Alaska (Alanso and Rust; 1977). As elsewhere in the State, by the 1950's, smaller North Slope villages were losing people to their regional center, Barrow, as well as to urban Alaska. In spite of high rates of natural increase, Point Hope and Wainwright grew relatively slowly. The smaller settlements of Atqasuk, Nuiqsut, and Point Lay diminished to almost nothing by the 1970's. On the other hand, Barrow—after it emerged as the regional center in the 1940's—grew rapidly with infusions of people from other villages (Milan, 1978).

The early 1980's population boom was a unique event in the demographic history of the North Slope. It indicates indirectly the economic and social magnitude of the NSB's CIP. During these years, CIP economic infusions

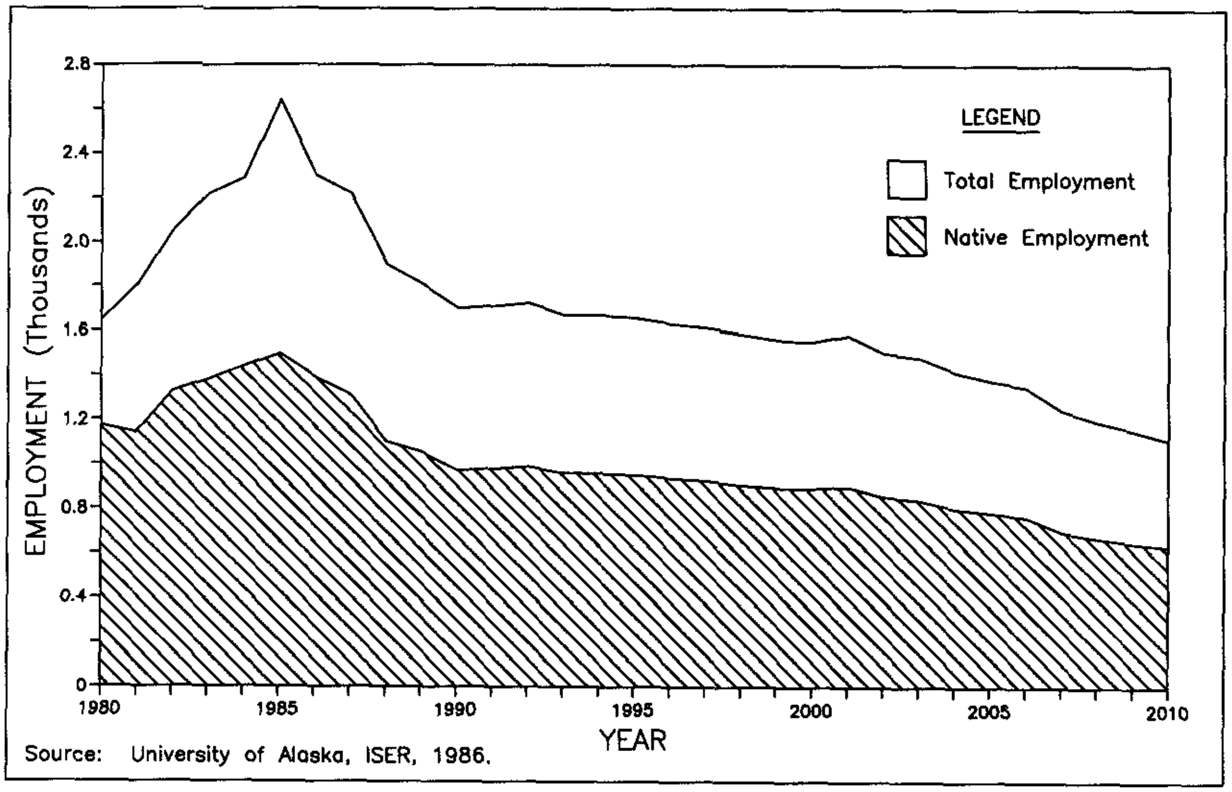


Figure III.C.1-1. Employment (Actual and Projected) of Native and Total Residents of the North Slope Borough Under Existing Conditions, 1980-2010

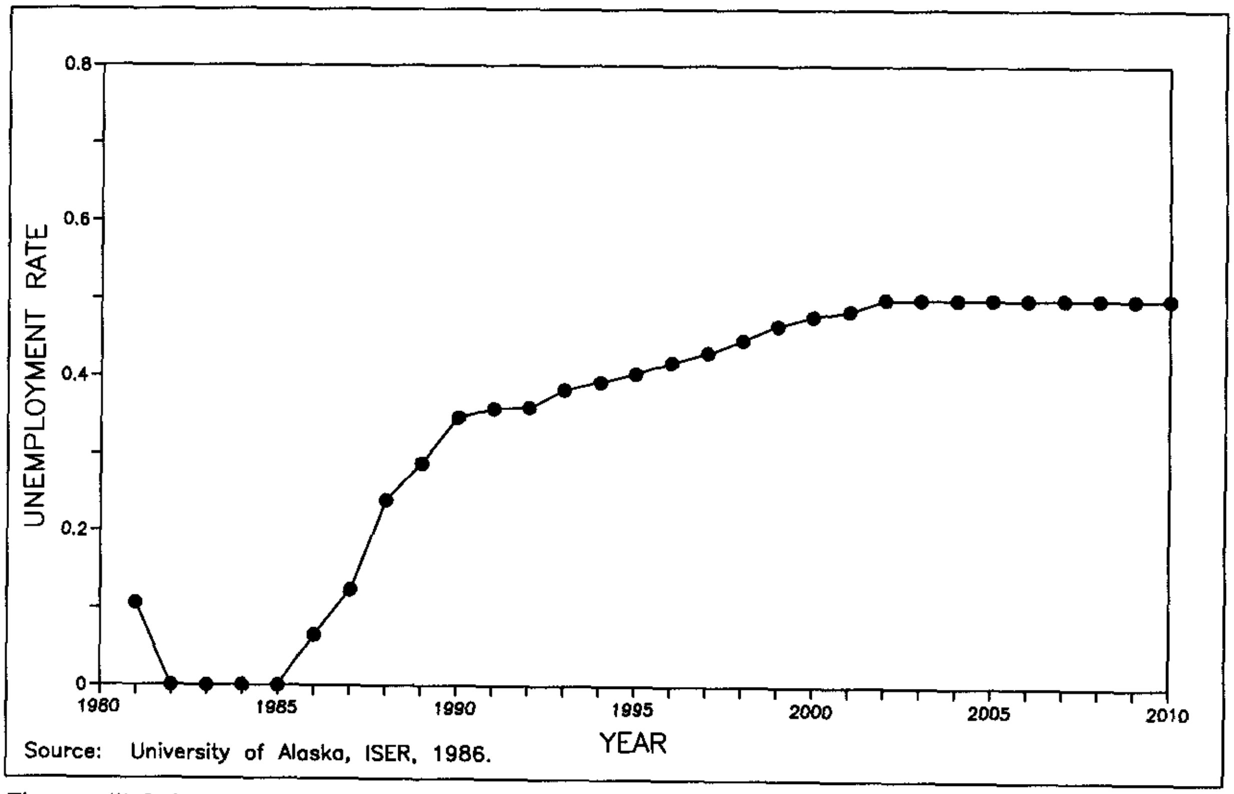


Figure III.C.1-2. Unemployment Rates (Actual and Projected) for Native Residents of the North Slope Borough After Migration, 1981-2010 created jobs, housing, and infrastructure in all the North Slope villages. In these communities, this led to higher levels of population retention, to the return of people who had previously sought employment elsewhere, and to immigration of individuals—particularly non-Natives—who previously had not resided in the area. This growth reflects higher per capita housing construction in the newer settlements. Outside Barrow, housing construction was the driving force in these CIP-fueled economies (Galginaitis, 1984). Barrow's growth boom in the 1980's—14.3 percent annually—indicates its role as the political and bureaucratic center for all these activities. Much of this growth has occurred from the immigration of non-Natives. This group is made up primarily of Caucasians but includes Blacks, Filipinos, Koreans, Mexicans, and others (Smythe and Worl, 1985).

A reduction in CIP expenditures could be expected whether or not more OCS or onshore oil developments occur on the North Slope. Because recent population growth has been tied to CIP-related opportunities, similar growth is not expected in the foreseeable future.

In recent years, governmental functions have concentrated in Barrow, and its Native residents may be less affected by projected reductions in CIP expenditures than those in the smaller villages. Finally, with the reduction of construction jobs, Native families may rely more on subsistence harvests. Native households with more developed subsistence-harvest and -sharing patterns may be less affected by demographic shifts than households without them. This may be particularly true in settlements other than Barrow.

2. Sociocultural Systems: The topic of sociocultural systems encompasses the social organization and cultural values of the society. This section provides a profile of the sociocultural systems that characterize the communities near the Sale 144 area that might be affected by this lease sale: Barrow, Atqasuk, Nuiqsut, and Kaktovik (see Fig. II-A.1). All of these communities are within the 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), the Chukchi Sea Sale 109 FEIS (USDOI, MMS, 1987b, Sec. III.C.3), and the Beaufort Sea Sale 124 FEIS (USDOI, MMS, 1990, Sec. III.C.2), which are incorporated by reference. The following summary is pertinent to Sale 144 and is augmented by additional material, as cited.

a. Introduction: The North Slope has a fairly homogeneous population of Inupiat—approximately 72 percent Inupiat in 1990. This is an approximation because the 1990 Census did not distinguish between other Inupiat, other Alaska Natives, and American Indians, although there were only 110 individuals (1.8% of the total NSB population) in the NSB that fell into these latter two classifications. The percentage in 1990 ranged from 92.7 percent Inupiat in Nuiqsut to 61.8 percent Inupiat in Barrow (USDOC, Bureau of the Census, 1991). In 1990, the populations of each of the communities in the sale area were 3,469 in Barrow, 216 in Atqasuk, 354 in Nuiqsut, and 224 in Kaktovik (USDOC, Bureau of the Census, 1991; see also Sec. III.C.1).

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 pace of change quickened by the area's oil developments (Lowenstein, 1981). In 1952, the anthropologist Spencer was dependent upon interpreters for his Barrow fieldwork (Spencer, 1959); but today, few North Slope residents lack English skills (Klausner and Foulks, 1982:48), and communication with the "outside" is no longer uncertain. All North Slope communities are tied to the larger world via telephone, cable television, and regularly scheduled commercial air transportation. In the Prudhoe Bay-Kuparuk industrial complex, oil-related work camps have altered the seascape and landscape, making some areas off limits to traditional pursuits such as hunting. Large NSB CIP's dramatically changed the physical appearance of NSB communities. Blocks of modern houses, new schools, water-treatment plants, power plants, and community buildings stand out. Snowmachines, three- and four-wheeled vehicles, all-terrain vehicles, and, in many communities, cars and pickups abound.

Social services have increased dramatically from 1970 to the present, with increased NSB budgets and grants acquired by or through the Inupiat Corporation of the Arctic Slope. In 1970 and 1977, residents of North Slope villages were asked about their state of well-being in a survey conducted by the University of Alaska Anchorage, ISER (Kruse et al., 1983). Significant increases in complaints about alcohol and drug use were noted in all villages between 1970 and 1977. Health and social-services programs have attempted to meet the needs of alcohol and drug-related problems with treatment programs and shelters for wives and families of abusive spouses and with greater emphasis on recreational programs and services.

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, 1984]); Alaska Consultants, Inc. [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 areawide 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 all-terrain vehicles now help blend these pursuits with wage work. Inupiat whaling remains a proud tradition that involves ceremonies, dancing, singing, visiting, cooperation between communities, and the sharing of foods.

The possible effects of the proposed action on subsistence, specifically, whales and whaling, has been in the past and continues to be a major scoping issue for residents of the North Slope (Kruse, Baring-Gould, and Schneider, 1983; ACI/Braund, 1984; USDOI, MMS, 1994). Whaling remains a primary subsistence activity for Barrow, Nuiqsut, and Kaktovik (see Sec. III.C.3)--an activity that has roots in Eskimo prehistory (Giddings, 1967). Whales are not only an important subsistence issue; they are and have been the singlemost important animal in the long prehistory of the North Slope sociocultural system (Lantis, 1938; Bockstoce et al., 1979; Worl, 1979).

The following sections describe the communities that may be affected by Sale 144. These community-specific descriptions discuss factors relevant to the sociocultural analysis of the community in relation to industrial activities, population, and current socioeconomic conditions. Following these descriptions, social organization, cultural values, and other issues of all Sale 144 communities are discussed.

(1) Barrow: Barrow is likely to be one of the air-support bases for exploration. A large part of Barrow's marine subsistence-harvest areas is within the proposed Sale 144 area, and a pipeline route from Pitt Point would pass through Barrow's terrestrial subsistence-harvest area.

On the North Slope, Barrow is the largest community and the regional center. Barrow already has 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 (USDOC, Bureau of the Census, 1971); by 1990, the proportion had dropped to 63.9 percent (USDOC, Bureau of the Census, 1991; Harcharek, 1992). In 1985, non-Natives outnumbered Natives between the ages of 26 and 59 (NSB, Dept. of Planning and Community Services, 1989). An increasing number of non-Native families also have established permanent residence in Barrow, and by 1990 Barrow was home to 76.2 percent of all non-Native residents in the Borough. Another significant feature of the Barrow population since 1970 is the increase in ethnic diversification: Caucasians comprise 26.1 percent and Asians and Hispanics comprise 10.8 percent of the total Barrow population. Other population groups include other Alaska Natives, Blacks, Hispanics, Asians or Pacific Islanders, and "Other" (persons of multiracial, multiethnic, or mixed origins) (USDOC, Bureau of the Census, 1991; Harcharek, 1992). The influx of non-Natives to Barrow also has 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 from 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; between 1980 and 1985, Barrow's population grew by 35.6 percent (Kevin Waring Associates, 1989). 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 significant shifts in the economy. Other fluctuations have occurred during different economic cycles (fur trapping, U.S. Navy and arctic contractors' employment, the CIP boom, and periods of downturn [Worl and Smythe, 1986]). As a consequence of the changes it already has sustained, Barrow may be more capable of absorbing additional changes as a result of Sale 144 than would a smaller, homogeneous Inupiat community.

(2) Atqasuk: Atqasuk is a small (216 residents in 1990 [USDOC, Bureau of the Census, 1991]), predominantly Inupiat community (92% in 1990 [USDOC, Bureau of the Census, 1991]) located inland from the Arctic Ocean on the Meade River about 97 km (60 mi) south of Barrow. Atqasuk is not located in the vicinity of proposed lease-sale activities, nor is it expected to experience any direct additional population growth or employment as a result of Sale 144. 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 Atqasuk. Effects on the sociocultural system of this community are expected to occur only as a result of increased NSB revenues and their consequent effects on the lifestyle and subsistence-harvest patterns of the community.

(3) Nuiqsut: Nuiqsut (population 354 in 1990, 92% Inupiat [USDOC, Bureau of the Census, 1991]) is located on the west bank of the Nechelik Channel of the Colville River Delta, about 40 km (25 mi) from the Arctic Ocean and approximately 241 km (150 mi) southeast of Barrow. Nuiqsut, one of three abandoned Inupiat villages in the North Slope region identified in ANCSA, was resettled in 1973 by 27 families from Barrow.

Most of Nuiqsut's marine subsistence-harvest area lies within the proposed Sale 144 lease-sale area; and its terrestrial, fish, and bird subsistence-harvest areas are in the vicinity of possible landfalls at Pitt, Oliktok, and Bullen Points. Additionally, pipelines from Pitt and Oliktok Points would go through Nuiqsut's land subsistence-harvest area; and Nuiqsut also could be used for some air support for lease activities.

(4) Kaktovik: Kaktovik (population 224, 83% Inupiat in 1990 [USDOC, Bureau of the Census, 1991; State of Alaska, Dept. of Fish and Game [ADF&G], 1993b]), the easternmost village in the North Slope Borough was incorporated in 1971 (Kevin Waring Associates, 1989). It is located on the north shore of Barter Island, which is between the Okpilak and Jago Rivers on the Beaufort Sea coast. Barter Island is one of the largest of a series of barrier islands along the north coast and is about 482 km (300 mi) east of Point Barrow. Kaktovik has been an important "place of barter" for centuries. Canadian and Barrow Inupiat stopped on Barter Island to trade. In 1923, the white trader, Tom Gordon, established a store at Barter Island that provided a permanent location for resident trappers for trading furs and gaining supplies, as well as a convenient stopover for trading. With reindeer introduction to the area in the 1920's, the settlement slowly grew into a permanent village (Kevin Waring Associates, 1989).

Like Nuiqsut, much of Kaktovik's marine subsistence-harvest area is within the proposed Sale 144 lease-sale area; and its terrestrial mammal, fish, and bird subsistence-harvest areas include a possible landfall at Bullen Point. Kaktovik also would be used for some lease-sale air support.

b. Social Organization: The social organization of communities near the Sale 144 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 increases in mobility, availability of housing, and changes in traditional kinship patterns. However, kinship ties in Inupiat society continue to be important and remain 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 also are embedded in those groups that are responsible for hunting, distributing, and consuming subsistence resources (Burch, 1970).

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. 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, baby-sitting, 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 workforce. 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 exchanging of subsistence resources (Nelson, 1969; Burch, 1971; Worl, 1979; ACI/Braund, 1984; ACI/Courtnage/Braund, 1984; Luton, 1985; Chance, 1990). Kinship also is strengthened through cooperation in terms of group efforts to provide 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. 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 its 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, 1990). 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 144 area. The Inupiat remain socially, economically, and ideologically loyal to their subsistence heritage. Indeed, "most Inupiat still consider themselves primarily hunters and fishermen" (Nelson, 1969). This refrain is repeated again and again by the residents of the North Slope (Kruse et al., 1983; ACI/Braund, 1984; Impact Assessment Inc., 1990a,b; USDOI, MMS, 1994). Task groups still are organized to hunt, gather, and process subsistence foods. Cooperation in hunting and fishing activities also remains an important part of the Inupiat life. With whom one cooperates is a major component of the definition of significant kin ties (Heinrich, 1963). Since subsistence tasks are, to a large extent, age and sex specific, subsistence task groups are important as well for the definition of relations such as the roles of husband and wife, child and parent, friend, etc. (Wolfe, 1981; Thomas, 1982; Jorgensen, 1984; Little and Robbins, 1984; Chance 1990). In addition, large amounts of subsistence foods are shared within the community. Whom one gives to and receives from are major components of the definition of significant kin ties (Heinrich, 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, cultural value also is apparent in the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations (some families will dominate one type of government administration, 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 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). Barrow resident Beverly Hugo testifying at the public hearings for Beaufort Sea Sale 124 summed up Inupiat cultural values this way:

> . . .these are values that are real important to us, to me; this is what makes me who I am. . . .the knowledge of the language, our Inupiat language, is a real high one; sharing with others, respect for others; we respect other people; and cooperation; and respect for elders; love for children; hard work; knowledge of our family tree; avoiding conflict; respect for nature; spirituality; humor; our family roles. Hunter success is a big one, and domestic skills, responsibility to our tribe, humility. . . .These are some of the values. . .that we have. . .that make us who we are, and these values have co-existed for thousands of years, and they are good values. . .. (Beaufort Sea Sale 124 FEIS, USDOI, MMS, 1990).

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; Impact Assessment, Inc., 1990a).

Additionally, 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 occurs for summer boat hunting holds true for caribou hunting, fishing, and other subsistence pursuits, as well. In these communities, the giving of meat to 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 when compared with 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. Barrow resident Daniel Leavitt articulated these concerns this way during the 1990 public hearing for Beaufort Sea Sale 124: ". . .as I have lived in my Inupiat way of livelihood, that's the only. . .thing that drives me on is to get something for my family to fill up their stomachs from what I catch" (Beaufort Sea Sale 124 FEIS, USDOI, MMS, 1990). One analysis of Inupiat 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 most concerns centered on 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 the concerns expressed in 83 percent of all the testimony taken on the North Slope (Kruse et al., 1983, Table 16; USDOI, MMS, 1994; Human Relations Area Files, Inc., 1992).

Another great concern that North Slope Borough Inupiat communities observe is the lack of traditional knowledge and testimony appearing in governmental analyses documents, particularly MMS's oil lease-sale EIS's. Mayor George N. Ahmaogak, Sr., of the North Slope Borough said in a 1990 letter to MMS: "The elders who spoke particularly deserve a response to their concerns. . .You should respect the fact that no one knows this environment better than Inupiat residents. . ." (Mayor's letter to Alan Powers, MMS Regional Director, May 9, 1990). In 1993 public testimony concerning a Letter of Authorization for bowhead whale monitoring at the Kuvlum Prospect, Burton Rexford, Chairman of the Alaska Eskimo Whaling Commission, stated that the most important information would come from whaling captains, crew members, and whaling captains' wives. "We know our environment—our land and resources—at a deep level" (LOA Hearing Minutes, 1993). These same concerns were unanimously echoed by those testifying at the Barrow, Kaktovik, and Nuiqsut public hearings for Beaufort Sea Sale 144 in November 1995 (Barrow, Kaktovik, and Nuiqsut Public Hearing Transcripts, Beaufort Sea Sale 144, November 6-8, 1995).

d. Other Issues: Other issues important to an analysis of sociocultural systems are those that will affect or are already affecting Inupiat society. Sections III.C.2 of the Sale 97 and Sale 124 FEIS's detail issues about fiscal and institutional growth in the NSB, changes in employment, increases in income, decreases in Inupiaq fluency, rising crime rates, and substance abuse; these issues are summarized in this section. The Sale 87 FEIS (USDOI, MMS, 1984, Sec. III.C.2), the Sale 97 FEIS (USDOI, MMS, 1987a, Sec. III.C.2), and the Sale 124 FEIS (USDOI, MMS 1990, Sec. III.C.2) consider the NSB's fiscal and institutional growth; and, in addition, Smythe and Worl (1985) and Impact Assessment, Inc. (1990a) detail the growth and responsibilities of local governments.

The NSB provides most government services for all five communities that might be affected by Sale 144. 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. Future fiscal and institutional growth is expected to be limited because of economic constraints to direct Inupiat participation in oil-industry employment and growing constraints in the Statewide budget, although NSB revenues remain healthy and its own permanent fund account continues to grow as does its role as primary employer in the region (Kruse et al., 1983; Harcharek, 1992). A massive NSB CIP in the early 1980's built facilities such as schools, houses, roads, community buildings, fire stations, and health clinics and provided employment for the North Slope residents. The Arctic Slope Regional Corporation, formed under ANCSA, runs several subsidiary corporations. 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 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 decreasing oil revenues in 1985 and 1986, CIP employment opportunities decreased, and there was concern on the North Slope about future employment opportunities. Additionally, the oil industry continues to report a high turnover in the Native workforce due to conflicts between village life and industry work schedules (Marshall, 1993). The CIP downturn and the consequent concern about employment has been alleviated to a large degree by steady NSB service-employment increases and the development of the Resident Employment and Living Improvement (RELI) Program (similar to earlier CIP programs but of a smaller scale) since the mid-1980's, although total per capita earnings are much less than during the CIP boom (Impact Assessment, Inc., 1990a; Human Relations Area Files, Inc., 1992; Harcharek, 1992).

While decreases in Native-language fluency have been noted among younger NSB residents, North Slope Inupiat still are generally bilingual. About 87 percent speak Inupiaq with some fluency and, of those, only about 6 percent either cannot speak English or speak it poorly. Although most people can speak Inupiaq, there seems 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, 1984; Luton, 1985; Impact Assessment, Inc., 1990a). The NSB School District continues to introduce Inupiaq texts into the school curriculum and is committed to the teaching of its Native language.

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, although a study conducted in the early 1980's on the North Slope indicates that no direct relationship was found between energy development and "accelerated social disorganization" (Kruse, Kleinfeld, and Travis, 1982, cited in Impact Assessment, Inc., 1990b). Studies done in Barrow (Worl and Smythe, 1986) detail 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 recently have begun to assume a greater 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 serve as evidence of massive change and growth. In such a situation, the potential for "lost spirit"—or the losing one's Native identity and "soul,"—increases (Vesilind, 1983). This increase in stresses on social well-being and on cultural integrity and cohesion comes at a time of economic well-being that has not been challenged as significantly as once thought by the decline in CIP funding from the State of Alaska. This has come about mostly through the dramatic growth of the Borough's own permanent fund and the NSB taking on more of the burden of its own capital improvement. Even though State funding has decreased significantly since the mid-1980's (with a brief but dramatic increase in unemployment in

1984 and 1985), by 1992 unemployment rates were lower than in 1980, and NSB government expenditures had increased from $63 million in 1982 to $119 million in 1991 (Kruse et al., 1983; Harcharek, 1992; Impact Assessment, Inc., 1990b).

3. *Subsistence-Harvest Patterns:*

a. Introduction: This section describes the subsistence-harvest patterns of the Inupiat (Eskimo) communities closest to the Sale 144 area: Barrow, Atqasuk, Nuiqsut, and Kaktovik. 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 Beaufort Sea Sale 144 area are described in Section III.C.3 of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a) and the Beaufort Sea Sale 124 FEIS (USDOI, MMS, 1990) and are incorporated by reference. The following summary description is augmented by information from current studies including ADF&G (1993a,b); Berman, Goldsmith, and Hull (1990); Stephen R. Braund and Associates (1989); Stoker and Krupnik (1993); USDOI, FWS (1992); Human Resources Area Files (1992, 1994); Impact Assessment, Inc. (1990a,b,c,d); Kevin Waring and Associates (1989); and Marshall (1993).

The community residents adjacent to the Sale 144 area participate in a subsistence way of life. While new elements have been added to the way people live, this way of life is a continuation of centuries-old traditional patterns. Until January 1990, Alaska statutes defined "subsistence uses" as: "the non-commercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural area of the state for personal or family consumption" (AS Sec. 16.05.940); and subsistence uses were given priority over other uses. In January 1990, as a result of McDowell vs. State of Alaska, this law was declared unconstitutional by the Alaska Supreme Court. However, Federal law (Title VIII of ANILCA) continues to define Alaskan subsistence and grants it priority over other uses as well. The new ruling means Alaska cannot legally (according to State law) establish rural preference for subsistence. The effect of the Alaska Supreme Court's decision was stayed until July 1, 1990. The State had until then to devise a solution to the issues raised in the McDowell decision. The Alaska State Legislature was not able to pass any subsistence legislation despite a special session called for that purpose. On Federal lands in Alaska, Federal laws grant subsistence priority over other uses, and Federal Agencies are now managing these hunts and will continue to do so until State legislation can be enacted (USDOI, FWS, 1992).

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 concerns regarding oil development for Sale 144 that were identified during scoping can be divided into four categories: (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, and 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 adjacent to the Sale 144 area—Nalukataq, which celebrates the bowhead whale harvest. The sharing, trading, and bartering of harvestable subsistence resources structures relationships among communities adjacent to the Sale 144 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 communities 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 CIP projects has declined and continues to decline 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 be affected as well. The temporary elimination of a species from a community's subsistence-harvest spectrum could impair the hunt of that particular 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 144 area. The extent of the subsistence area used by each community in the sale area is shown in Figure III.C.3-1. Figures III.C.3-2 through III.C.3-7a show the harvest-concentration areas for the various subsistence resources used by the communities of Barrow, Atqasuk, Nuiqsut, and Kaktovik. 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 four communities near the sale area would be affected at least indirectly by proposed Sale 144, most of the marine-subsistence-harvest areas of Nuiqsut and Kaktovik lie within the Sale 144 boundary. Parts of Atqasuk's and Barrow's marine-subsistence-harvest areas—for bowhead whales and other marine mammals, marine fishes, and migratory waterfowl—lie within this boundary. The caribou-hunting areas of Barrow, Atqasuk, Nuiqsut, and Kaktovik would be most directly affected by pipelines and other onshore facilities associated with the proposed action.

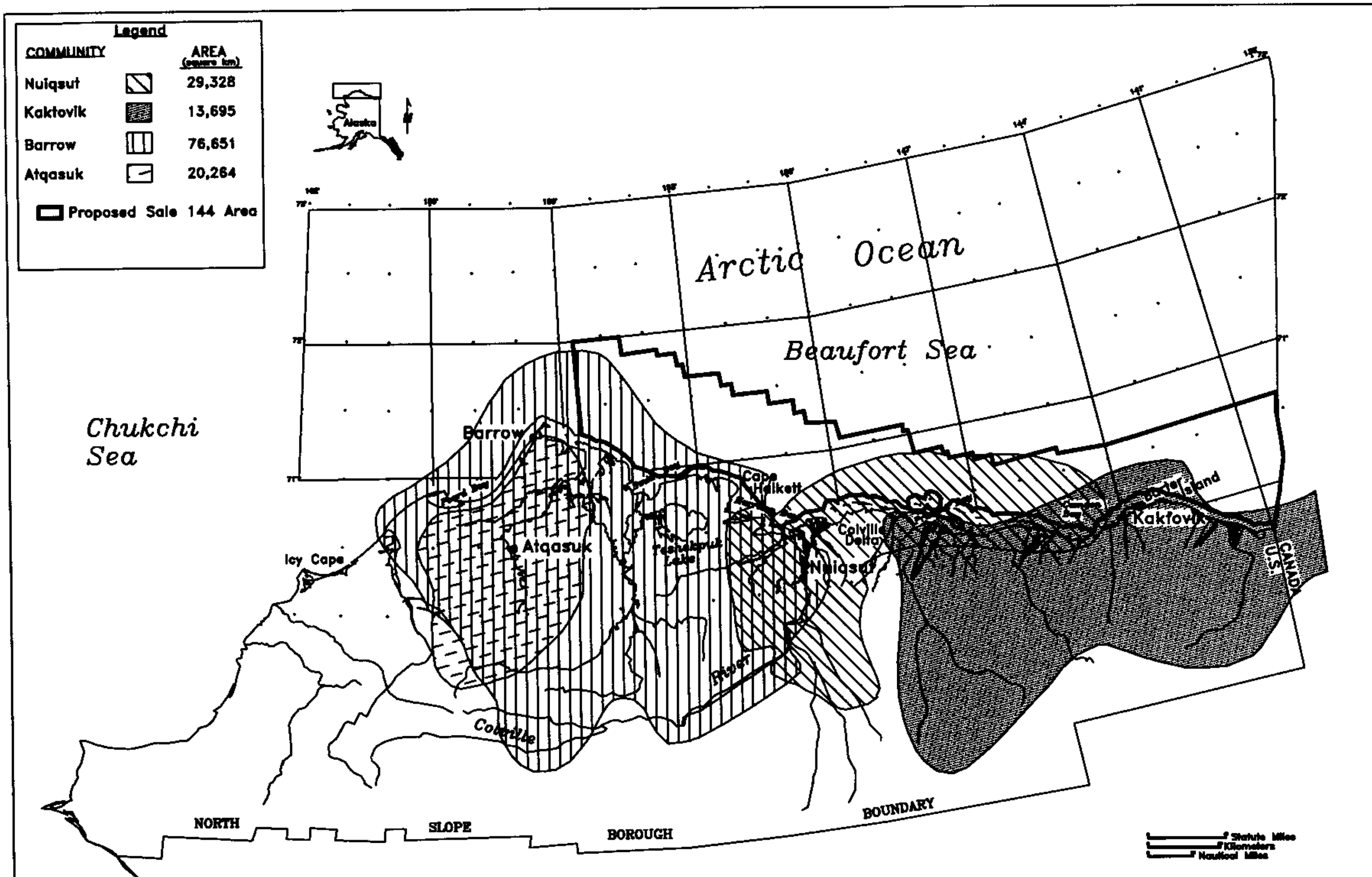
The subsistence harvest of vegetation by communities adjacent to the Sale 144 area is limited, while the harvest of faunal resources such as marine and terrestrial mammals and fishes is heavily emphasized. The spectrum of available resources in this region is limited when compared with more southerly regions. Table III.C.3-1 presents a list of resources harvested by each community in the sale area, and Table III.C.3-2 compares the proportion of Inupiat household food obtained from subsistence in the years 1977, 1988, and 1993 (see the Beaufort Sea Sale 97 FEIS, Sec. III.C.3 [USDOI, MMS, 1987a], the Chukchi Sea Sale 109 FEIS [USDOI, MMS, 1987b], and the Beaufort Sea Sale 124 FEIS [USDOI, MMS, 1990]).

While subsistence-resource harvests differ from community to community, the resource combination of caribou, bowhead whales, and fishes was identified as being the primary grouping of resources harvested (Table III.C.3-3). Available data on kilograms (kg) of harvested and/or consumed subsistence resources provide a good idea of subsistence levels and dependency (Stoker, 1984, as cited by ACI/Braund, 1984; Stephen R. Braund & Associates, 1989a, b; Stephen R. Braund & Associates, 1993b; ADF&G, 1993a, b). Caribou is the most important overall subsistence 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 kg harvested). The bowhead whale is the preferred meat and the subsistence resource most important as the basis for sharing and community cooperation (Stoker, 1984, as cited by ACI/Braund, 1984); in fact, the bowhead could be said to be the foundation of the sociocultural system (see the Sale 97 FEIS, Sec. III.C.3). Depending on the community, fish is the second- or third-most important resource after caribou and bowhead whale (Table III.C.3-3). The bearded seal and various types of birds also are 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 144 area. The subsistence pursuit of bowhead whales occurs at Barrow, Nuiqsut, and Kaktovik and is the most valued activity in the subsistence economy of these communities today. This is true in spite of harvest constraints by imposed quotas of the International Whaling Commission (IWC); relatively plentiful supplies of other resources such as 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 income, these traditions remain as central values and activities for all Inupiat in these communities (see Sale 97 FEIS, Sec. III.C.3, and Sale 124 FEIS, 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. In this way, whaling activities provide strength, purpose, and unity in the face of rapid change. Barrow is the only community within the area that harvests whales in both the spring and the fall (see Fig. III.C.3-2). Nuiqsut and Kaktovik residents hunt bowhead only during the fall season.

Harvest data for Barrow, Nuiqsut, and Kaktovik are only estimates that represent average values. Because of this limitation, resource-harvest data are presented in terms of a 20-year average (from 1962-1982) for selected North Slope communities (Table III.C.3-3). Table III.C.3-3, which shows the contribution made by various harvestable



Source: Impact Assessment Inc., 1990a and b (Nuiqsut and Kaktovik); and Braund, 1989a and b (Barrow)
NSB Contract Staff, 1979; Braund and Burnham, 1984; Arundale and Schneider, 1987;
Jacobson and Wentworth, 1982; Schneider, Pederson and Libbey, 1980; Hoffman, Libbey and Spearman, 1988; Dames and Moore, 1978.

Figure III.C.3–1. Subsistence–Harvest Areas for Sale 144 Communities

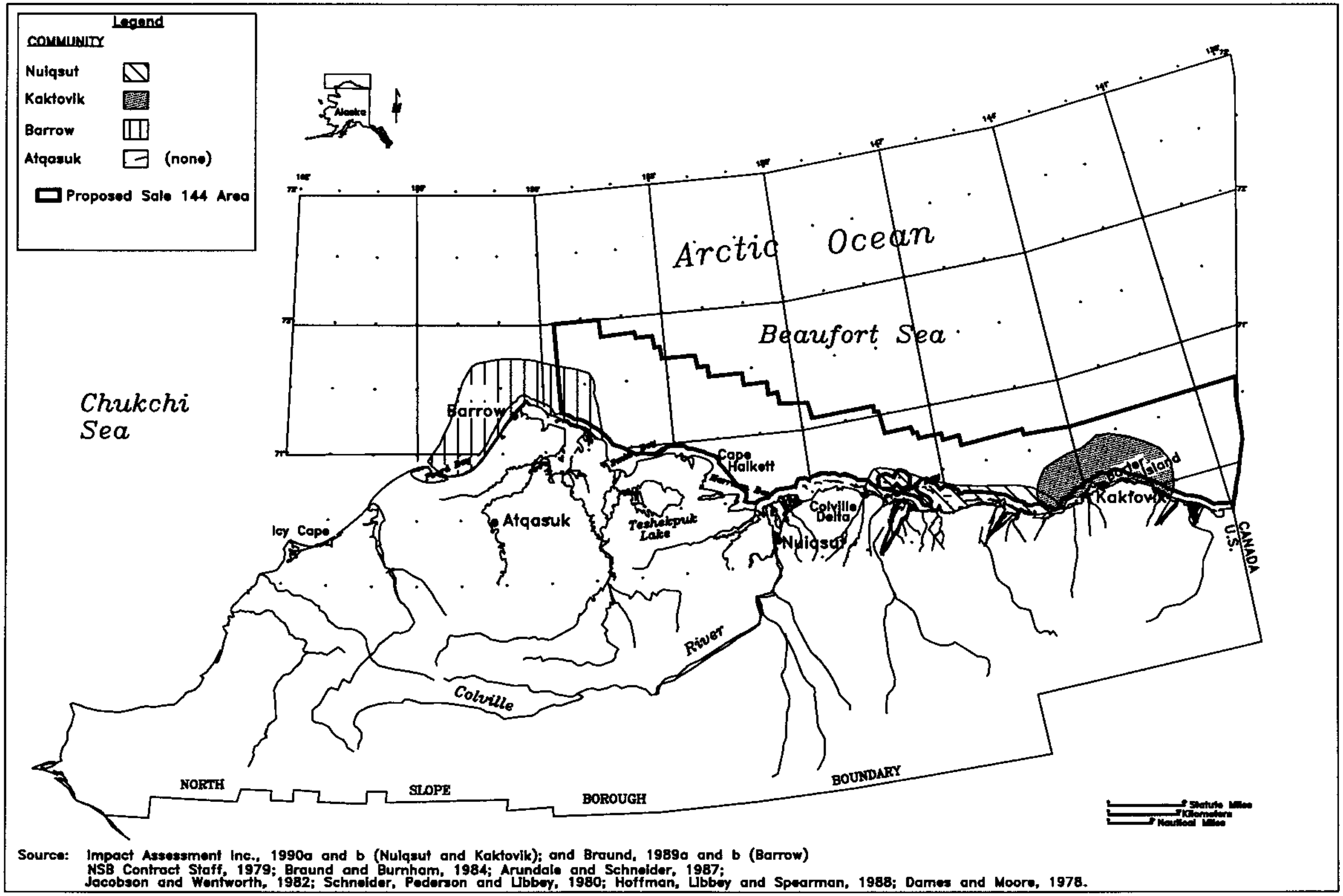
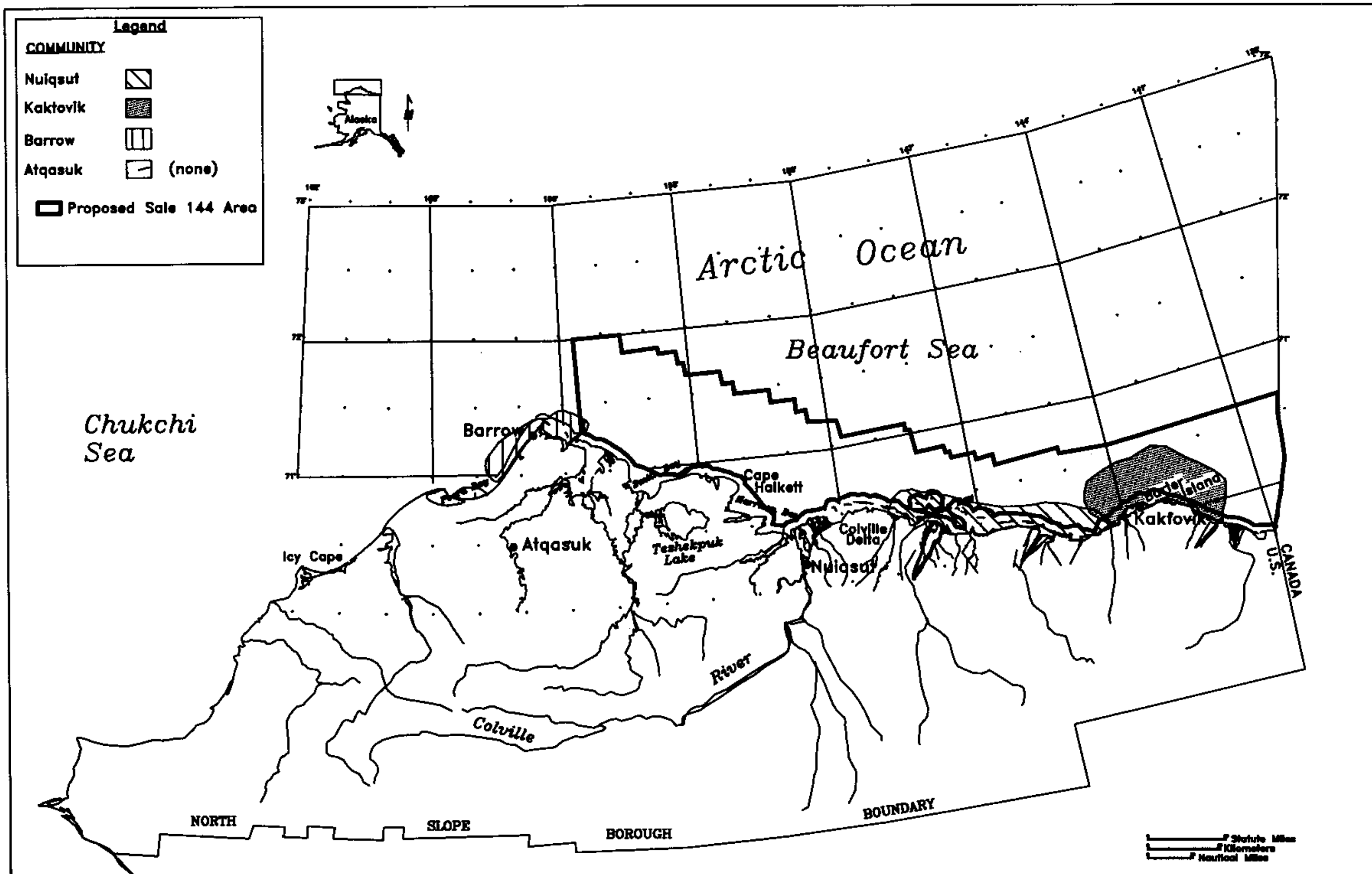
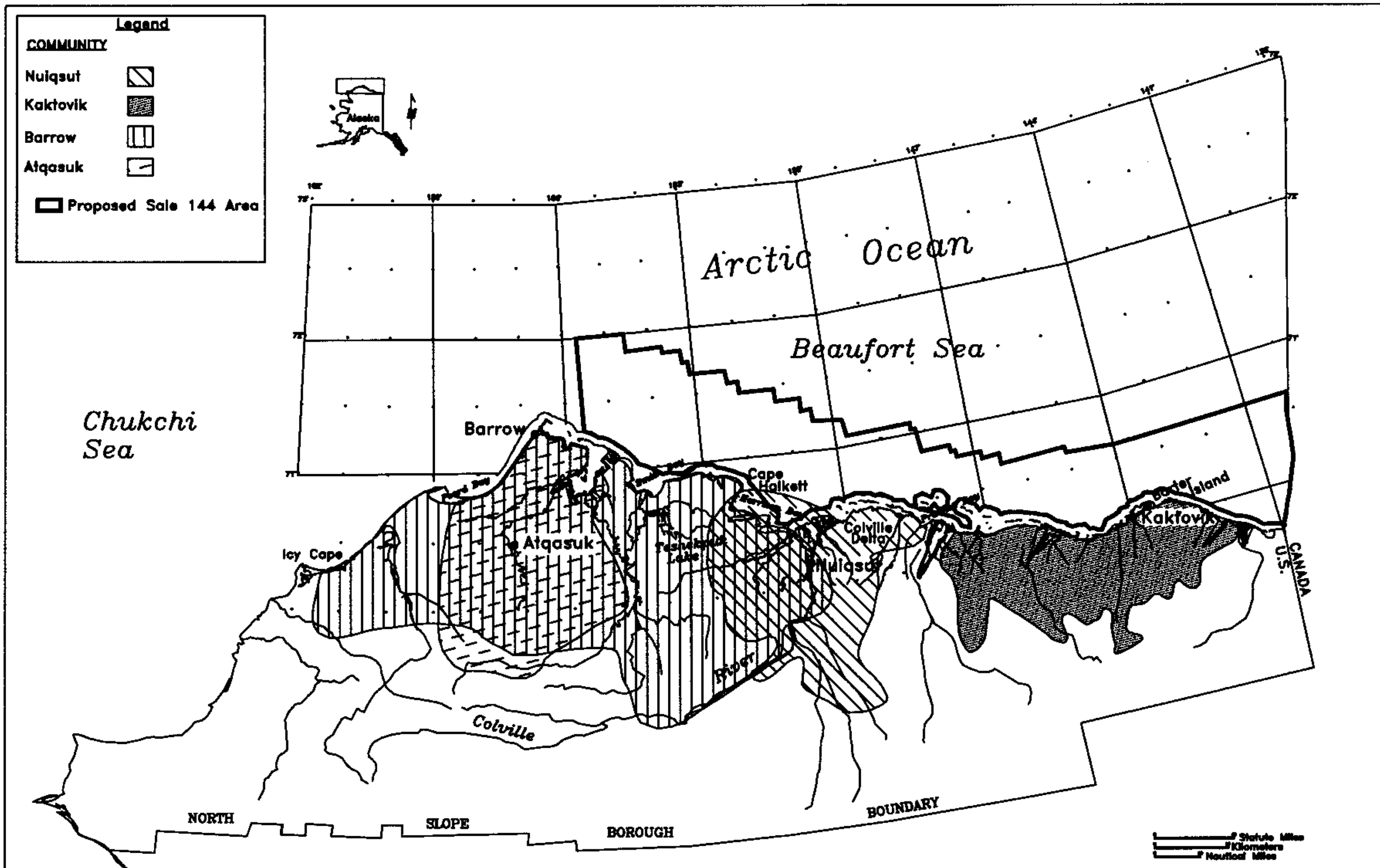


Figure III.C.3–2. Subsistence–Harvest–Concentration Areas for Bowhead Whales



Source: Impact Assessment Inc., 1990a and b (Nuiqsut and Kaktovik); and Braund, 1989a and b (Barrow)
NSB Contract Staff, 1979; Braund and Burnham, 1984; Arundale and Schneider, 1987;
Jacobson and Wentworth, 1982; Schneider, Pederson and Libbey, 1980; Hoffman, Libbey and Spearman, 1988; Dames and Moore, 1978.

Figure III.C.3–3. Subsistence–Harvest–Concentration Areas for Belukha Whales



Source: Impact Assessment Inc., 1990a and b (Nuiqsut and Kaktovik); and Braund, 1989a and b (Barrow) NSB Contract Staff, 1979; Braund and Burnham, 1984; Arundale and Schneider, 1987; Jacobson and Wentworth, 1982; Schneider, Pederson and Libbey, 1980; Hoffman, Libbey and Spearman, 1988; Dames and Moore, 1978.

Figure III.C.3–4. Subsistence–Harvest–Concentration Areas for Caribou

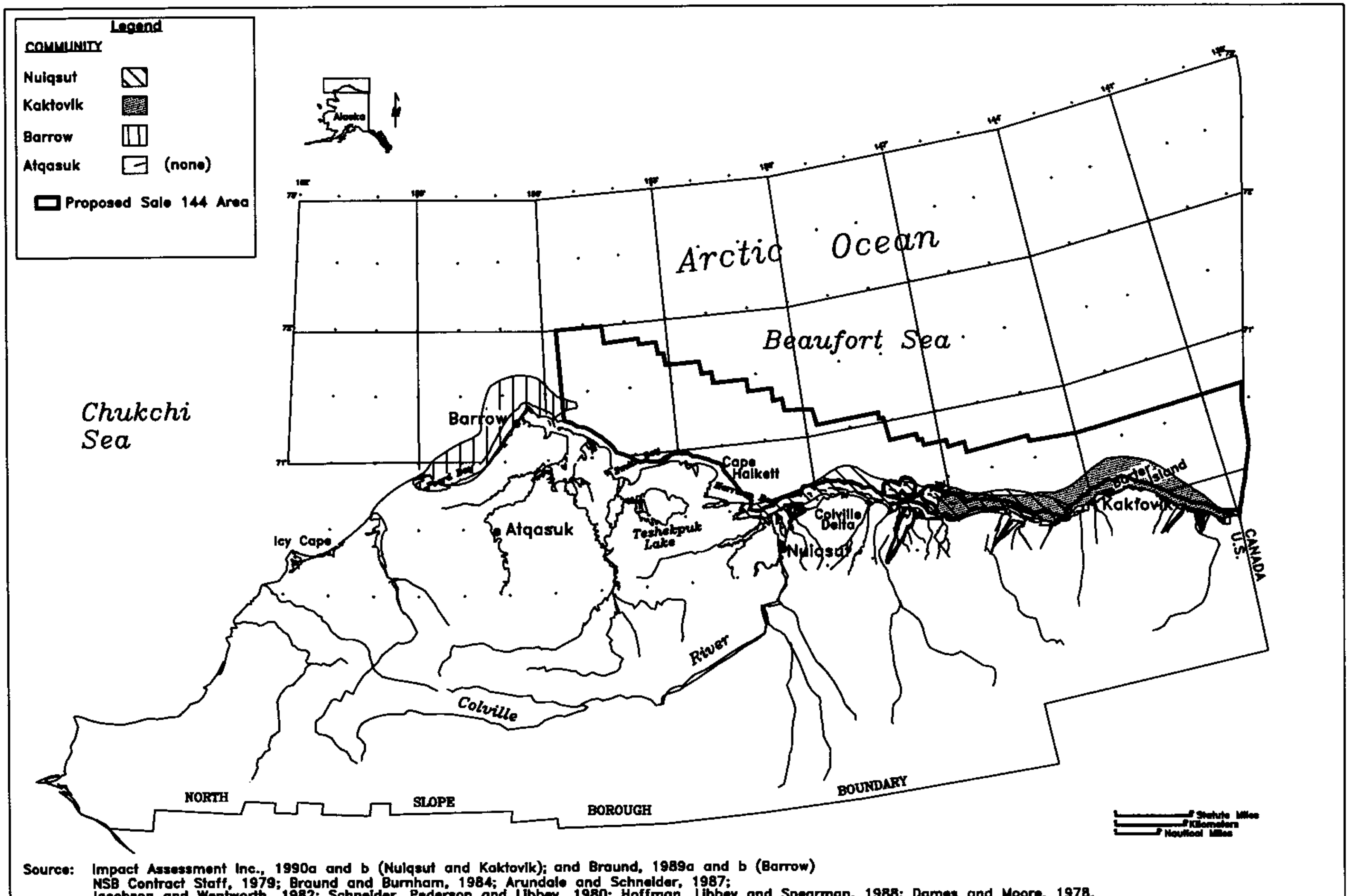
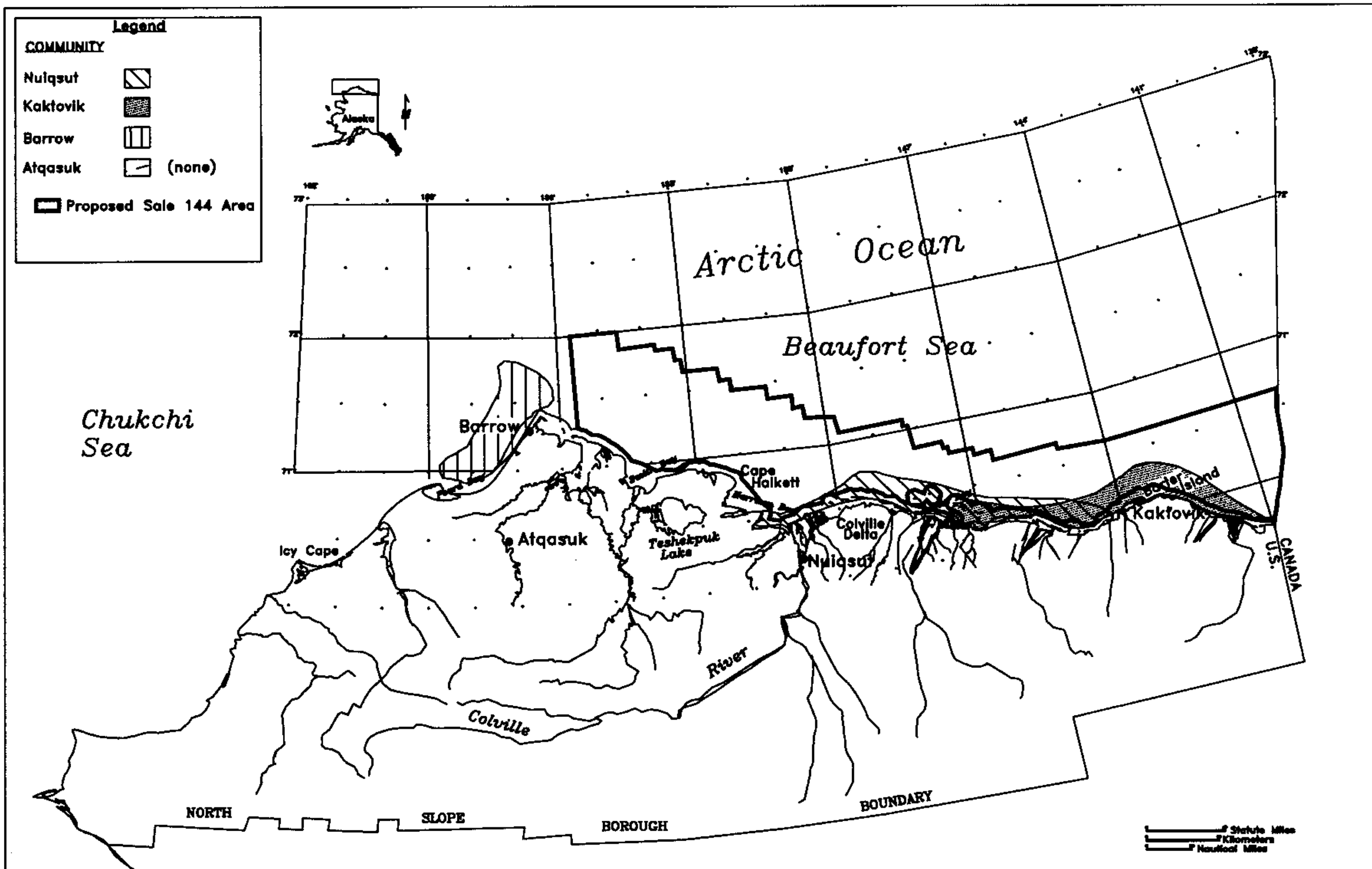
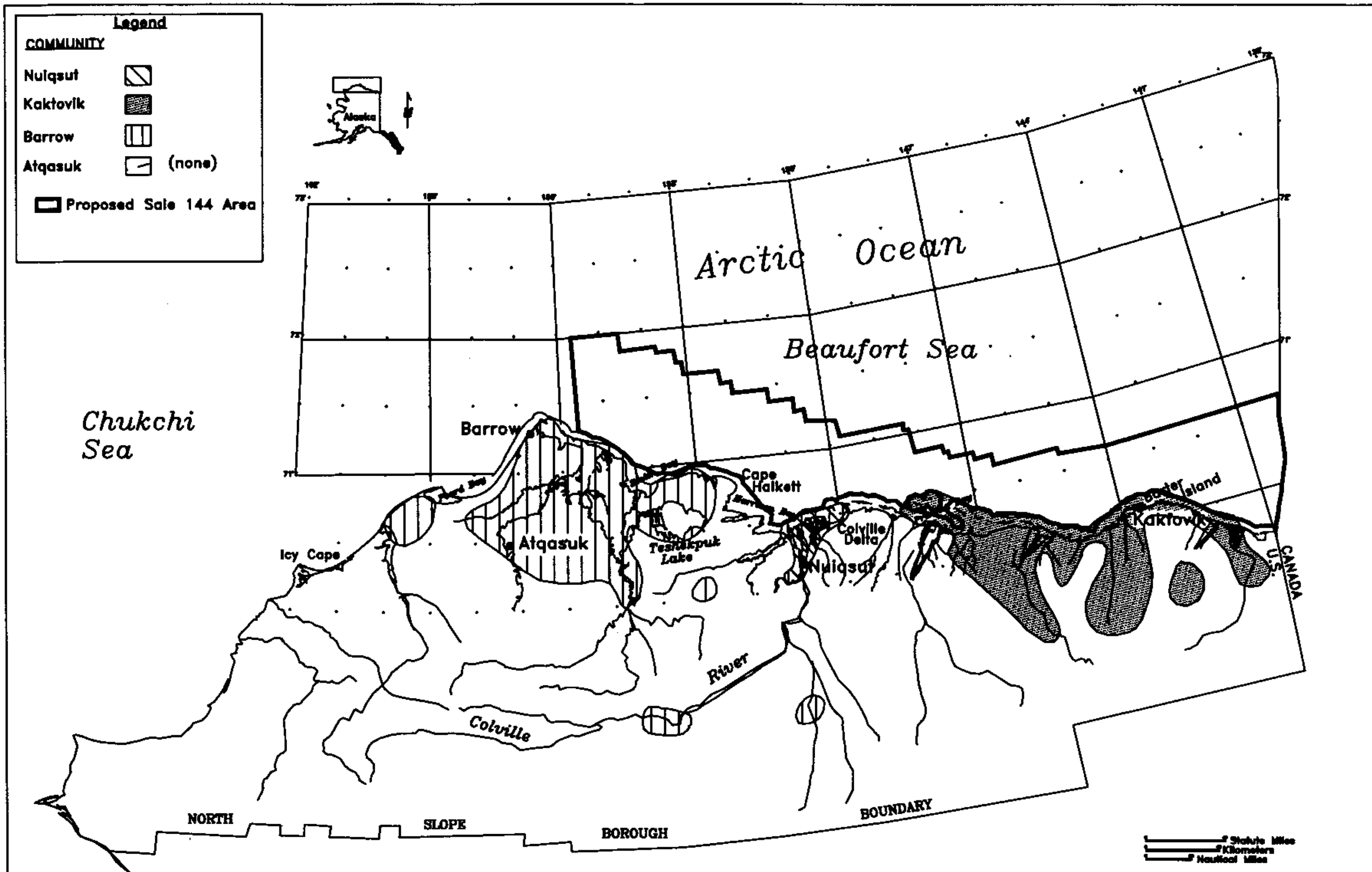


Figure III.C.3-5. Subsistence-Harvest-Concentration Areas for Seals



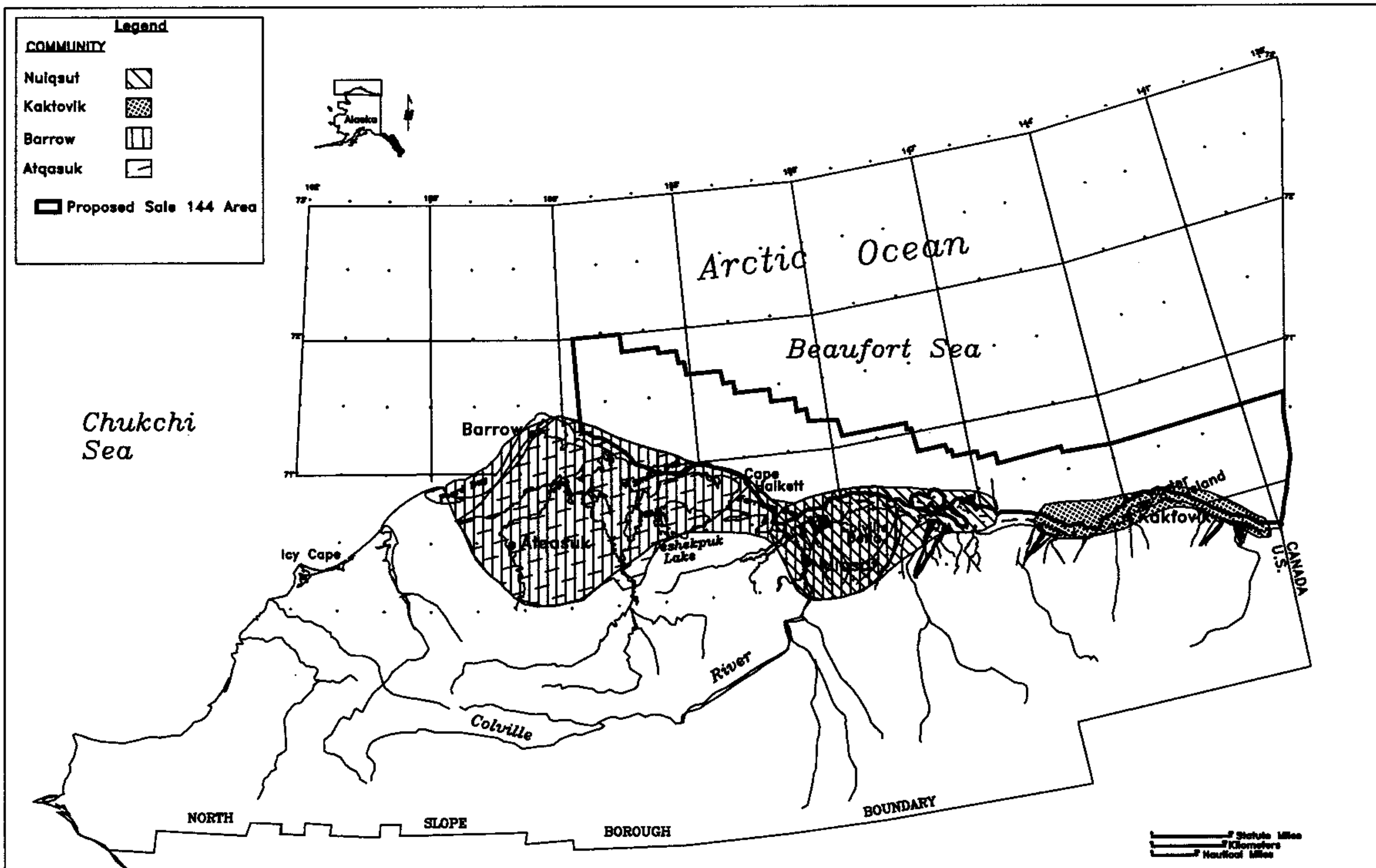
Source: Impact Assessment Inc., 1990a and b (Nuiqsut and Kaktovik); and Braund, 1989a and b (Barrow)
NSB Contract Staff, 1979; Braund and Burnham, 1984; Arundale and Schneider, 1987;
Jacobson and Wentworth, 1982; Schneider, Pederson and Libbey, 1980; Hoffman, Libbey and Spearman, 1988; Dames and Moore, 1978.

Figure III.C.3-6. Subsistence-Harvest-Concentration Areas for Walruses



Source: Impact Assessment Inc., 1990a and b (Nuiqsut and Kaktovik); and Braund, 1989a and b (Barrow) NSB Contract Staff, 1979; Braund and Burnham, 1984; Arundale and Schneider, 1987; Jacobson and Wentworth, 1982; Schneider, Pederson and Libbey, 1980; Hoffman, Libbey and Spearman, 1988; Dames and Moore, 1978.

Figure III.C.3–7. Subsistence–Harvest–Concentration Areas for Fishes



Source: Impact Assessment Inc., 1990a and b (Nuiqsut and Kaktovik); and Braund, 1989a and b (Barrow); NSB Contract Staff, 1979; Braund and Burnham, 1984; Arundale and Schneider, 1987; Jacobson and Wentworth, 1982; Schneider, Pederson and Libbey, 1980; Hoffman, Libbey and Spearman, 1988; Dames and Moore, 1978.

Figure III.C.3–7a. Subsistence–Harvest–Concentration Areas for Waterfowl

Table III.C.3-1
Subsistence Resources Harvested by Selected North Slope Communities[1]

Resource	Barrow C/IN[3]	Atqasuk IN[4]	Nuiqsut[2] IN/C	Kaktovik C/IN
Bowhead Whales[5]	X	X	X	X
Caribou	X	X	X	X
Fishes	X	X	X	X
Belukha Whales	X	X	X	X
Seals (Ringed/Spotted)	X	X	X	X
Bearded Seals	X	X	X	X
Walruses	X	X	X	X
Polar Bears	X	X	X	X
Moose	X	X	X	X
Brown Bear	X	X	X	X
Musk Ox				X
Sheep	X	X	X	X
Small Land Mammals	X	X	X	X
Ducks	X	X	X	X
Geese[6]	X	X	X	X
Ptarmigan	X	X	X	X
Bird Eggs	X	X	X	X
Berries	X	X	X	X
Plants/Greens/Mushrooms	X	X	X	X

Sources: NSB Contract Staff, 1979:10-14; ACI/Braund, 1984, Tables 96, 97, 98, and 108; ADF&G, 1993a, b; Stephen R. Braund and Associates, 1993a, b.

1 This list of resources is derived from NSB Contract Staff (1979:14) and ADF&G, Community Profile Database (1993). 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 In 1985, two Nuiqsut households worked on a successful Barrow whaling crew (ADF&G, 1993a).
3 C = Coastal/Marine; IN = Inland/Freshwater, the code listed first is emphasized.
4 Atqasuk harvests caribou, fishes, and waterfowl in certain areas used by Barrow subsistence hunters, and the subsistence hunt for marine mammals finds Atqasuk hunters in Barrow whaling crews in the spring.
5 Of these three important resources—bowhead whales, caribou, and fishes—caribou and fishes are major resources for both inland and coastal settlements. Bowhead whales are an important resource for all coastal North Slope communities.
6 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 fishes.

Table III.C.3-2
Proportion of Inupiat Household Food Obtained from Subsistence Activities, 1977, 1988, and 1993
(proportion is measured in percent)

All Communities of the North Slope Borough			
Proportion	1977	1988	1993
None	13	20	18
Less Than Half	42	31	25
Half	15	14	15
More Than Half	30	35	42
North Slope Borough Excluding Barrow			
Proportion	1977	1988	1993
None	16	14	13
Less Than Half	35	31	26
Half	12	14	15
More Than Half	37	28	46
Barrow Only			
Proportion	1977	1988	1993
None	11	26	25
Less Than Half	49	32	24
Half	18	15	13
More Than Half	23	28	38

Source: Harcharek, 1995.

Table III.C.3-3
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	Nuiqsut	Kaktovik
Bowhead Whales	10.10	0.30	1
	89,890	2,670	8,900
	21.3%	8.6%	27.5%
Caribou	3,500	400	75
	245,000	28,000	5,250
	58.2%	90.2%	16.2%
Walruses	55	---	+3
	19,250	---	1,050
	4.6%	---	3.2%
Bearded Seals	150	---	30
	12,000	---	2,400
	2.9%	---	7.4%
Hair Seals	955	---	70
	18,145	---	1,330
	4.3%	---	4.1%
Belukha Whales	5	---	5
	2,000	---	2,000
	0.5%	---	6.2%
Polar Bears	7	1	4
	1,125	225	900
	0.3%	0.1%	2.8%
Moose	5	---	5
	1,125	---	1,125
	0.3%	---	3.5%
Dall Sheep	0.0	---	27
	0	---	1,227
	0%	---	3.8%

Table III.C.3-3
Annual Harvest of Subsistence Resources Averaged for the Period 1962-1982 for Selected North Slope Communities[1, 2, 3,]
(percentage distribution of responses)
(continued)

Small Land Mammals	---[5]	---	4
	455	---	136
	0.1%	---	0.4%
Birds	---[5]	---	4
	3,636	---	136
	0.9%	---	0.4%
Fishes	---[5]	---	4
	27,955	---	7,045
	6.6%	---	21.7%
Vegetation	---	---	---
Total Harvest (kg)	421,031	---	32,408
Per Capita Harvest	245	---	219

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

[1] For each resource, data are expressed in descending order as follows: number of animals harvested, usable weight (kg), and percentage of average total community harvest. Note that --- denotes no data.
[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.C.3-5 and III.C.3-7.
[3] No data are available for 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.

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 snowmachines for dogsleds 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 walrus (to some extent) remain significant human foods, and walrus 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. The loss of high-paying wage work on CIP projects in the 1980's actually may have contributed to an increase in subsistence-resource harvests. The hunting of walrus and polar bears, particularly, may increase because of their importance for Native handicrafts. Because of changes in technology and in the subsistence-harvest patterns mentioned above, the dietary importance of waterfowl also may continue to increase (Table III.C.3-2). However, none of these changes would affect the central and specialized dietary roles that caribou, whales, and fish—the three most important subsistence-food resources--play in the NSB subsistence system and for which there are no viable substitutes.

(1) Barrow: As with other communities adjacent to the Sale 144 area, Barrow residents (population 3,469 in 1990 [USDOC, Bureau of the Census, 1991]) 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 Chukchi and Beaufort Seas. This location offers superb opportunities for hunting a diversity of marine and terrestrial mammals and fishes. Barrow could be used as an air-support-staging base for exploration, and a possible pipeline route from Pitt Point (in the high case) would transit a portion of Barrows's terrestrial subsistence-harvest area.

(a) Bowhead Whales: Unlike residents of other communities close to the Sale 144 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 an overall quota for subsistence hunting of the bowhead whale by Alaskan Inupiat. The quota currently is regulated by the Alaska Eskimo Whaling Commission (AEWC), which annually decides how many bowheads each whaling community may take. Table III.C.3-4 indicates bowhead whale-subsistence harvests for the communities of Barrow, Atqasuk, Nuiqsut, and Kaktovik for the 33-year period from 1962 to 1995 (see also Table III.C.3-7). Barrow whalers continue to hunt in the fall to meet their quota, as well as seek strikes that can be transferred to the community from other villages from the previous spring hunt. There are approximately 30 whaling camps along the edge of the landfast ice. The locations of these camps depend on ice conditions and currents; and, normally, strong currents and many leads near Point Barrow prohibit crews from camping near the actual point. Most whaling camps are located south of Barrow, some as far south as Walakpa Bay. Depending on the season, the bowhead is hunted in two different areas. In the spring (from early April until the first week of June [Fig. III.C.3-8]), the bowheads are hunted from leads that open when pack-ice conditions deteriorate. At this time, bowhead whales are harvested along the coast from Point Barrow to the Skull Cliff area (Fig. III.C.3-2). The distance of the leads from shore varies from year to year. The leads generally are parallel and quite close to shore, but occasionally they break directly from Point Barrow to Point Franklin and force Barrow whalers to travel over the ice as much as 16 km offshore to the open leads. Typically, the lead is open from Point Barrow to the coast; and hunters whale only 2 to 5 km 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 skin boats (ACI/Courtnage/Braund, 1984). Fall whaling occurs east of Point Barrow (Fig. III.C.3-2) from the Barrow vicinity to Cape Simpson. Hunters use aluminum skiffs with outboard motors to chase the whales during the fall migration, which takes place in open water up to 48 km (30 mi) 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 accounted for 21.3 percent (an average of 10.10 whales per year) of the annual subsistence harvest from 1962 to 1982 (Table III.C.3-3). In 1988 and 1989, a 2-year subsistence study was conducted in Barrow (Braund, 1989b). In this 2-year period, 40.7 percent of the total harvest was marine mammals, and 33.6 of the total harvest was bowhead whales (Table III.C.3-5). As with all species, the harvest of bowheads varies from year to year; over the past 30 years, the number taken each year has varied from 0 to 23 (Table III.C.3-4). In the memory of community residents, 1982 is the only year in which a bowhead whale was not harvested (ACI/Courtnage/Braund, 1984).

Table III.C.3-4
Annual Subsistence Harvest of Bowhead Whales for Selected North Slope Communities, 1962-1992

Year	Barrow/Atqasuk[1]	Nuiqsut	Kaktovik	Total
1962	5	--[2]	0	5
1963	5	--	0	5
1964	11	--	2	13
1965	4	--	0	4
1966	7	--	0	7
1967	3	--	0	3
1968	10	--	0	10
1969	11	--	0	11
1970	15	--	0	15
1971	13	--	0	13
1972	19	--	0	19
1973	17	1	3	21
1974	9	0	2	11
1975	10	0	0	10
1976	23	0	2	25
1977	20	0	2	22
1978	4	0	2	6
1979	3	0	5	8
1980	9	0	1	10
1981	4	0	3	7
1982	0	1[3]	1	2
1983	2	1	1	3
1984	4	0	1	5
1985	5	1[4]	0	5
1986	8	1	3	12
1987	7	1	0	8
1988	11	0	1	12
1989	10	2	3	15
1990	11	1	2	13
1991	13	2	0	14

Table III.C.3-4
Annual Subsistence Harvest of Bowhead Whales for Selected North Slope Communities, 1962-1992
(continued)

1992	22	2	3	27
1993	6	3	3	12
1994	16	0	4	20
1995	16	4	4	24

Sources: Stoker, 1983, as cited in ACI/Braund, 1984; ADF&G, 1993a,b; George et al., 1993; Gusey, 1993; Philo et al., 1994; Stoker and Krupnik, 1993; AEWC, 1993, 1994, 1995.

[1] Atqasuk whalers participated in the subsistence bowhead hunt by joining Barrow whaling crews.
[2] The community of Nuiqsut was not settled until 1973.
[3] Prior to 1982, most Nuiqsut hunters who wanted to hunt whales went spring whaling with one of the other coastal villages (Impact Assessment, Inc., 1990a [Nuiqsut]).
[4] According to ADF&G 1993a, two Nuiqsut households worked on a successful Barrow whaling crew and received shares equivalent to .1 whale each (whale weight = 19.625 lbs).

(b) Belukha Whales: Belukha whales are available from the beginning of whaling season through June and occasionally in July and August (Fig. III.C.3-8) in ice-free waters. Barrow hunters do not like to hunt belukha whales during the bowhead hunt for fear of scaring the bowheads. The hunters harvest belukhas after the spring bowhead season ends, which depends on when the bowhead quota is achieved. Belukhas are harvested in the leads between Point Barrow and Skull Cliff (Fig. III.C.3-3). Later in summer, belukhas are occasionally harvested on both sides of the barrier islands of Elson Lagoon (ACI/Courtnage/ Braund, 1984). The annual average belukha harvest over the 20-year period from 1962 to 1982 is estimated at five whales, or 5 percent of the total annual subsistence harvest (Table III.C.3-3). In Braund's (1989b) study, there were no harvests of belukha whales in the 2-year period of data collection.

(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.C.3-8). Specific harvest-area locations for caribou are shown in Fig. III.C.3-4. Over the 20-year period from 1962-1982, residents harvested an annual average of 3,500 caribou (Table III.C.3-3), which accounts for 58.2 percent of the total annual subsistence harvest. In Braund's study (1989b), caribou provided 28.6 percent of the total edible pounds harvested (Table III.C.3-6).

(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 from February through March (Fig. III.C.3-8). 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 Beaufort Sea although some hunting occurs off Point Barrow and along the barrier islands that form Elson Lagoon (Fig. III.C.3-5). 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 also are 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). From 1962 to 1982, hair seal harvests were estimated at between 31 and 2,100 seals a year (Table III.C.3-7). The average annual harvest from 1962 to 1982 is estimated at 955 seals, or 4.3 percent of the total annual subsistence harvest (Table III.C.3-3). Hair seals, ringed only, provided 2.8 percent (417 seals) of the edible pounds harvested from 1987 to 1989 (Table III.C.3-5; Braund, 1989b).

The hunting of bearded seals is an important subsistence activity in Barrow because the bearded seal is a preferred food and because bearded seal skins are sought after for covering material for whaling skin-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 because their skins are preferred. They are hunted from spring camps in the Beaufort Sea and from open water during the concurrent pursuit of other marine mammals. Most bearded seals are harvested during the spring and summer months; occasionally, they are available in Dease Inlet and Admiralty Bay (Fig. III.C.3-5) (ACI/Courtnage/ Braund, 1984). No early harvest data were available for the number of bearded seals harvested annually; thus, the annual subsistence harvest averaged over 20 years from 1962 to 1982 was only 150 seals, or about 2.9 percent of the total annual subsistence harvest (Table III.C.3-3). Harvests from 1988 to 1989 were documented at 213 seals, providing 6.0 percent of the total edible pounds harvested (Table III.C.3-5).

(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.C.3-8). 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.C.3-7). Most fishing occurs closer to Barrow in three areas: (1) along the Beaufort Sea coastline from Point Barrow to Walakpa 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 Beaufort 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,

Table III.C.3-13
Nuiqsut 1985 Subsistence-Harvest Estimates for Birds[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Birds	n/a	--	--	--	--	--
Total Geese	708.0	3,181.5	79.54	15.08	1,345	6,045
Goose (nonspecified)	--	--	--	--	--	--
Brant	3.0	9.0	0.23	0.04	6	17
Whitefronted	705.0	3,172.5	79.31	15.04	1,340	6,028
Snow	--	--	--	--	--	--
Canada	--	--	--	--	--	--
Total Eiders	n/a	--	--	--	--	--
Eiders (nonspecified)	--	--	--	--	--	--
Common	--	--	--	--	--	--
King	--	--	--	--	--	--
Spectacled	--	--	--	--	--	--
Ptarmigan	1,030.0	721.0	18.03	3.42	1,957	1,370
Ducks	204.0	306.0	7.65	1.45	388	581

Source: ADF&G, Community Profile Database, 1993a.

[1] Number of households in the sample = 40; number of households in the community = 76.

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), it does not appear to be an important subsistence species and apparently is liked but not abundantly caught (George and Nageak, 1986; George and Kovalsky, 1986; Moulton, 1986, pers. comm.; ADF&G, 1993a).

The fall/winter under-ice harvest of fishes begins after freezeup when the ice is safe for snowmachine travel. 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, and the primary species harvested are arctic and least cisco; other fishing for cisco occurs in the Nechelik and Main Channels of the Colville River. Arctic and least cisco amounted to 88 and 99 percent of the harvest in 1984 and 1985, respectively; however, this percentage varied greatly depending on the net-mesh size. Humpback and broad whitefish, sculpin, and some large rainbow smelt also are harvested, but only 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 occurs at Itkillikpaat, 10 km from Nuiqsut, but the success rate for grayling is quite low (George and Nageak, 1986).

The summer catch in 1985 totaled about 8,755 kg of mostly broadfish; and in the fall, approximately 27,682 kg of fish were caught, totaling 36,436 kg—an annual per capita catch of 109 kg (244 lb); some of this catch was shipped to Barrow (Craig, 1987). A 1985 ADF&G subsistence survey estimated the edible pounds of all fish harvested at 176.13 lb per capita (ADF&G, 1993a). 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 an abundant and stable food source, and as a fresh-food source during the midwinter months, fish are shared at Thanksgiving and Christmas feasts and given to relatives, friends, and community elders. Fish also appear in traditional sharing and bartering networks that exist among North Slope communities. Because it often involves the entire family, fishing serves as a strong social function in the community, and most Nuiqsut families (out of a total 76 households) participate in some fishing activity (ADF&G, 1993a).

(h) Marine and Coastal Birds: Waterfowl and coastal birds are a subsistence resource that has been growing in importance since the mid-1960's. Birds are harvested year-round, with peak harvests in May to June and September to October (Fig. III.C.3-14). The most important species at Nuiqsut are the white-fronted goose, Canada goose, Pacific brant, oldsquaw, eider, snow goose, and pintail duck, although other birds, such as loons, may be occasionally harvested (see Table III.C.3-13; ADF&G, 1993a). Waterfowl hunting occurs mostly in the spring, beginning in June, and continues throughout the summer and probably into September. In the summer and early fall, such hunting usually occurs as an adjunct to other subsistence activities, such as checking nets. Nuiqsut hunters may harvest Pacific brant intensely in August and early September. Nuiqsut's primary subsistence-harvest areas for waterfowl are shown in Figure III.C.3-7a.

(i) Moose: Moose is harvested from August to September by boat on the Colville, Chandler, and Itkillik Rivers (Fig. III.C.3-14). When water levels become too low in fall for access to prime moose-harvest areas, the hunt is discontinued. Moose is too large and difficult to handle to be hunted by Nuiqsut hunters on snowmachines (Impact Assessment, Inc., 1990c). In 1985, seven moose were harvested by 40 households (out of a total 76 households) surveyed (ADF&G, 1993a; see Table III.C.3-11).

Figures III.C.3-15 and III.C.3-16 indicate recent trends in Nuiqsut household consumption of subsistence foods and expenditures on subsistence activities (Harcharek, 1995).

(4) Kaktovik: Kaktovik is situated on Barter Island off the Beaufort Sea coast (population 224 in 1990 [USDOC, Bureau of the Census, 1991]). For Kaktovik, the subsistence resources that could be affected by Sale 144 are bowhead and belukha whales, seals, polar bears, caribou, fishes, and marine and coastal birds. The intensity of effort and preferred harvest periods are indicated in Figure III.C.3-17; harvest data for bowheads and polar bears for the period 1962 to 1982 are summarized by Stoker (1983, as cited in ACI/Braund, 1984) and appear in Tables III.C.3-3 and III.C.3-14. More recent summaries appear in Tables III.C.3-4, III.C.3-15, and III.C.3-16. Like Nuiqsut, much of Kaktovik's marine subsistence-harvest area is within

Table III.C.3-12
Nuiqsut 1985 Subsistence-Harvest Estimates for Fish[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Fish	n/a	--	--	--	--	--
Total Whitefish	6,450.0	15,971.8	399.30	75.70	12,255	30,347
Round Whitefish (Uraraq)	5.0	5.0	0.13	0.02	10	10
Broad Whitefish (Akakiik)	4,158.0	14,137.2	352.43	67.00	7,900	26,861
Humpback Whitefish	2,287.0	1,829.6	45.74	8.67	4,345	3,476
Cisco	24,462.0	15,449.4	386.24	73.22	46,478	29,354
Total Other Freshwater Fish	n/a	--	--	--	--	--
Grayling	2.134.0	1,920.6	48.02	9.10	4,055	3,650
Char (general)	558.0	1,562.4	39.06	7.41	1,060	2,969
Arctic Char	558.0	1,562.4	39.06	7.41	1,060	2,969
Burbot	352.0	1,408.0	35.20	6.67	669	2,675
Northern Pike	--	--	--	--	--	--
Lake Trout	12.0	48.0	1.20	0.23	23	91
Total Salmon	232.0	719.2	17.98	3.41	441	1,366
Chum Salmon	--	--	--	--	--	--
Pink Salmon	232	719.2	17.98	3.41	441	1,366
Silver Salmon	--	--	--	--	--	--
King Salmon	--	--	--	--	--	--
Total Other Coastal Fish	1,670.0	83.5	2.09	0.40	3,173	159
Capelin	--	--	--	--	--	--
Rainbow Smelt	1,670.0	83.5	2.09	0.40	3,173	159
Arctic Cod	--	--	--	--	--	--
Tomcod	--	--	--	--	--	--

Source: ADF&G, Community Profile Database, 1993a.

[1] Number of households in the sample = 40; number of households in the community = 76.

Table III.C.3-11
Nuiqsut 1985 Subsistence-Harvest Estimates for Terrestrial Mammals[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Caribou	270.0	31,590.0	789.75	149.72	513	60,021
Moose	7.0	3,500.0	87.50	16.59	13	6.650
Dall Sheep	--	--	--	--	--	--
Brown Bear	5.0	500.0	12.50	2.37	10	950
Parka Squirrel	315.0	129.1	3.23	0.61	599	245
Wolverine	13.0[2]	0.0	0.00	0.00	25	0
Arctic Fox	13.0[2]	0.0	0.00	0.00	25	0
Red Fox	20.0[2]	0.0	0.00	0.00	38	0

Source: ADF&G, Community Profile Database, 1993a.

[1] Number of households in the sample = 40; number of households in the community = 76.
[2] Not eaten.

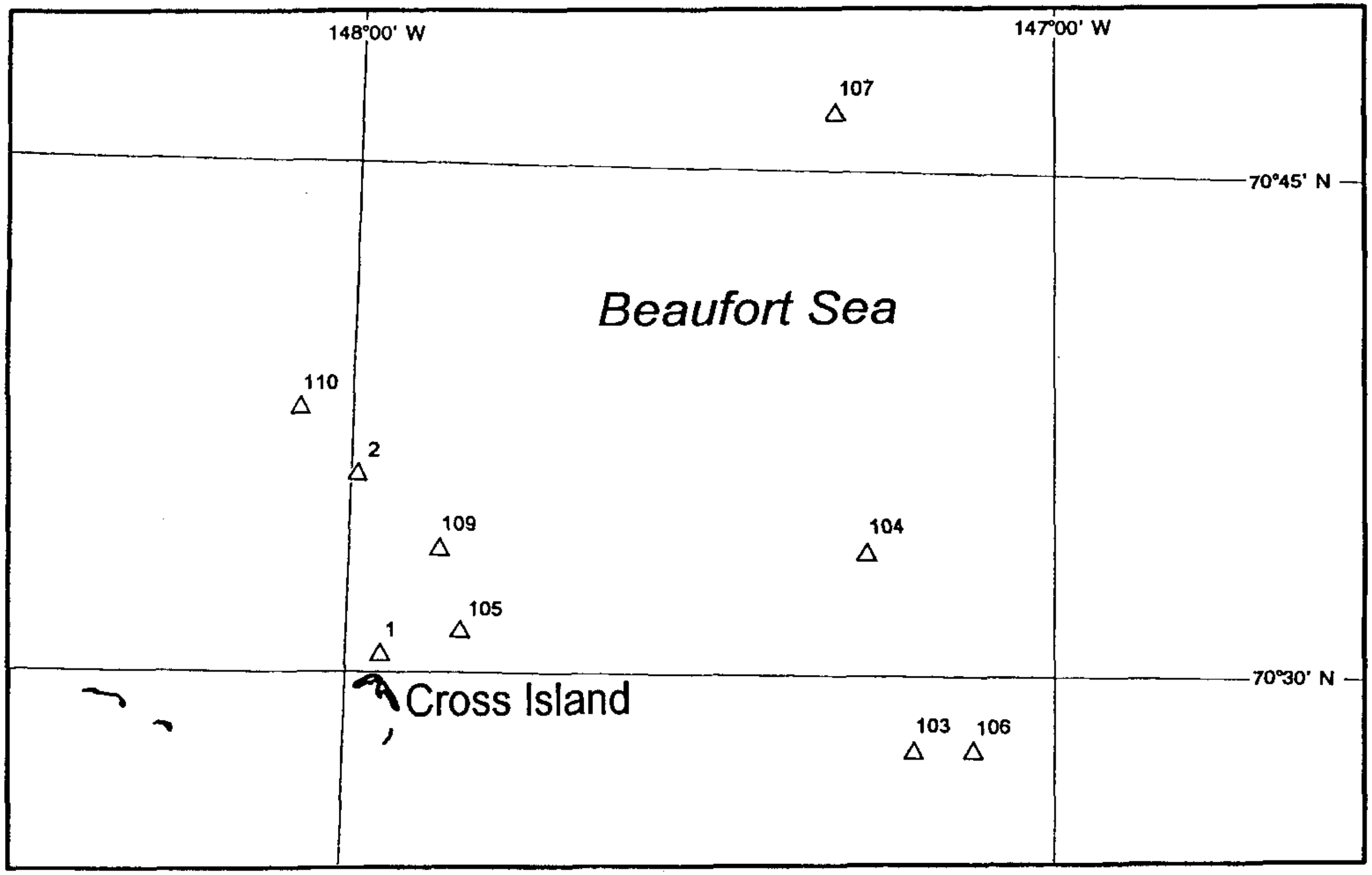
recent polar bear subsistence harvests for the community can be seen in Table III.C.3-9a (see also Tables III.C.3-3 and III.C.3-10; ADF&G 1993a). The distribution of polar bear meat may have a special, traditional form that involves non-kin and also can play a special role during Christmas festivities. The polar bear is prized for its fur, which is used to manufacture cold-weather gear such as boots, mitts, and coats. These items often are bartered, given as gifts to relatives and friends, or sold. According to Nuiqsut resident and whaling captain Thomas Napageak, the taking of polar bear is not very important now because Federal regulations prevent the selling of the hide: "as valuable as it is, [it] goes to waste when we kill a polar bear" (Nuiqsut Public Hearing Transcripts, Beaufort Sea Sale 144, November 6, 1995).

(f) Caribou: Nuiqsut harvests several large land mammals, including caribou, moose, and brown bear. Of these, caribou is the most important and is of the greatest concern under the proposed action. Caribou is Nuiqsut's primary source of meat, and data gathered in 1976 shows it provided an estimated 90.2 percent of the total subsistence harvest (Table III.C.3-3; Stephen R. Braund & Associates, 1993b). More recent subsistence caribou-harvest data are shown in Table III.C.3-11 (ADF&G, 1993a). Caribou are harvested throughout the year, with peak harvests from April through June and in September and October (Fig. III.C.3-14); Nuiqsut's caribou-harvest area is shown in Figure III.C.3-4. Caribou-harvest statistics for 1976 show 400 caribou provided approximately 28,000 kg of meat (Stoker, 1983, as cited by ACI/Braund, 1984). In 1985, an estimated 513 caribou were harvested, providing and estimated 60,021 edible pounds of meat (37.5% of the total subsistence harvest; ADF&G 1993a). Because of the unpredictable movements of the Western Arctic, Central Arctic, and Porcupine herds and because of the ice and weather- dependent hunting techniques, Nuiqsut's annual caribou harvest can fluctuate markedly; but when herds are available and when weather permits, caribou are harvested year-round. Elders Samuel and Sarah Kunaknana have related that caribou hunters in the past had to go inland to hunt caribou, because they never came down to the coast as they do now (in Shapiro and Metzner, 1979).

Hunting often is most intense in April, May, August, and September. Caribou may be the most preferred mammal in Nuiqsut's diet; and during periods of high availability, caribou provides a source of fresh meat throughout the year. Caribou meat often is shared with kinsmen, friends, and elders within the community and sent to relatives as far away as Anchorage; occasionally the meat is bartered. Caribou also plays an important part in holiday feasts. The skins of caribou taken in July and August are used to manufacture parkas, boot soles, mitts, and mukluk tops. The skins of caribou taken in October and November are used as blankets and sleeping pads.

(g) Fishes: Anadromous fishes provide an important subsistence resource for Nuiqsut (see Table III.C.3-12; ADF&G, 1993a). The harvests of most subsistence resources, such as caribou, can fluctuate widely from year to year because of variable migration patterns and because harvesting techniques are dependent on ice and weather conditions. The harvest of fishes is not subject to seasonal limitations, a condition that adds to their importance in Nuiqsut's subsistence round, and Nuiqsut has been shown to have the largest documented subsistence-fish harvest on the Beaufort Sea coast (Moulton, Field, and Brotherton, 1986). Moreover, in October and November, fishes may provide the only source of fresh subsistence foods.

Fishing is an important activity for Nuiqsut residents due to the community's location on the Nechelik Channel of the Colville River with its large resident fish populations. The river supports 20 species of fishes, and approximately half of these are taken by Nuiqsut residents (George and Nageak, 1986). Local residents generally harvest fishes during the summer and fall, but the fishing season runs basically from January through May and from late July through mid-December, with the peak harvest apparently occurring in November and early December (Fig. III.C.3-14). 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 (Figs. III.C.3-14 and III.C.3-7). 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, and humpback whitefish are harvested in the Main Channel of the Colville south of Nuiqsut. Traditionally, coastal areas were fished in June and July when rotting ice created enough open water for seining. Nuiqsut elder Sarah Kunaknana interviewed in 1979 said: ". . .in the little bays along the coast we start seining for fish (iqalukpik). After just seining 1 or 2 times, there would be so many fish we would have a hard time putting them all away" (in Shapiro and Metzner, 1979). Salmon species reportedly have been caught in August, but not in large numbers, and all five species of Pacific salmon have been reported in the Colville. Pink



Sources: Long, 1996; North Slope Borough Palnning Dept., 1993.

Figure III.C.3-14a. Recent Whale Harvest Locations Near Cross Island for the Community of Nuiqsut.

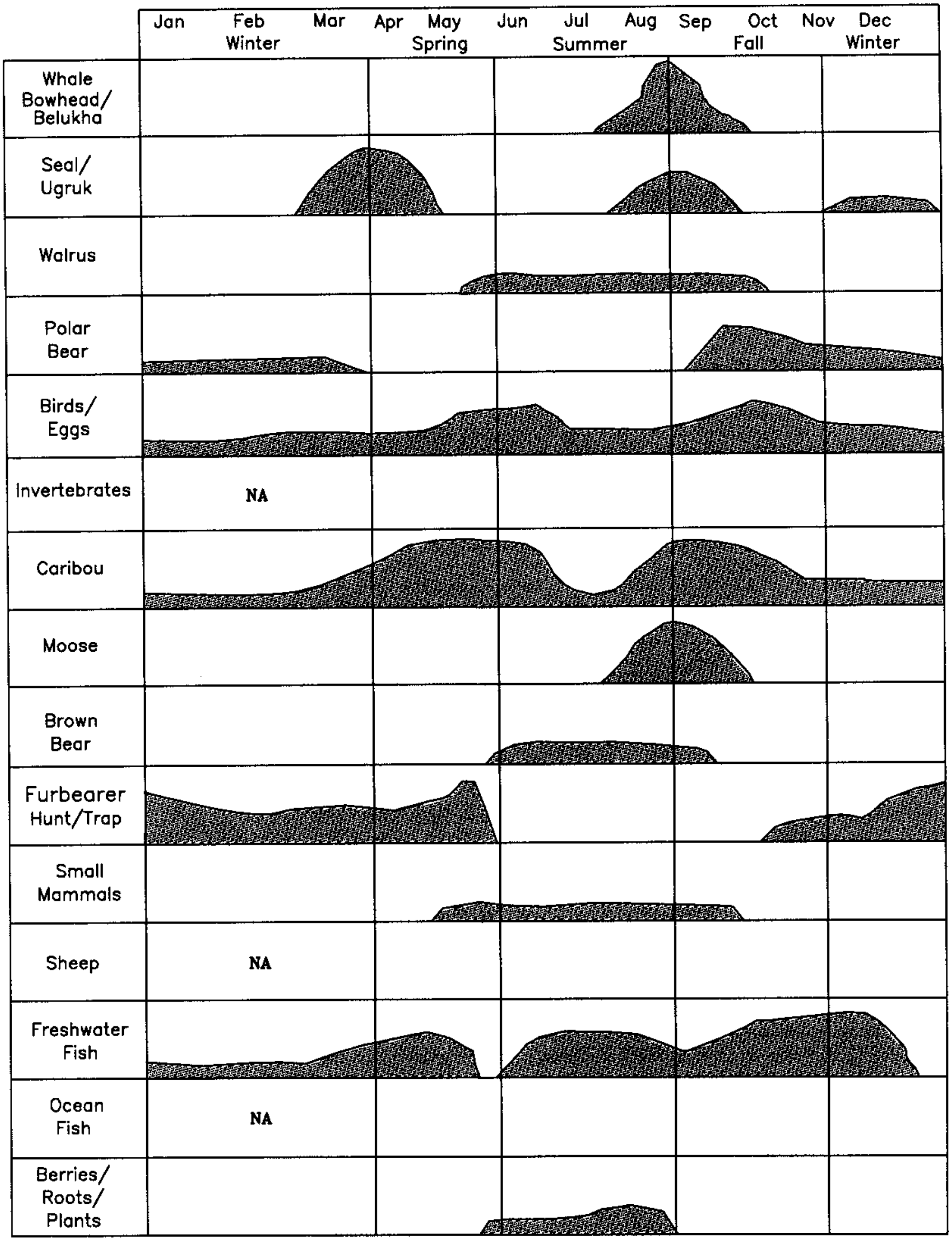
(a) Bowhead Whales: Even though Nuiqsut is not located on sometimes the coast, marine mammals are a major subsistence resource, especially bowhead whales. Bowhead whaling usually occurs between late August and early October; the exact timing depends on ice and weather conditions. Also, ice conditions can dramatically extend the season to last longer than 2 months or contract it to <2 weeks (Fig. III.C.3-14). Unlike spring-whaling communities, which hunt the bowhead from the edge of ice leads in skin boats, Nuiqsut whalers use aluminum skiffs with outboard motors to hunt bowheads in open water. Generally, they whale within 16 km (10 mi) of shore, but at times they may travel 32 km (20 mi) or more from shore. Bowhead whales commonly are harvested by Nuiqsut residents off of Cross Island, but the entire coastal area from Nuiqsut east to Flaxman Island and the Canning River Delta may be used (see Figs. III.C.3-2 and III.C.3-14a). In the past, Nuiqsut has not harvested many bowhead whales [20] whales since 1972); however, their success has improved in the past few years, with unsuccessful harvests occurring since 1982 only in the years 1984, 1988, 1993, and 1994 (see Tables III.C.3-4, III.C.3-10, and III.C.10a). Although bowheads are not the main subsistence resource in Nuiqsut, they remain, as in other North Slope communities, culturally prominent to residents. The bowhead is shared extensively with other North Slope communities and often with Inupiat residents in communities such as Fairbanks and Anchorage. Bowhead baleen is bartered in traditional networks and is important in the manufacture of traditional arts and crafts.

(b) Belukha Whales: Belukha whales may be harvested throughout the open-water season (Fig. III.C.3-14) and taken incidentally to the bowhead harvest (Fig. III.C.3-3). Little harvest information is available for Nuiqsut harvests of belukha whales (see Table III.C.3-10). While belukhas do not have the same religious significance as bowheads, the distribution of harvested belukha whales may have a special, traditional form that involves many non-kin. Belukha teeth are used in the production of arts and crafts.

(c) Seals: Seals are hunted year-round (Fig. III.C.3-14), but the bulk of the seal harvest occurs during the open-water season, with breakup usually occurring in June. In the spring, seals can be hunted once the landfast ice goes ice. Henry Nashanknik from Barrow related that seaward of the McClure Islands there were huge pressure ridges that hunters traveled through in the spring, and that not too far out from the pressure ridges there were open leads where they would hunt seals (H. Nashanknik, in Shapiro and Metzner, 1979). When elder Bruce Nukapigak lived at Pt. McIntyre in the 1930's, he noted there was good seal hunting between Cross and McClure Islands because there usually was some open water in the channel between the islands (B. Nukapigak, in Shapiro and Metzner, 1979). Nuiqsut elder Samuel Kunaknana, when interviewed in 1979, noted that when the ice is near shore in the summer, it is considered to be good for seal hunting (S. Kunaknana, in Shapiro and Metzner, 1979). During the winter, these harvests consist almost exclusively of ringed seals taken along open leads in the ocean ice. In summer, boat crews harvest ringed, bearded, and spotted seals; and the hunt can take place along the entire Beaufort Sea coast from Cape Halkett to Anderson Point (Fig. III.C.3-5 and Table III.C.3-10). While seal meat is eaten, the dietary significance of seals primarily comes from seal oil, served with almost every meal that includes subsistence foods. Seal oil also is used as a preservative for meats, greens, and berries. Seal skins are important in the manufacture of clothing, and because of their beauty, spotted seal skins often are preferred for making boots, slippers, mitts, and parka trim. In practice, however, ringed seal skins are used more often in the making of clothing because the harvest of this species is more abundant. Also important are bearded seal hides that are necessary for the manufacture of boot soles. Handmade products such as boots, slippers, mitts, and parkas are sold, given as gifts to relatives and friends, and bartered.

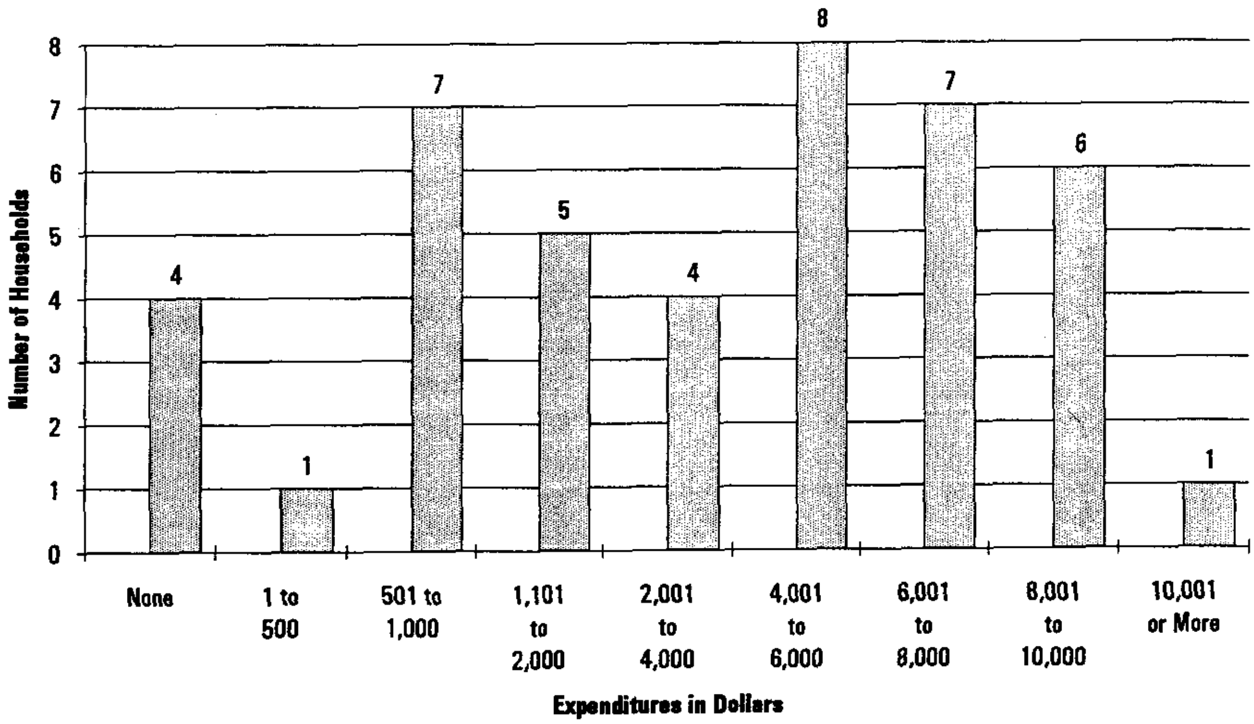
(d) Walruses: Walruses also are occasionally harvested during the open-water season from June through early October (Fig. III.C.3-14). Walrus hunting occurs along the entire Beaufort Sea coast from Cape Halkett to Anderson Point (Fig. III.C.3-6). Recent ADF&G subsistence-survey data indicate that a single walrus was harvested in 1985; no new walrus data for the community have been gathered since then (see Table III.C.3-10; ADF&G, 1993a). Walrus meat is eaten and its ivory used in the manufacture of traditional arts and crafts.

(e) Polar Bears: The harvest of polar bears by Nuiqsut hunters begins in mid-September and extends into late winter (Fig. III.C.3-14). Polar bear meat often is consumed, although little harvest data are available. One bear was harvested in the 1962 to 1982 period, and more



Source: North Slope Borough Contract Staff, 1979.
Figure III.C.3–14. Nuiqsut Annual Subsistence Cycle *

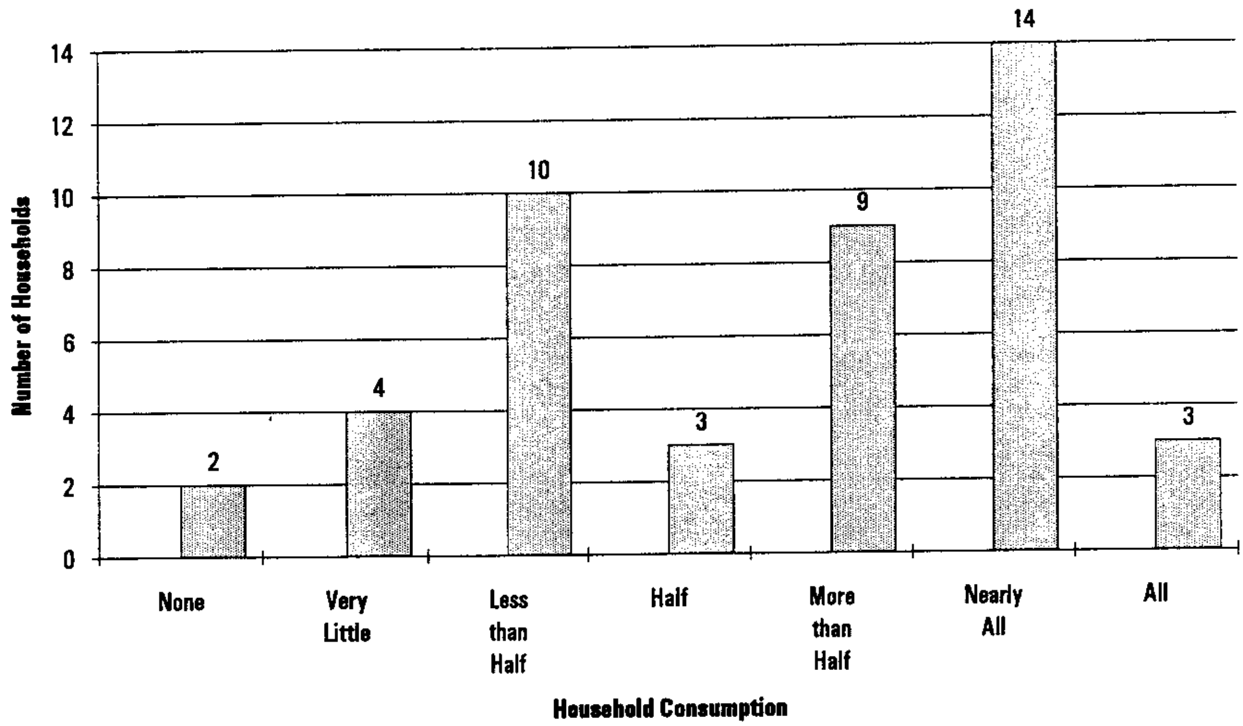
* Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods of pursuit of subsistance resources.



Source: Harcharek, 1995.

Figure III.C.3-13. Atqasuk Household Expenditures on Subsistence Activities.[1]

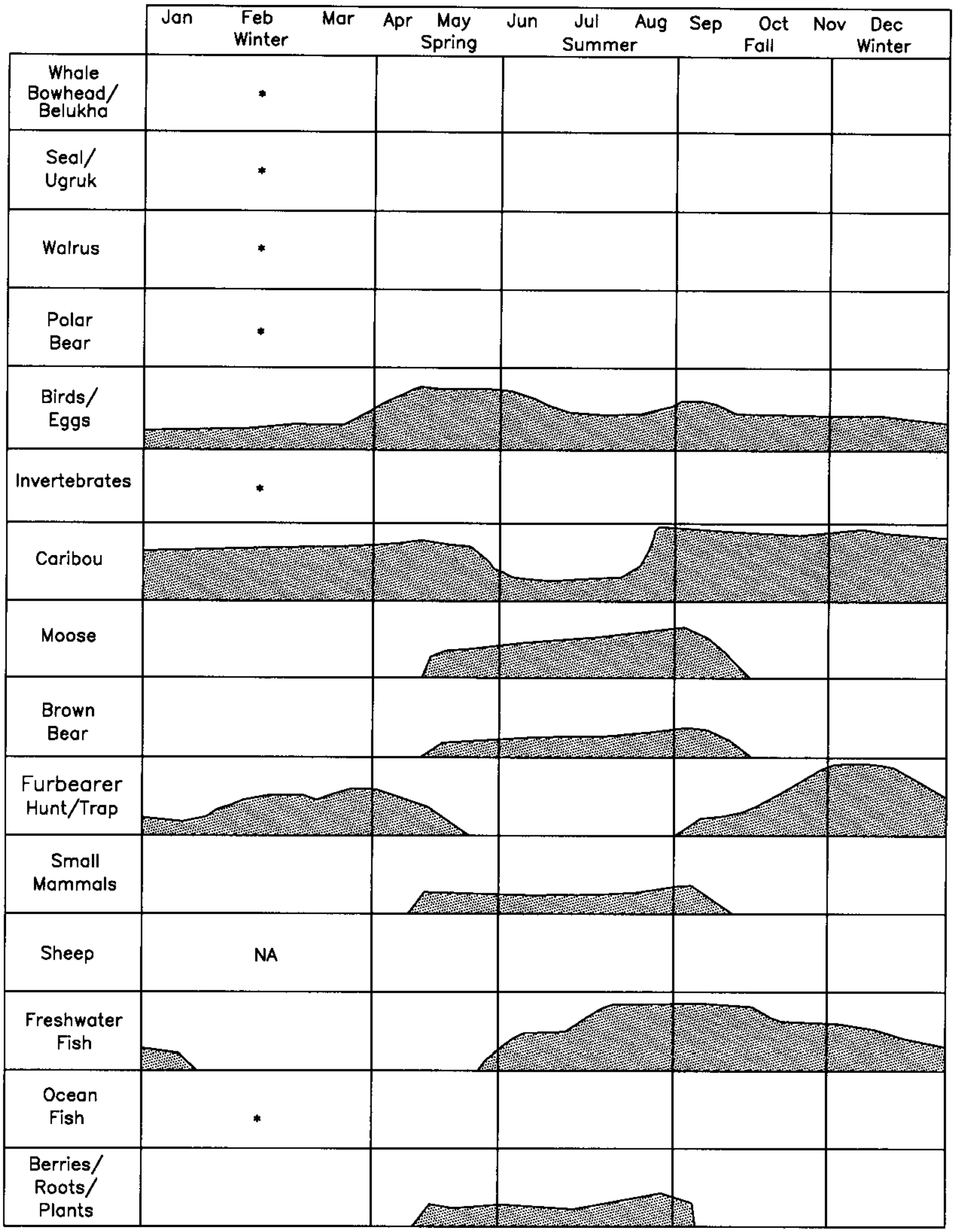
[1] These results include only those households that participated in the census survey.



Source: Harcharek, 1995.

Figure III.C.3-12. Atqasuk Household Consumption of Meat, Fish, and Birds from Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.

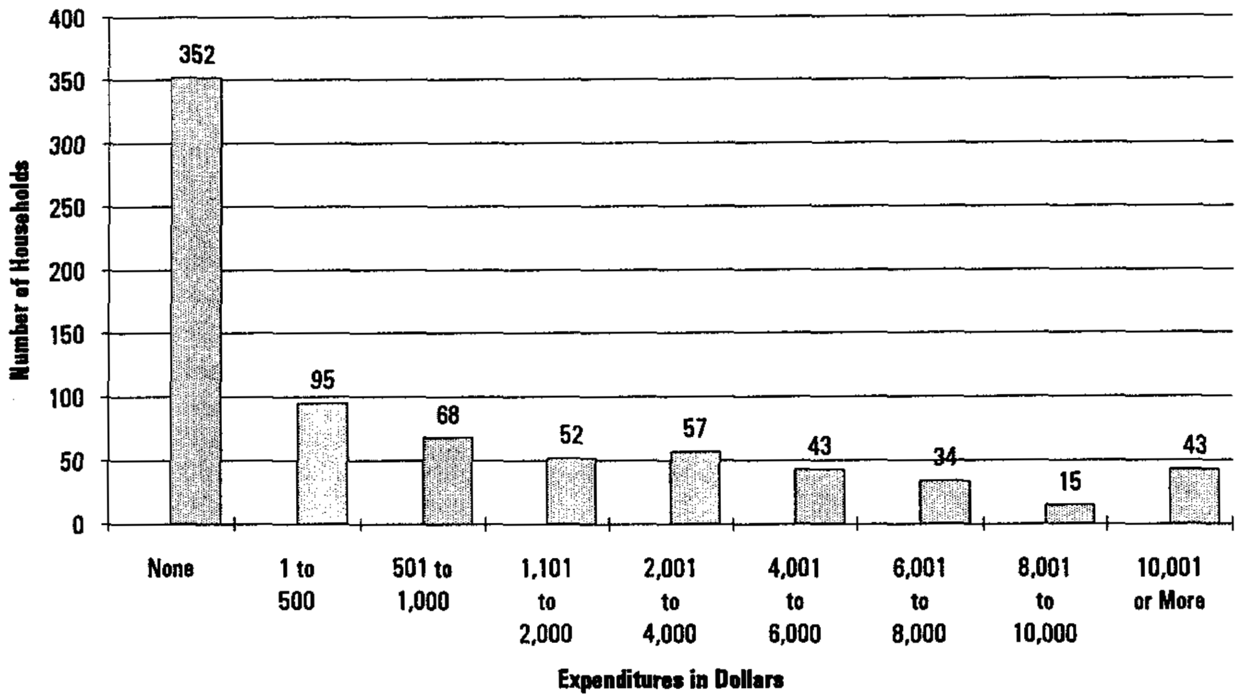


Source: North Slope Borough Contract Staff, 1979.

Figure III.C.3-11. Atqasuk Annual Subsistence Cycle[1]

[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 subsistance resources.

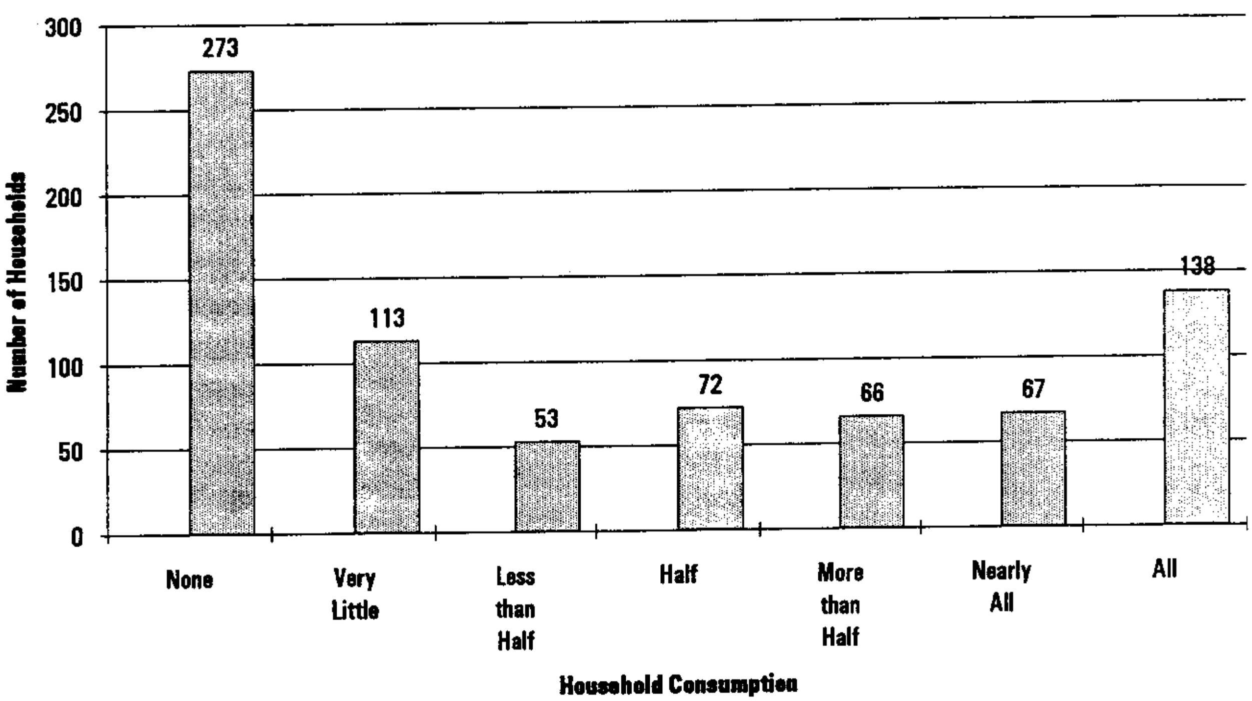
* These species are harvested only out of hunts originating in Barrow.



Source: Harcharek, 1995.

Figure III.C.3-10. Barrow Household Expenditures on Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.



Source: Harcharek, 1995.

Figure III.C3-9. Barrow Household Consumption of Meat, Fish, and Birds from Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.

A North Slope Borough subsistence study conducted in 1993 and Figures III.C.3-9 and III.C.3-10 indicate more recent household consumption of and expenditures on subsistence activities (Harcharek, 1995).

(2) Atqasuk: Atqasuk (population 216 in 1990 [USDOC, Bureau of the Census, 1991]) is the only inland community close to the Sale 144 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.3.b(2). 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). Contrastingly, Atqasuk hunters harvest fish, migratory birds, and caribou in some harvest areas that overlap with those of Barrow, as well as some exclusive to the community (Stephen R. Braund & Associates, 1993b).

(a) Caribou: Caribou is the most important resource harvested by Atqasuk residents. (Atqasuk's caribou harvest area is shown in Fig. III.C.3-4.) Although the fall harvest is the most important, caribou also are harvested throughout the winter and in early spring (Fig. III.C.3-11). Caribou migration patterns and limited access 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 hunt (distances are not available). Caribou camps along the Meade, Inaru, Topagoruk, and Chipp River drainages also are used for fishing (ACI/Courtnage/Braund, 1984).

(b) Fishes: Fish is a preferred food in Atqasuk, although in an ACI/ Courtnage/Braund study (1984), respondents indicated that fish is the secondary resource in quantity harvested. Most fishing occurs along the Meade River. Fish camps also are located on two nearby rivers, the Usuktuk and the Nigisaktuvik, downstream on the Meade River, and near the Okpiksak River (Craig, 1987). Humpback whitefish, least cisco, grayling, broad whitefish, burbot, and chum salmon are fished with gillnets and baited hooks and by jigging (Craig, 1987). The most successful fishing months are July and August (Fig. III.C.3-11), when water levels drop in the Meade River and becomes clearer. Nets are most commonly set close 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; Stephen R. Braund & Associates, 1993b).

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 produced a harvest of approximately 3,840 kg of fish. Adding catches with other gear and winter catches (500 kg and 1,227 kg, respectively), the total harvest was approximately 5,568 kg. The annual per capita catch was about 19.5 kg (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 (Fig. III.C.3-11 and Fig. III.C.3-7a). Eggs are gathered in the immediate vicinity of the community for a short period in June (ACI/Courtnage/Braund, 1984; Stephen R. Braund & Associates, 1993b).

Figures III.C.3-12 and III.C.3-13 are taken from a North Slope Borough subsistence study conducted in 1993 and indicate more recent trends in Atqasuk household consumption of subsistence foods and expenditures on subsistence activities (Harcharek, 1995).

(3) Nuiqsut: Nuiqsut (population 354 in 1990 [USDOC, Bureau of the Census, 1991]) is situated near the mouth of the Colville River, which drains into the Beaufort Sea. For Nuiqsut, the subsistence resources that might be affected by Sale 144 include bowhead and belukha whales, seals, walruses, polar bears, caribou, fishes, and marine and coastal birds. The intensity of effort and preferred harvest periods for Nuiqsut are indicated in Figure III.C.3-14. Most of Nuiqsut's marine subsistence-harvest area lies within the proposed Sale 144 lease-sale area; its terrestrial mammal, fish, and bird subsistence-harvest areas are in the vicinity of possible landfalls at Oliktok and Bullen Points.

Table III.C.3-9a
Annual Harvest of Polar Bear for the Harvest Years 1983 to 1994 for the Communities of Barrow, Nuiqsut, and Kaktovik

Harvest Season[1]	Barrow	Nuiqsut	Kaktovik
1983/84	27	0	1
1984/85	31	1	0
1985/86	13	4	5
1986/87	21	5	3
1987/88	14	1	6
1988/89	30[2]	2	10
1989/90	14	0	2
1990/91	11	0	2
1991/92	23	2	1
1992/93	26	0	3
1993/94	26	5	5

Source: Schliebe, 1995.

1 Harvest year runs from 1 Jult to 30 June.
2 Atqasuk harvested 2 bears during the 1988/89 season.

Table III.C.3-9
Barrow 1988 to 1989
Harvest Estimates for Birds[1,2]

Resource	Conversion Factor[3] Edible Weight Per Resource in Pounds	Community Totals		Average Pounds Harvested[3]		Percent of Total Edible Pounds Harvested	Percent of all Barrow Households Harvesting Resource
		Edible Number Harvested	Pounds Harvested	Per Household	Per Capita		
Total Birds	n/a	n/a	21,519	22.97	7.1	3.5%	32.8%
Total Geese		2,959	13,062	13.94	4.3	2.1%	18.2%
Goose (nonspecified)	4.5	197	886	0.95	0.3	0.1%	1.5%
Brant	3.0	166	499	0.53	0.2	0.1%	3.5%
White-fronted goose	4.5	2,591	11,656	12.44	*	**	16.3%
Snow goose	4.5	4	17	0.02	*	**	10.3%
Canada goose	4.5	1	3	0.00	*	**	10.0%
Total Eiders		4,764	7,145	7.63	2.4	1.1%	9.7%
Eiders (nonspecified)	1.5	4,686	7,030	7.50	2.3	1.1%	9.7%
Common eider	1.5	19	29	0.03	*	**	0.4%
King eider	1.5	57	86	0.09	*	**	7.7%
Spectacled eider	1.5	1	2	0.00	*	**	6.0%
Ptarmigan	0.7	1,792	1,254	1.34	0.4	0.2%	12.1%
Other Ducks	1.5	39	58	0.06	*	**	1.5%

Source: Stephen R. Braund & Associates, 1989b.

1 * represents less than .1 pound.
** represents less than .1 percent.
n/a means not applicable.
2 Estimated sampling errors do not include errors in reporting, recording, and converting to usable weight.
3 See Braund, 1989b, Table A-4, for sources of conversion factors.

Table III.C.3-8
Barrow 1988 to 1989
Harvest Estimates for Fish[1,2]
(continued)

Pink (Humpback) salmon	3.1	9	28	0.03	*	**	0.3%
Silver (Coho) salmon	6.0	74	446	0.48	0.1	0.1%	1.3%
King (Chinook) salmon	18.0	2	42	0.05	*	**	0.3%
Total Other Coastal Fish		5,709	1,210	1.29	*	**	4.0%
Capelin	0.2	1,676	335	0.36	*	**	3.4%
Rainbow smelt	0.2	71	14	0.02	*	**	0.1%
Arctic cod	0.2	3,877	775	0.83	0.3	0.1%	0.2%
Tomcod	1.0	85	85	0.09	*	**	0.6%

Source: Stephen R. Braund & Associates, 1989b.

1 * represents less than .1 pound.
** represents less than .1 percent.
n/a means not applicable.
2 Estimated sampling errors do not include errors in reporting, recording, and converting to usable weight.
3 See Braund, 1989b, Table A-4, for sources of conversion factors.

Table III.C.3-8a
Barrow Annual Harvest of Walrus for the Harvest Years 1988 to 1995

Year	Harvest Total
Pre-Rule[1]	1[2]
1988[3]	1
1989	11
1990	7
1991	23
1992	21
1993	30
1994	15
1995	2

Sources: Stephensen, Cramer, and Burn, 1994; Cramer, pers. com., 1996.

[1] Walrus harvested from December 21, 1972 to October 26, 1988.
[2] No data available for years 1980-1987. Stoker (1983 as cited in ACI/Courtnage/Braund, 1984) estimated an annual average harvest of 55 animals for the 9-year period 1970 to 1979 (ACI/Courtnage/Braund, 1984).
[3] Walrus harvested between October 26, 1988 and December 31, 1988. Data from 1988 to present are FWS Marine Mammal Marking, Tagging, and Reporting Program (MTRP) data.

Table III.C.3-8
Barrow 1988 to 1989
Harvest Estimates for Fish[1,2]

Resource	Conversion Factor[3] Edible Weight Per Resource in Pounds	Community Totals		Average Pounds Harvested[3]		Percent of Total Edible Pounds Harvested	Percent of all Barrow Households Harvesting Resource
		Edible Number Harvested	Pounds Harvested	Per Household	Per Capita		
Total Fish	n/a	n/a	58,825	62.78	19.5	9.5%	25.1%
Total Whitefish		23,797	45,604	48.67	15.1	7.3%	16.7%
Whitefish (nonspecified)	2.0	2,663	5,326	5.69	1.8	0.9%	2.0%
Round whitefish	1.0	1,392	1,392	1.49	0.5	0.2%	9.0%
Broad whitefish (river)	2.5	9,674	24,184	25.81	8.0	3.9%	6.0%
Broad whitefish (lake)	3.4	1,059	3,599	3.84	1.2	0.6%	2.8%
Humpback whitefish	2.5	1,395	3,488	3.72	1.2	0.6%	5.4%
Least cisco	1.0	6,905	6,905	7.37	2.3	1.1%	2.5%
Bering, Arctic cisco	1.0	710	710	0.76	0.2	0.1%	6.8%
Total Other Freshwater Fish		10,797	11,259	12.02	3.7	1.8%	12.9%
Arctic grayling	0.8	9,955	7,964	8.50	2.6	1.3%	7.1%
Arctic char	2.8	59	166	0.18	*	**	4.4%
Burbot (Ling cod)	4.0	695	2,781	2.97	0.9	0.4%	3.9%
Northern pike	2.3	1	3	0.00	*	**	0.5%
Lake trout	4.0	87	346	0.37	0.1	0.1%	0.5%
Total Salmon		124	752	0.80	0.2	0.1%	1.2%
Salmon (nonspecified)	6.1	34	206	0.22	0.1	**	0.2%
Chum (Dog) salmon	6.1	5	30	0.03	*	**	0.5%

Table III.C.3-7
Barrow Annual Harvest of Subsistence Resources
for Which Sufficient Data Are Available, 1962-1982[1]

Year	Bowhead Whales	Walruses	Hair Seals[2]	Polar Bears	Total Harvest[3] (Kg)
1962	5	--	450	-[4]	366,046
1963	5	165	412	-[4]	403,824
1964	11	10	--	-[4]	413,291
1965	4	57	114	-[4]	351,462
1966	7	12	63	-[4]	361,443
1967	3	55	31	-[4]	390,284
1968	10	16	102	-[4]	433,996
1969	11	7	2,100	-[4]	478,896
1970	15	39	2,000	-[4]	461,496
1971	13	51	1,800	-[4]	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
1980/81[5]	9	--[6]	--	8[7]	365,766
1981/82	4	--	--	6	412,131
1982/83	0	--	--	14	--
Annual Average	10.1	55	955	7.8	424,716

Source: Stoker, 1983, as cited in ACI/Braund, 1984; Schliebe, 1983; Schliebe and Evans, 1995; Stephensen, Cramer, and Burn, 1994.

1 -- means no data are available.
2 Seal-harvest figures are estimates only and are probably on the low side.
3 Estimated kilograms, includes all species.
4 Data are not available by community, only for the entire State (Schliebe, 1987, pers. comm.).
5 For more recent harvest data for these species see Tables III.C. 3-4, III.C.3-7a, and III.C.3-7b.
6 See Table III.C.3-7b.
7 Schliebe, 1983; 1995.

Table III.C.3-6
Barrrow 1988 to 1989
Harvest Estimates for Terrestrial Mammals[1,2]

Resource	Conversion Factor[3] Edible Weight Per Resource in Pounds	Community Total		Average Pounds Harvested[3]		Percent of Total Edible Pounds Harvested	Percent of all Barrow Households Harvesting Resource
		Edible Number Harvested	Pounds Harvested	Per Household	Per Capita		
Total Terrestrial Mammals	n/a	n/a	204,558	218.3	67.8	32.9%	27.3%
Caribou	17.0	1,523	178,195	190.2	59.1	8.6%	5.0%
Moose	500.0	50	25,163	26.9	8.3	4.0%	4.8%
Dall sheep	99.0	11	1,052	1.1	0.3	0.2%	0.6%
Brown bear	100.0	1	117	0.1	*	**	0.6%
Other Terrestrial Mammals		14	31	0.03	*	**	0.5%
Porcupine	10.0	3	26	0.03	*	**	0.5%
Ground squirrel	0.4	12	5	0.01	*	**	0.1%
Wolverine	n/a	3	n/a	n/a	n/a	n/a	0.3%
Arctic fox (blue)	n/a	160	n/a	n/a	n/a	n/a	1.4%
Red fox (Cross, Silver)	n/a	6	n/a	n/a	n/a	n/a	0.1%

Source: Stephen R. Braund & Associates, 1989b.

1 Estimated sampling errors do not include errors in reporting, recording, and converting to usable weight.
2 * represents less than .1 pound.
** represents less than .1 percent.
n/a means not applicable.
3 See Braund, 1989b, Table A-4, for sources of conversion factors.

fall-whaling stations, and other camps. Marine fishing is conducted with gillnets 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 generally are 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, Topagoruk, 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 to 1973, the average annual harvest of fishes was about 37,727 kilograms (kg) (Craig, 1987); from 1962 to 1982, the estimated annual average was 27,955 kg, which accounts for 6.6 percent of the total annual subsistence harvest (Table III.C.3-3). 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). In Braund's (1989b) study, 1988 to 1989 fish harvests provided 9.5 percent of the total edible subsistence harvest (Table III.C.3-8).

(f) Walruses: Walruses are harvested during the spring marine-mammal hunt west of Point Barrow and southwest to Peard Bay (Fig. III.C.3-6). Most hunters will travel no more than 24 to 32 km (15-20 mi) to hunt walruses. The major walrus-hunting effort occurs from late June through mid-September, with the peak season in August (Fig. III.C.3-8). The annual average harvest from 1970 through 1979 is estimated at 57 (Table III.C.3-7). The annual average harvest over 20 years from 1962 to 1982 is estimated at 55 walruses, or 4.6 percent of the total annual subsistence harvest (Table III.C.3-3). Braund's 1987 to 1989 study (1989b) indicated increased walrus harvest; a harvest of 88 walruses provided 10.9 percent of the total edible pounds of meat harvested during this period (Table III.C.3-5). More recent subsistence-harvest figures for walrus from 1988 to 1995 are shown in Table III.C.3-8a.

(g) Migratory Birds: Migratory birds, particularly eider ducks and geese, provide an important food source for Barrow residents. This is not because of the quantity of meat harvested or the time spent hunting them, but because of the dietary importance of birds during spring and summer. Geese are harvested more often inland, along rivers, while most eider and other ducks are harvested along the coast (Fig. III.C.3-7a). Once harvested extensively, snowy owls are no longer taken regularly. Birds' eggs still are 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) when their flights follow the open leads—provide a fresh-meat source for whaling camps. Later in the spring, Barrow residents harvest many geese and ducks; the harvest peaks in May and early June and continues until the end of June (Fig. III.C.3-8). Birds may be harvested throughout the summer, but only incidentally to other subsistence activities. In late August and early September, with peak movement 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, as well.

After spring whaling, geese are hunted inland. 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 Beaufort Sea from Elson Lagoon. This area, a highly successful hunting spot during spring and fall bird migrations, is easily accessible to Barrow residents (ACI/Courtnage/Braund, 1984). Barrow residents harvested an estimated annual average from 1962 to 1982 of 3,636 kg of birds, which accounts for about 0.9 percent of the total annual subsistence harvest (Table III.C.3-3). From 1988 to 1989, 21,529 pounds were harvested, accounting for 3.5 percent of the total edible pounds harvested (Braund, 1989b; Table III.C.3-9).

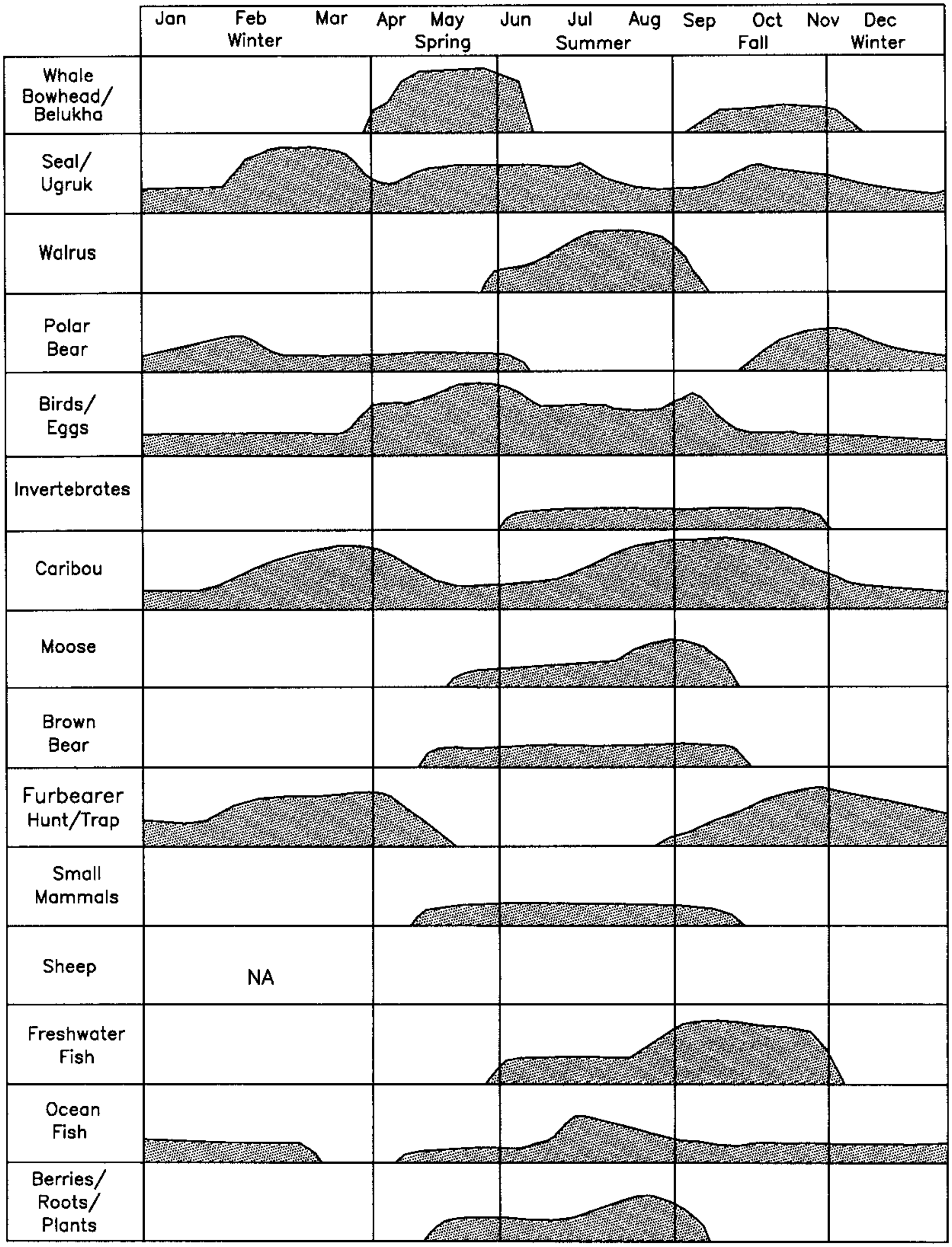
(h) Polar Bears: Barrow residents hunt polar bears from October to June (Fig. III.C.3-8). Polar bears comprise a small portion of the Barrow subsistence harvest, with an annual average of 7.8 bears harvested from 1962 to 1983 (Table III.C.3-7), or only 0.3 percent of the annual subsistence harvest (Table III.C.3-3). From 1988 to 1989, 11 polar bear were harvested, providing 0.9 percent of the total edible pounds harvested (Braund, 1989b; Table III.C.3-5). More recent subsistence-harvest figures for polar bears from 1983 to 1994 are shown in Table III.C.3-9a.

Table III.C.3-5
Barrow 1988 to 1989
Harvest Estimates for Marine Mammals[1,2]

Resource	Conversion Factor[3] Edible Weight Per Resource in Pounds	Community Totals[3]		Average Pounds Harvested[4]		Percent of Total Edible Pounds Harvested	Percent of all Barrow Households Harvesting Resource
		Edible Number Harvested	Pounds Harvested	Per Household	Per Capita		
Total Terrestrial Mammals	n/a	n/a	337,225	359.9	111.8	754.2%	40.7%
Bowhead whale[4,5]	11,612.0	9	209,015	223.1	69.3	33.6%	32.4%
Walrus	772.0	88	67,623	72.2	22.4	10.9%	9.0%
Bearded seal	176.0	213	37,467	40.0	12.4	6.0%	16.9%
Polar bear	469.0	11	5,600	6.0	1.9	0.9%	1.3%
Total Ringed and Spotted Seals	42.0	417	17,519	18.7	5.8	2.8%	12.2%
Ringed seal	42.0	414	17,396	18.6	5.8	2.8%	12.2%
Spotted seal	42.0	3	123	0.1	*	**	0.2%

Source: Stephen R. Braund & Associates, 1989b.

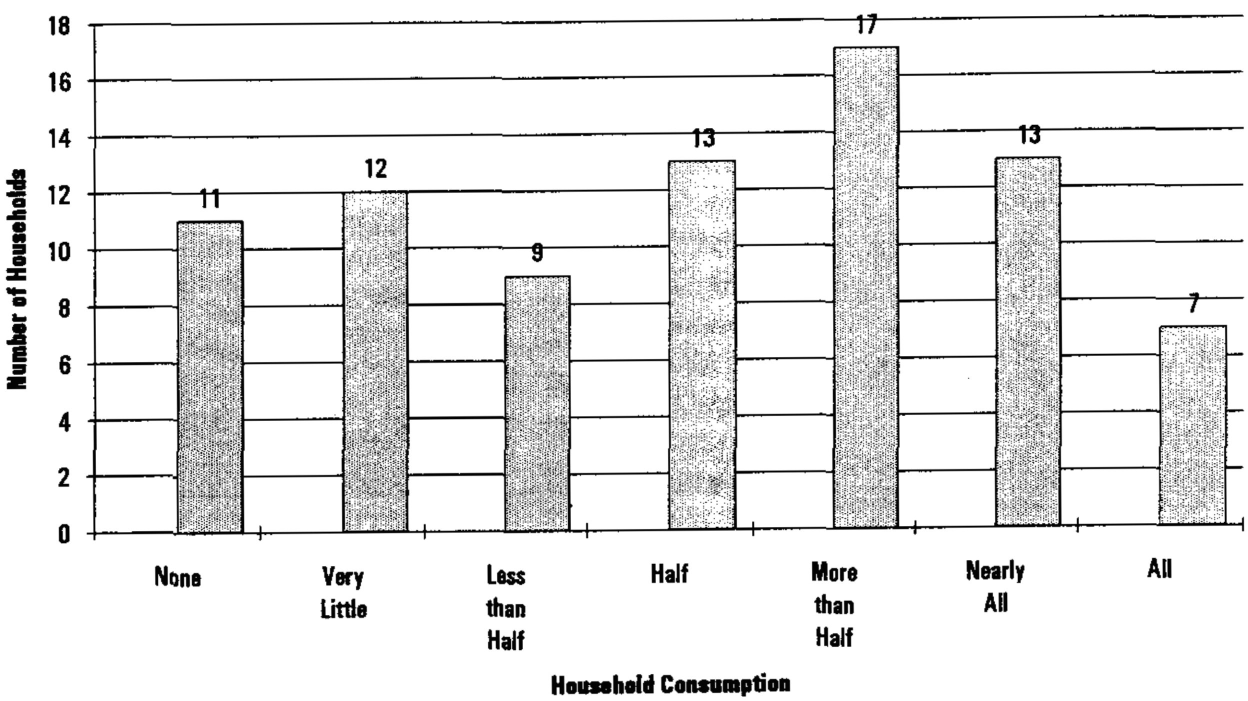
1 Estimated sampling errors do not include errors in reporting, recording, and converting to usable weight.
2 * represents less than .1 pound.
** represents less than .1 percent.
n/a means not applicable.
3 See Braund, 1989b, Table A-4, for sources of conversion factors.
4 Bowhead harvest does not contribute to the sampling error for marine mammals because the bowhead harvest is based on a complete count.
5 The percent of Barrow households harvesting bowheads represents the percent of Barrow households receiving crew-member shares at the whale-harvest site, as extrapolated from the sample households.



Source: North Slope Borough Contract Staff, 1979.

Figure III.C.3-8. Barrow Annual Subsistence Cycle [1]

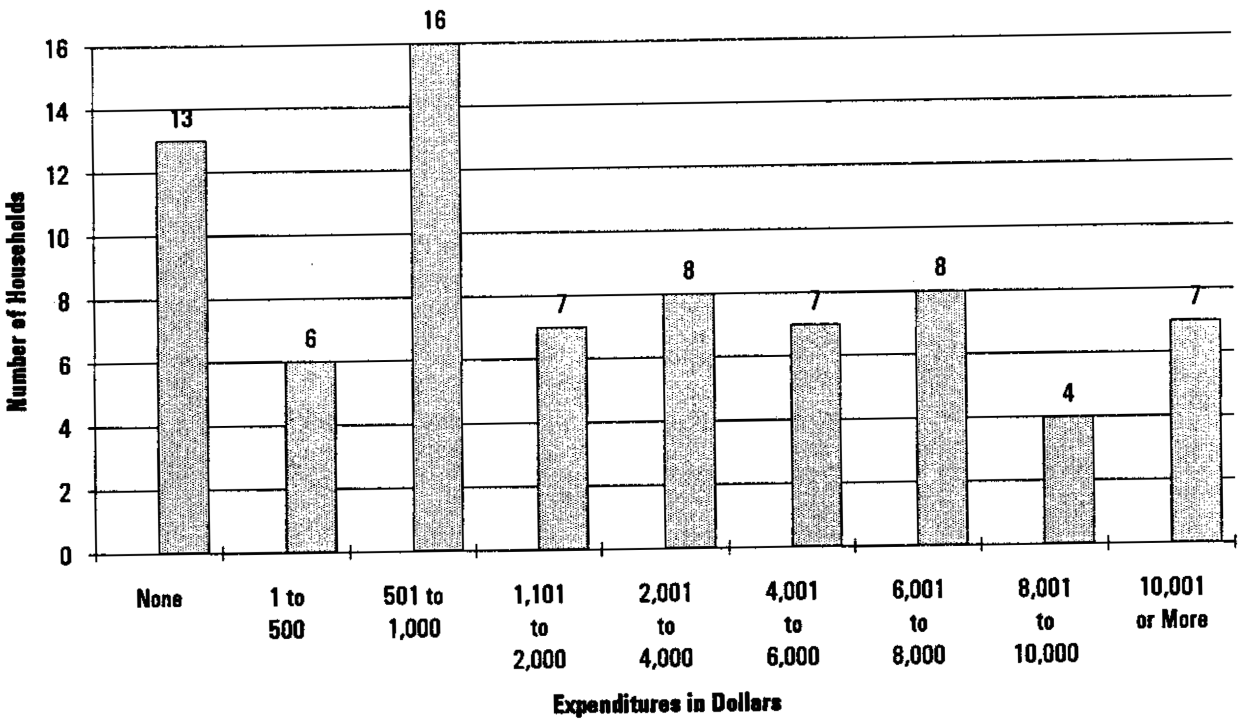
[1] Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods of pursuit of subsistance resources.



Source: Harcharek, 1995.

Figure III.C.3-15. Nuiqsut Household Consumption of Meat, Fish, and Birds from Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.



Source: Harcharek, 1995.

Figure III.C.3-16. Nuiqsut Household Expenditures on Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.

Table III.C.3-14
Kaktovik Annual Harvest of Subsistence Resources, 1962 to 1982

Year	Bowhead Whale	Polar Bear[1]
1962	0	-
1963	0	-
1964	2	-
1965	0	-
1966	0	-
1967	0	-
1968	0	-
1969	0	-
1970	0	-
1971	0	-
1972	0	5
1973	3	0
1974	2	1
1975	0	1
1976	2	1
1977	2	5
1978	2	1
1979	5	0
1980	1	22[2]
1981	3	1 (81-82)[3]
1982	0	1 (82-83)

Source: Stoker, 1983, as cited by ACI/Braund, 1984; Schliebe and Evans, 1995.

[1] No subsistence-harvest data are available for the years 1962-1971.
[2] According to Jacobson and Wentworth (1982), 28 polar bear were taken in 1980.
[3] Harvest season runs 1 July -30 June; see Table III.C.3-7a for polar bears harvested since the 1982/83 season, and Table III.C.3-4 for bowheads harvested since 1982.

the proposed Sale 144 lease-sale area, and the western edge of the community's terrestrial mammal, fish, and bird subsistence-harvest areas overlap a possible landfall at Bullen Point; Kaktovik also could be used for some air support for lease activities.

(a) Bowhead Whales: Bowhead whaling occurs between late August and early October (Fig. III.C.3-17), with the exact timing depending on ice and weather conditions. The whaling season can range anywhere from greater than 1 month to less than 2 weeks, depending on these conditions. As in Nuiqsut, Kaktovik whalers hunt the bowhead in aluminum skiffs in open water rather than in skin boats from the edge of ice leads. Whaling crews generally hunt bowheads within 16 km (10 mi) of shore but occasionally may range as much as 32 km (20 mi) from the coast (Fig. III.C.3-2). Bowhead whales provide a fairly large proportion of Kaktovik's subsistence harvest, but the number landed has varied from zero to as many as four each year since 1962, with the exception of 1979 when five were landed (see Fig. III.C.3-17a and Tables III.C.3-4, III.C.3-14, and III.C.3-14a). In the ADF&G 1992 subsistence harvest survey, bowhead whales amounted to 63 percent of the total subsistence harvest for the community, or 560.35 lb per person (ADF&G, 1993b; see Tables III.C.3-15 and III.C.3-16). Bowheads are an important meat resource and the source for maktak, an especially preferred food. The sharing of the bowhead is a central aspect of Kaktovik's Thanksgiving and Christmas feasts and the focus of the community's whale feast, Nalukataq. As in other North Slope communities, the bowhead is shared extensively. Its baleen is bartered in traditional networks and is used in the manufacture of traditional arts and crafts.

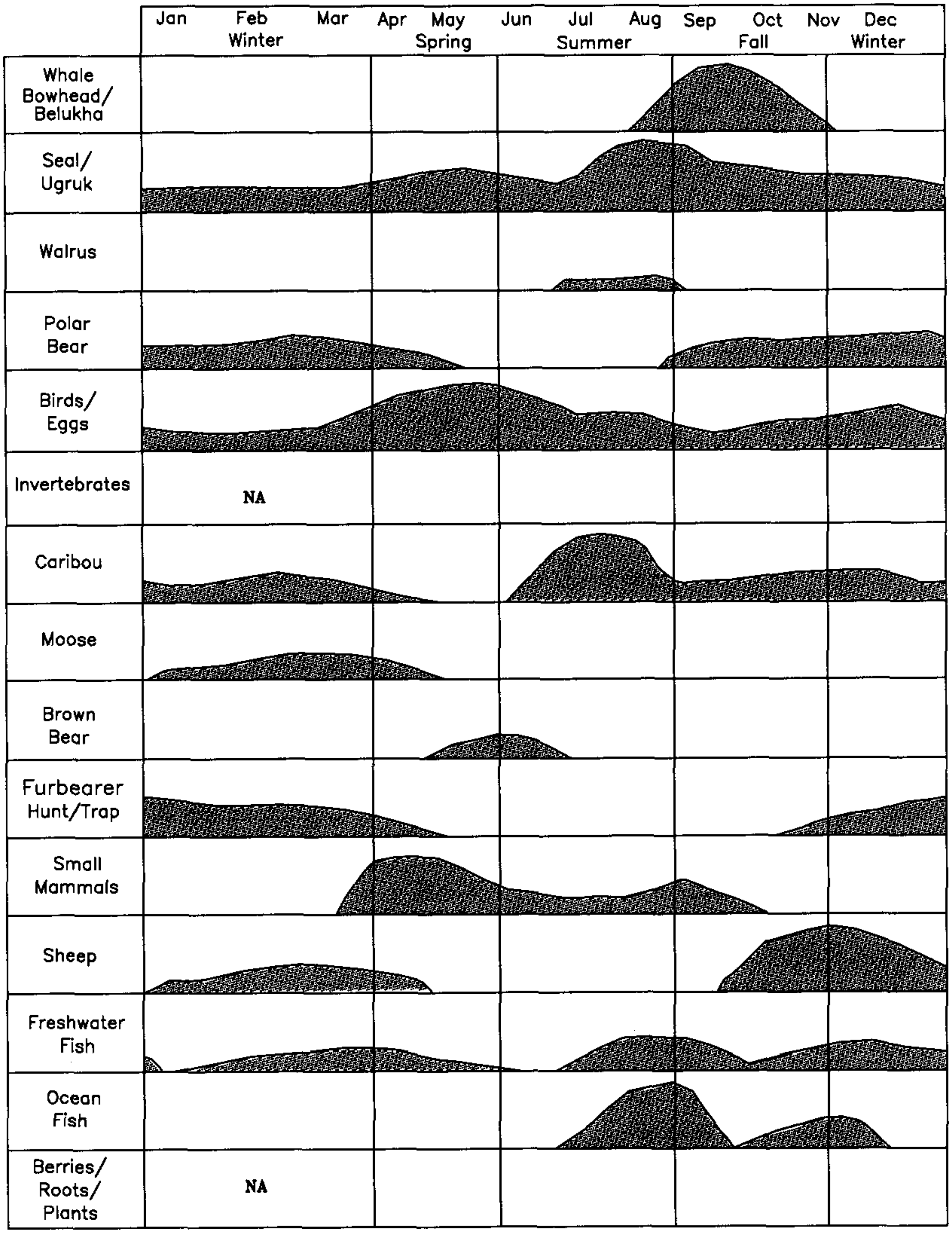
(b) Belukha Whales: Belukha whales usually are harvested in August through November (Fig. III.C.3-17), incidental to the bowhead harvest (Fig. III.C.3-3). However, belukhas sometimes are taken earlier in the open-water season when boating and camping groups are concentrating on the harvest of seals, caribou, or fish (Tables III.C.3-15 and III.C.3-16).

(c) Seals: Seals are hunted year-round, but the bulk of the seal harvest occurs during the open-water season from July to September (Fig. III.C.3-17). Elder Elija Kakinya, when interviewed in 1979, stated that "when polar ice is not far from the barrier islands, is a good chance of catching seals when ice is close to shore" (in Shapiro and Metzner, 1979). During the winter, these harvests consist almost exclusively of ringed seals taken along open leads in the ocean ice many miles offshore. Summer harvests are made by boat crews and consist of ringed, bearded, and spotted seals (Fig. III.C.3-5; see Tables III.C.3-15 and III.C.3-16). Summer sealing typically occurs 8 to 16 km (5-10 mi) offshore but may range up to 32 km (20 mi) offshore (Fig. III.C.3-5). Elder Bruce Nukapigak related how his father-in-law Uqumailaq taught him about hunting seals at Barter Island: "He took me on hunts as far as Cross Island and east of Barter Island to in front of the Jago River" (in Shapiro and Metzner, 1979).

Seal meat is eaten, and bearded seal meat is most preferred. However, the primary dietary significance of seals comes from seal oil, which is served with every meal that includes subsistence foods; seal oil is used, as well, as a preservative for meats, greens, and berries. Seal skins are important in the manufacture of clothing. Because of their beauty, spotted seal skins often are preferred for making boots, slippers, mitts, and parka trim, but ringed seal skins also are important in the manufacture of these same items. Bearded seal hides are necessary for the manufacture of boot soles. Seal skin products such as boots, slippers, mitts, and parkas are sold, bartered, and given as gifts to relatives and friends.

(d) Walruses: Walruses are harvested much less frequently than are seals in Kaktovik because the community lies east of the mammal's optimum range. They are harvested opportunistically by boat crews hunting other species in July and August (Fig. III.C.3-17; Tables III.C.3-15 and III.C.3-16). Harvests occur in open water along the coast in conjunction with seal hunting (Fig. III.C.3-6). Jacobson and Wentworth (1982) stated that in 1982, only five or six walruses had been harvested in the last two decades. If harvested, walrus meat is eaten, and its ivory used in the manufacture of traditional arts and crafts.

(e) Polar Bears: Polar bears are harvested during the winter months (Fig. III.C.3-17) on ocean ice and along ocean leads. When discovered, these bears may be pursued seaward of the barrier islands for 16 km (10 mi) or more. The meat is often consumed (see Tables III.C.3-9a, III.C.3-14, III.C.3-15, and III.C.3-16). With the passage of the Marine Mammal Protection Act in 1972, less



Source: North Slope Borough Contract Staff, 1979.
Figure III.C.3-17. Kaktovik Annual Subsistence Cycle[1]

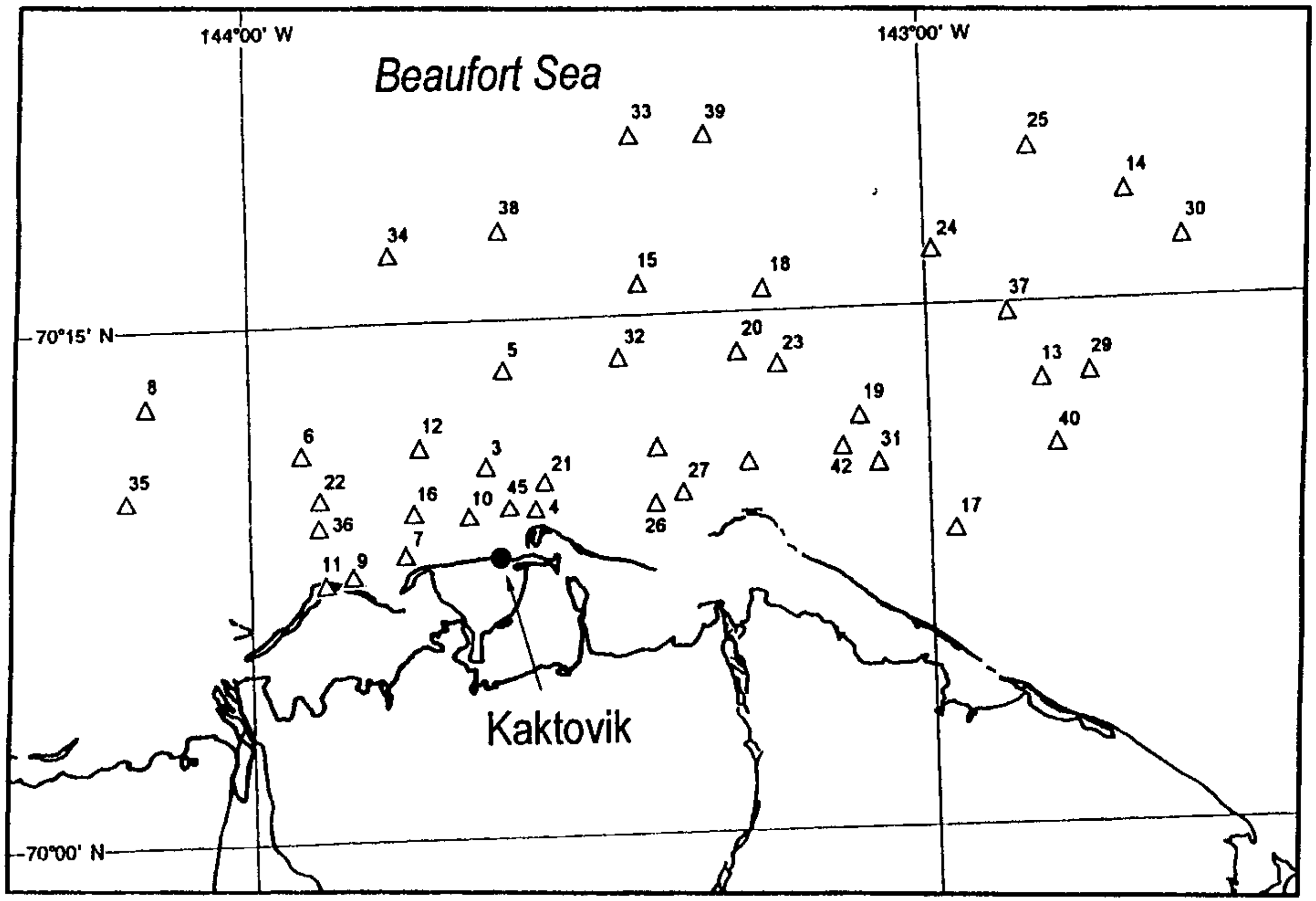
[1] **Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods of pursuit of subsistence resources.**

Table III.C.3-14a
Bowhead Whale Harvest Data - Kaktovik

Number	Whaling Captain	Year	Number	Whaling Captain	Year
3[1]	Archie Brower	1964	28	Nolan Solomon	1986
4	Herman Aishanna	1973	29	Archie Brower	?
5	Herman Aishanna	1974	30	Isaac Akootchook	?
6	Herman Rexford	1975	31	Tommy Agiak	1988
7	Herman Aishanna	1975	32	Tommy Agiak	1989
8	Archie Brower	1976	33	James Killbear	1989
9	Archie Brower	1977	34	Joseph Kaleak	1989
10	Alfred Linn	1977	35	Herman Aishanna	1990
11	Nolan Solomon	1977	36	Jimmie Soplu	1990
12	Tommy Agiak	1977	37	Daniel Akootchook	1991
13	Joseph Kaleak	1977	38	James Lampe, Sr.	1992
14	Joseph Kaleak	1978	39	Daniel Akootchook	1992
15	Joseph Kaleak	1978	40	Joseph Kaleak	1992
16	Nolan Solomon	1978	41	James Killbear	1993
17	Alfred Linn	1980	42	Herman Aishanna	1993
18	Tommy Agiak	1982	43	Joseph Kaleak	1993
19	Alfred Linn	1982	44	James Killbear	1994
20	Isaac Akootchook	1983	45	Herman Aishanna	1994
21	Nolan Solomon	1983	46	Edward Rexford	1994
22	Tommy Agiak	1983	47	Tommy Agiak	1995
23	Herman Aishanna	1984	48	James Killbear	1995
24	Isaac Akootchook	1984	49	James Lampe, Sr.	1995
25	Nolan Solomon	1984	50	Issac Akootchook	1995

Sources: Kaleak, 1996; North Slope Borough Planning Dept. 1993.

1 See Fugure III.C.3-7a for whale harvest locations



Sources: Kaleak, 1996; North Slope Borough Palnning Dept., 1993.

Figure III.C.3-17a. Recent Whale Harvest Locations Near Kaktovik.

Table III.C.3-15
Kaktovik 1987 Subsistence-Harvest Estimates for Marine Mammals[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Marine Mammals	41,732.0	41,732.0	887.91	256.02	49,723	49,723
Bowhead Whale	36,680.0[2]	36,680.0	780.43	225.03	43,704	43,704
Belukha Whale	0.0	0.0	0.00	0.00	0	0
Walrus	0.0	0.0	0.00	0.00	0	0
Polar Bear	2.0	992.0	21.11	6.09	2	1,182
Bearded Seal	14.0	2,464.0	52.43	15.12	17	2,936
Ringed Seal	37.0	1,554.0	33.06	9.53	44	1,851
Spotted Seal	1.0	42.0	0.89	0.26	1	50

Source: ADF&G, Community Profile Database, 1993a.

[1] Number of households in the sample = 47; number of households in the community = 56.
[2] Harvest amount for the sample is an artificial estimate based on a known community harvest.

Table III.C.3-16
Kaktovik 1992 Subsistence-Harvest Estimates for Marine Mammals[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Marine Mammals	75.44	115,640.62	1,835.57	599.11	--	--
Bowhead Whale	3.00	108,159.70	1,716.82	560.35	--	--
Belukha Whale	0.00	0.00	0.00	0.00	--	--
Walrus	0.06	46.91	0.74	0.24	--	--
Polar Bear	2.68	1,329.70	21.11	6.89	--	--
Bearded Seal	24.13	4,246.47	67.40	22.00	--	--
Ringed Seal	41.55	1,688.94	26.81	8.75	--	--
Spotted Seal	4.02	168.89	2.68	0.88	--	--

Source: ADF&G, Community Profile Database, 1993b.

[1] Number of households in the sample = 47; number of households in the community = 63.

incentive developed for hunting polar bears, because the act made the sale of the unprocessed hides illegal (Jacobson and Wentworth, 1982). However, the polar bear is important for its fur, which is used to manufacture cold-weather gear such as boots, mitts, and coats. These sewn items are bartered, sold, and given as gifts to relatives and friends.

(f) Caribou: Kaktovik harvests several large land mammals including caribou, Dall sheep, moose, and brown bear. Caribou is of major concern under the proposed action. Kaktovik's annual caribou harvest fluctuates widely because of the unpredictable movements of the Porcupine and Central Arctic herds, weather-dependent hunting technology, and ice conditions. Limited only by availability and unfavorable weather conditions, caribou can be harvested almost year-round (Fig. III.C.3-17). With open water comes a period of intense caribou harvest that usually occurs in July. Kaktovik boat crews hunt caribou along the coast, with hunting usually lasting until mid-August when the caribou move inland and are no longer abundant (Fig. III.C.3-4). Approximately 70 percent of all caribou harvests take place on the coastal plain near the coast, and most harvesting is accomplished by boat crews. By late October, snow buildup allows hunters access to inland caribou (Fig. III.C.3-4). From then on until the onset of breakup, which usually occurs sometime in May, Kaktovik hunters take caribou by snowmachine in inland mountains and valleys and, to a lesser extent, on the coastal plain.

Caribou is eaten fresh, frozen, and dried and is the most preferred land mammal in Kaktovik's diet. Caribou can be a source of fresh meat throughout the year, during periods of high availability. The meat often is shared with kinsmen, friends, and elders within the community. Outside the community, caribou meat is sent to relatives as far away as Anchorage, and it is bartered occasionally. Caribou plays an important part in holiday feasts. The skins of caribou taken in July and August are used to manufacture parkas, boot soles, mitts, and mukluk tops. Blankets and sleeping pads are made from the skins of caribou taken in October and November.

In Pedersen and Coffing's (1985) 3-year study (1981-1983) of Kaktovik's caribou hunting, they found that the general caribou-hunting range covered about 19,684 km^2 (7,600 mi^2) and that the intensely used area covered about 7,511 km^2 (2,900 mi^2). This latter figure is only a short-term measure of use intensity because the distribution and availability of caribou fluctuate over a period of years, and the size and location of the intensely used area also change. As expected from earlier research (NSB Contract Staff, 1979), harvest levels were highly variable. During the 1981 to 1982 season, 43 caribou were taken; during the 1982 to 1983 season, 110 were taken. The annual average harvest was 71.5, or approximately .4 caribou per capita. These figures indicate that the earlier State Department estimate of 100 to 300 caribou harvested per year by Kaktovik hunters might have been high (U.S. Department of State, 1980), until the 1992 ADF&G subsistence harvest survey that indicated a take of 158 caribou that season (ADF&G, 1993b). ACI/Braund (1984) estimated that an annual average of 75 caribou were taken by Kaktovik hunters between 1962 and 1983; Jacobson and Wentworth (1982) estimated that 80 were taken in 1980. While Jacobson and Wentworth (1982) found high-yield areas in both coastal and inland habitats, 70 percent of all caribou harvests were found to take place on the coastal plain and near the coast. Most of these caribou were harvested by boat crews. For more recent subsistence caribou harvest data, see Tables III.C.3-17 and III.C.3-18.

It should be noted that these figures cannot be extrapolated to apply to other North Slope communities because species availability and use varies from settlement to settlement (NSB Contract Staff, 1979). For example, Kaktovik hunts musk ox, a big-game species unavailable to other North Slope communities. Kaktovik also is more heavily dependent on fish than most communities (Jacobson and Wentworth, 1982). Moreover, these figures cannot be assumed to reflect the long-term per capita harvests made by Kaktovik hunters. Pederson and Coffing conducted their work in the early 1980's, a period of intense CIP construction, and reports from other North Slope communities during this time indicated that subsistence hunting may have dropped slightly during this period because of CIP wage employment; more recent data would tend to indicate an increase in subsistence hunting since the drop in availability of wage work. Additionally, it was discovered that Kaktovik's hunting patterns may have, even in the early 1980's, already been affected by the area's industrialization. Pedersen and Coffing (1985) wrote:

> A sizable portion of the general caribou hunting range, as well as a portion of the intensively used area, have been identified as lying within a rapidly industrializing portion of the east-central North Slope. However, very little caribou hunting activity has been conducted in the area recently by Kaktovik residents.

Table III.C.3-17
Kaktovik 1987 Subsistence-Harvest Estimates for Terrestrial Mammals[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Caribou	149.0	17,783.0	378.36	109.10	178	21,188
Moose	1.0	500.0	10.64	3.07	1	596
Dall Sheep	14.5	1,435.5	30.54	8.80	17	1,710
Musk ox	2.0	1.186.0	25.23	7.28	2	1,413
Brown Bear	0.0	0.0	0.00	0.00	0	0
Parka Squirrel	79.0	32.3	0.69	0.20	94	39
Wolverine	2.0[2]	0.0	0.00	0.00	2	0
Arctic Fox	67.0[2]	0.0	0.00	0.00	80	0
Red Fox	6.0[2]	0.0	0.00	0.00	7	0

Source: ADF&G, Community Profile Database, 1993a.

[1] Number of households in the sample = 47; number of households in the community = 56.
[2] Not eaten.

Table III.C.3-18
Kaktovik 1992 Subsistence-Harvest Estimates for Terrestrial Mammals[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Caribou	158.17	19,135.91	303.74	99.14	--	--
Moose	4.02	2,010.64	31.91	10.42	--	--
Dall Sheep	44.23	4,379.17	69.51	22.69	--	--
Musk ox	5.36	3,179.49	50.47	16.47	--	--
Brown Bear	0.00	0.00	0.00	0.00	--	--
Parka Squirrel	132.70	54.41	0.86	0.28	--	--
Wolverine	9.38[2]	0.00	0.00	0.00	--	--
Arctic Fox	36.19[2]	0.00	0.00	0.00	--	--
Red Fox	9.38[2]	0.00	0.00	0.00	--	--

Source: ADF&G, Community Profile Database, 1993b.

[1] Number of households in the sample = 47; number of households in the community = 63.
[2] Not eaten.

It was suggested that unclear harvesting regulations as well as industrialization may have led to avoidance of this region by Kaktovik caribou hunters.

(g) Dall Sheep: Although not a major subsistence resource in terms of pounds harvested, Dall sheep are the most preferred subsistence resource by Kaktovik hunters. With difficulties in musk ox-permit availability and the variability of caribou as a summer subsistence meat source, sheep might be one of the more stable meat sources available to the community. Sheep are hunted by snowmachine from late October through November and in the spring from March through April. The preferred hunting period is in the fall when the sheep have more fat. See Tables III.C.3-17 and III.C.3-18 for recent subsistence-harvest numbers for sheep (Impact Assessment, Inc., 1990d).

(h) Musk Ox: In 1969, ADF&G, with the assistance of the FWS, reintroduced musk ox into the Kaktovik area. Originally indigenous, the musk ox was extinct by the late 1800's, probably hunted out by non-Native hunters. Not until 1983 was a hunt permitted and then only by a limited permit drawing and the payment of a large permit fee. From 1986 to 1989, permitting problems prevailed. At the present time, seven permits are reserved for a sport hunting drawing in Fairbanks and seven are allocated for local Kaktovik hunters. Musk ox are hunted in March and April when the days are long and travel by snowmachine still good. The hunt is conducted in the Camden Bay area and in the Sadlerochit River drainage. See Tables III.C.3-17 and III.C.3-18 for musk ox-harvest numbers.

(i) Fishes: Fishes provide an important subsistence resource at Kaktovik. The community's harvest of most other subsistence resources can fluctuate widely from year to year because of variable migration patterns of game and because harvesting technologies are extremely dependent on ice conditions and weather. The harvest of fishes is not subject to these conditions, and this adds to their importance in Kaktovik's subsistence system (see Fig. III.C.3-7 for harvest areas). Moreover, in January and February, fishes may provide the only source of fresh subsistence foods (see Fig. III.C.3-17). In the summer, Kaktovik residents primarily harvest arctic char. Sea-run char are caught all along the coast, around the barrier islands, and up the navigable portions of the river deltas. Char are the first fishes to appear after the ice is gone in early July and are caught until late August. Arctic cisco are harvested in the ocean after the arctic char run peaks, beginning about the first of August through early September. Grayling is a major subsistence fish taken in the Hulahula River and in many other of the area's rivers and river deltas. Late summer, after freezeup, and then again in the spring, are the most likely times to catch grayling. Least cisco is taken in the lagoons, river deltas, and particularly the small lakes and streams of the river drainages. Broad whitefish is harvested in the deeper lakes and channels of the Canning River Delta from July through September. Less commonly harvested are round whitefish, also harvested in the Canning River. Pink and chum salmon are occasionally taken in July and August near Barter Island (Jacobsen and Wentworth, 1982). See Tables III.C.3-19 and III.C.3-20 for more recent data on Kaktovik's subsistence harvests of fishes.

Arctic flounder and fourhorn sculpin occasionally are taken during summer ocean fishing off Manning Point, Drum Island, Arey Spit, and in Kaktovik Lagoon between Manning Point and the mainland; but sculpin often is not eaten because it is too bony. Called Paigluk in Inupiaq, pike (not yet positively identified) is caught in the Hulahula River and occasionally in other rivers. Arctic cod or tomcod and smelt are caught in the summer along the Beaufort Sea coast, sometimes near the spits off Barter Island. Blackfish is harvested in the spring in the Canning, Hulahula, Kongakut, and, especially, the Aichilik rivers (Jacobsen and Wentworth, 1982).

During the fall/winter fish harvest, freshwater arctic char is taken inland on the rivers by fishing through holes in the ice. Broad whitefish is occasionally taken in the winter at fishing holes farther inland on the Canning River. Small numbers of ling cod sometimes are taken inland on the Canning River during the snow season. They are harvested only on the inland portions of rivers, at least 16 km (10 mi) from the coast. During winter, lake trout are caught in the Neruokpuk Lakes of the Brooks Range. Tomcod and smelt are sometimes caught by jigging in October and November north of Barter Island and at Iglukpaluk. Blackfish is harvested in the winter in the Canning, Hulahula, and Kongakut Rivers, with harvests in the Aichilik River the most productive (Jacobsen and Wentworth, 1982).

Because of the important role of fishes as an abundant and stable fresh-food source during midwinter months, they are shared at Thanksgiving and Christmas feasts, as well as given to relatives, friends, and village elders.

Table III.C.3-19
Kaktovik 1987 Subsistence-Harvest Estimates for Fish[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Fish	3,706.0	5,833.6	124.12	35.79	4,416	6,951
Whitefish	0.0	0.0	0.00	0.00	0	0
Round Whitefish (Uraraq)	--	--	--	--	--	--
Broad Whitefish (Akakiik)	0.0	0.0	0.00	0.00	0	0
Humpback Whitefish	--	--	--	--	--	--
Cisco	2,016.0	1,411.2	30.03	8.66	2,402	1,682
Total Other Freshwater Fish	n/a	--	--	--	--	--
Grayling	172.0	154.8	3.29	0.95	205	184
Char (general)	1,484.0	4,155.2	88.41	25.49	1,768	4,951
Arctic Char	1,484.0	4,155.2	88.41	25.49	1,768	4,951
Burbot	--	--	--	--	--	--
Northern Pike	--	--	--	--	--	--
Lake Trout	28.0	112.0	2.38	0.68	33	133
Total Salmon	--	--	--	--	--	--
Chum Salmon	--	--	--	--	--	--
Pink Salmon	--	--	--	--	--	--
Silver Salmon	--	--	--	--	--	--
King Salmon	--	--	--	--	--	--
Total Other Coastal Fish	n/a	--	--	--	--	--
Capelin	--	--	--	--	--	--
Rainbow Smelt	--	--	--	--	--	--
Arctic Cod	--	--	--	--	--	--
Tomcod	6.0	0.4	0.01	0.01	7	1

Source: ADF&G, Community Profile Database, 1993a.

1 Number of households in the sample = 47; number of households in the community = 56.

Table III.C.3-20
Kaktovik 1992 Subsistence-Harvest Estimates for Fish[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Fish	18,464.36	22,952.16	364.32	118.91	--	--
Whitefish	8,822.68	6,050.55	96.04	31.35	--	--
Round Whitefish (Uraraq)	--	--	--	--	--	--
Broad Whitefish (Akakiik)	0.00	0.00	0.00	0.00	--	--
Humpback Whitefish	--	--	--	--	--	--
Cisco	8,809.28	6,027.09	95.67	31.23	--	--
Total Other Freshwater Fish	n/a	--	--	--	--	--
Grayling	175.60	158.04	2.51	0.82	--	--
Char (general)	5,741.04	16,337.11	259.32	84.64	--	--
Arctic Char	5,522.55	15,463.15	245.45	80.11	--	--
Burbot	0.00	0.00	0.00	0.00	--	--
Northern Pike	--	--	--	--	--	--
Lake Trout	218.49	873.96	13.87	4.53	--	--
Total Salmon	49.60	105.14	1.67	0.54	--	--
Chum Salmon	--	--	--	--	--	--
Pink Salmon	8.04	17.05	0.27	0.09	--	--
Silver Salmon	0.00	0.00	0.00	0.00	--	--
King Salmon	0.00	0.00	0.00	0.00	--	--
Total Other Coastal Fish	n/a	--	--	--	--	--
Capelin	--	--	--	--	--	--
Rainbow Smelt	--	--	--	--	--	--
Arctic Cod	1,072.34	117.96	1.87	0.61	--	--
Tomcod	2,600.43	182.03	2.89	0.94	--	--

Source: ADF&G, Community Profile Database, 1993b.

[1] Number of households in the sample = 47; number of households in the community = 63.

Subsistence uses in Kaktovik are similar to those found elsewhere on the North Slope, where fishes figure in existing traditional sharing and bartering networks of the communities.

(j) ***Marine and Coastal Birds:*** Since the mid-1960's, waterfowl and coastal birds as a subsistence resource have been growing in importance. The most important subsistence species of birds for Kaktovik are black brants, oldsquaws, eiders, snow geese, Canada geese, and pintail ducks. Other birds, such as loons, are occasionally harvested. Waterfowl hunting occurs mostly in the spring, from May through early July (Fig. III.C.3-17); normally, a less intensive harvest continues throughout the summer and into September. During the spring, birds are harvested by groups of hunters that camp along the coast, with spits and points of land providing the best hunting locations. Kaktovik's primary subsistence-harvest areas for waterfowl are shown in Figure III.C.3-7a. In summer and early fall, bird hunting occurs as an adjunct to other subsistence activities, such as checking fishing nets.

Virtually the entire community of Kaktovik participates in the spring bird hunt. The hunt occurs at the end of the school year and has become a major family activity. Because waterfowl is a highly preferred food, it is shared extensively within the community, and birds are given to relatives, friends, and village elders. While most birds are eaten fresh, usually in soup, some are stored for the winter. Waterfowl is served for special occasions and holiday feasts such as Nalukataq and Thanksgiving, and occasionally birds are bartered. Tables III.C.3-21 and III.C.3-22 show subsistence bird-harvest data for household subsistence surveys conducted in 1987 and 1992 by ADF&G (ADF&G, 1993a,b).

Trends in Kaktovik household consumption of subsistence foods and expenditures on subsistence activities from a NSB subsistence survey conducted in 1993 are shown in Figures III.C.3-18 and III.C.3-19 (Harcharek, 1995).

4. Archaeological Resources: Archaeological resources are those deposits, structures, ruins, sites, buildings, graves, artifacts, fossils, or objects that are made or modified by humans. These resources provide information pertaining to history or prehistory. It is the policy of the MMS to consider the effects on archaeological resources in all aspects of planning, leasing, permitting, and regulatory decisions. To do this, an assessment of archaeological resources potential within the area to be affected by a proposed action must take place (MMS Manual Part 620.1.1).

The National Register of Historic Places is a national inventory of sites that meet specific criteria of significance. Most archaeological sites listed on or eligible for the Register meet Criterion D, Information Potential: Properties may be eligible for the National Register if they have yielded, or may be likely to yield, information important in prehistory or history. With rare exception, properties must be 50 or more years old to be considered eligible for the National Register (USDOI, National Register Bulletin No. 15).

A site is nominated to the National Register by preparing and submitting documentation that details specific information, measurements, locational data, and historic background—a time-consuming process that requires detailed information. Consequently, properties officially listed on the Register represent only a fraction of those sites that would be considered eligible for assessment purposes in the event of a proposed action. Sites identified in this manner are afforded equal protection in the process. Therefore, merely checking the Register for a list of sites is a minor part of the archaeological assessment that must take place. In the case of the Federal OCS, most of the Beaufort Sea Planning Area has never been surveyed for archaeological sites; and no sites on the OCS have been listed on the National Register. In that case, archaeological resources or potential resources within the planning area must be identified using regional baseline studies that are predictive models, geophysical/geological data, historic accounts of shipwreck disasters, and marine remote-sensing data compiled from required shallow-hazards surveys.

The following analyses represent the Prehistoric Resource Analysis and Shipwreck Update Analysis required in the MMS Handbook for Archaeological Resource Protection (620.1-H).

a. Prehistoric Resources: Prehistoric resources are those that "pertain to that period of time before written history. In North America, 'prehistoric' usually refers to the period before European contact" (MMS Manual 620.1-H).

Table III.C.3-21
Kaktovik 1987 Subsistence-Harvest Estimates for Birds[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Birds	1,307.0	1,998.3	42.53	12.26	1,561	2,382
Total Geese	311.0	1,183.5	25.18	7.26	371	1,410
Goose (nonspecified)	--	--	--	--	--	--
Brant	144.0	432.0	9.19	2.65	172	515
Whitefronted	--	--	--	--	--	--
Snow	16.0	72.0	1.53	0.44	19	86
Canada	151.0	679.5	14.46	4.17	180	810
Total Eiders	88.0	132.0	2.81	0.81	105	157
Eiders (nonspecified)	88.0	132.0	2.81	0.81	105	157
Common	--	--	--	--	--	--
King	--	--	--	--	--	--
Spectacled	--	--	--	--	--	--
Oldsquaw	54.0	81.0	1.72	0.49	64	96
Ptarmigan	849.0	594.3	12.64	3.65	1,012	708

Source: ADF&G, Community Profile Database, 1993a.

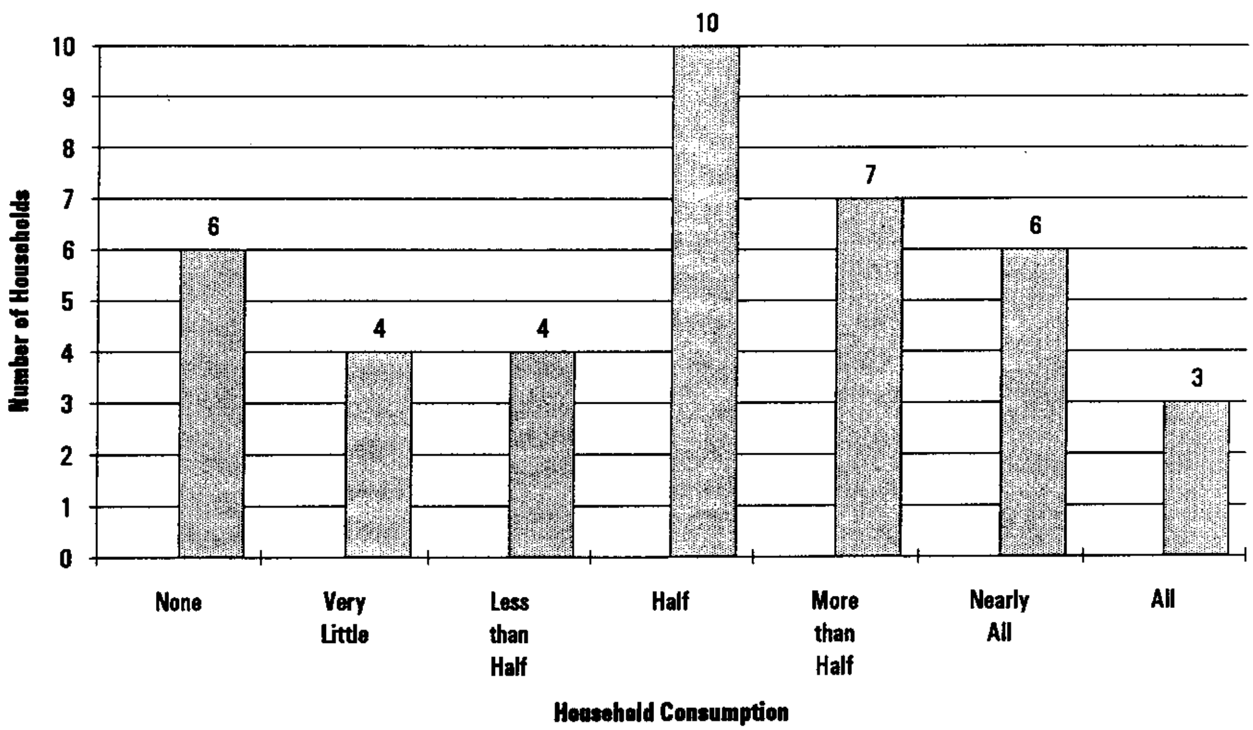
[1] Number of households in the sample = 47; number of households in the community = 56.

Table III.C.3-22
Kaktovik 1992 Subsistence-Harvest Estimates for Birds[1]

	Total Number Harvested	Edible Pounds Harvested			Estimated Community Totals	
		Total	Household Harvest Mean	Per capita	Number Harvested	Pounds Harvested
Total Birds	1,739.87	3,240.21	51.43	16.79	--	--
Total Geese	600.51	2,135.30	33.89	11.06	--	--
Goose (nonspecified)	--	--	--	--	--	--
Brant	378.00	1,134.00	18.00	5.88	--	--
Whitefronted	49.60	223.18	3.54	1.16	--	--
Snow	9.38	42.22	0.67	0.22	--	--
Canada	163.53	735.89	11.68	3.81	--	--
Total Eiders	247.98	371.97	5.90	1.93	--	--
Eiders (nonspecified)	--	--	--	--	--	--
Common	109.91	164.87	2.62	0.85	--	--
King	138.06	207.10	3.29	1.07	--	--
Spectacled	--	--	--	--	--	--
Oldsquaw	105.89	158.84	2.52	0.82	--	--
Ptarmigan	769.40	538.58	8.55	2.79	--	--

Source: ADF&G, Community Profile Database, 1993b.

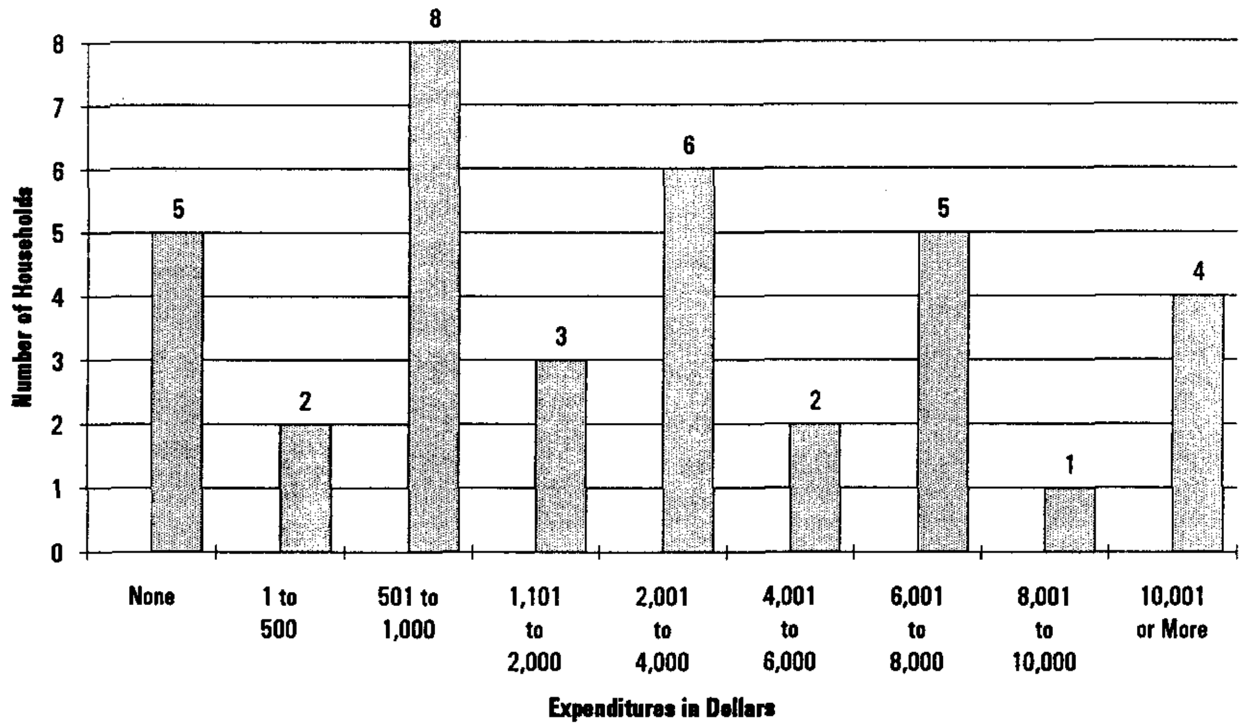
[1] Number of households in the sample = 47; number of households in the community = 63.



Source: Harcharek, 1995.

Figure III.C.3-18. Kaktovik Household Consumption of Meat, Fish, and Birds from Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.



Source: Harcharek, 1995.

Figure III.C.3-19. Kaktovik Household Expenditures on Subsistence Activities.[1]

[1] These results include only those households that participated in the census survey.

A review of the Alaska Heritage Resources Survey (AHRS) site files indicates that 18 sites with prehistoric components have been recorded in the Beaufort Sea Planning Area. They are comprised of habitation sites, lithic scatters, and isolated finds. Paleontological sites have also been recorded. These sites are located onshore (Dale, 1995, pers. comm.).

The potential for submerged prehistoric sites in the Sale 144 area was determined by an evaluation of the geophysical/geological and archaeological data available. This analysis was prepared to aid in the identification of lease blocks with prehistoric-site potential. The geologic processes that have acted on the ocean floor of the sale area are summarized with regard to the distribution, survivability, and detectability of potential archaeological resources sites. The Sale 144 area includes lease blocks that previously were offered in the following Beaufort Sea lease sales: the Joint Federal/State Beaufort Sale, Diapir Field Sale 71, Sale 87, Sale 97, and Sale 124.

Archaeological analyses were prepared for previous Beaufort Sea lease sales and are cited by reference in this report. The Sale 144 geologic report incorporates the previous work of Friedman and Schneider (USDOI, MMS, 1987) concerning the geomorphological processes pertaining to the survivability of potential prehistoric resource sites in the sale area and is updated with current reports, surveys, and information pertinent to this analysis. The analysis prepared by Friedman and Schneider (USDOI, MMS, 1987) recommended that all blocks in the Beaufort Sea sale area be exempted from prehistoric resource requirements. Those conclusions are retained in this present report.

(1) Review of the Baseline Study: There have been no new regional archaeological resource baseline studies prepared for the Beaufort Sea sale area. The analyses that Friedman and Schneider prepared for Sales 87 and 97, and which were referenced in the Sale 124 EIS, is the most current baseline study prepared for the Beaufort Sea sale area (USDOI, MMS, 1987).

(2) Review of Existing Geologic Reports: The OCS Report MMS 85-0111, Geologic Report for the Beaufort Sea Planning Area (Craig, Sherwood, and Johnson, 1985); OCS Report MMS 91-0076, Correlation Study of Selected Exploration Wells from the North Slope and Beaufort Sea, Alaska (Scherr, Banet, and Bascle, 1991); and MMS Report Geological, Geochemical, and Operational Summary, Aurora Well OCS Y-0943-1, Beaufort Sea, Alaska (Paul et al., 1994) were reviewed as the most recent applicable reports on the geology of the proposed Beaufort Sea sale area. Also reviewed was "Origin of Gravels from the Southern Coast and Continental Shelf of Beaufort Sea, Arctic Alaska" (Naidu and Mowatt, 1992). The sources in the Archaeological Analysis appendices for the Sales 87, 97, and 124 Final Environmental Impact Statements are cited by reference.

(3) Review of Sea-Level History: The Friedman and Schneider analysis for Sales 87 and 97 used -125 m as the maximum sea-level recession during the late Wisconsin. The Sale 124 analysis cites Hopkins, 1982, and uses a maximum sea-level lowering of -90 m for a minimum on the sea-level curve. The -90-m value was identified with the maximum glacial sea-level lowering approximately 18,000 years ago and is considered the earliest date for the arrival of people in the Arctic. Blocks in water deeper than the -90-m isobath would not have archaeological resource potential and have been removed from further consideration in this report.

(4) Review of Geological/Geophysical Data to Determine Survivability and Detectability of Archaeological Resource Sites: The analysis of the available high-resolution geophysical data collected in support of exploratory activities in the Beaufort Sea sale area supports the findings of Friedman and Schneider (USDOI, MMS, 1987). A review of these reports and data provides additional validation to the discussion of erosional processes such as ice gouging, shoal migration, and sediment transport, as described in the baseline study.

The recent exposure of archaeological sites along the Beaufort Sea coast provides additional documentation to the destructive processes prevalent in arctic environments (Mason, Gerlach, and Ludwig, 1991). Because the Beaufort Shelf is a gently sloping, stable platform with relatively little relief out to the shelf edge at approxi- mately the -200-m isobath, it is postulated that forces actively eroding the coastal environment have been active on the shelf during previous transgressions. Many of the onshore sites recorded are currently eroding.

Processes such as thermokarst collapse and thermal erosion, which are maximized by storm surges during the summer and fall open-water seasons, have caused rapid coastline erosion. These coastline sediments are acted upon by a number of destructive processes that disrupt and redeposit them across the shallow Beaufort shelf. The nearshore, shallow-shelf environment is subject to lateral current-transport of fine-grain sediment which, in conjunction with processes unique to the Arctic like frazil and anchor ice that entrain sediments, transport and redistribute near-surface sediments across the shelf. Seafloor features, such as strudel scour, provide evidence of the dynamic nature of the current forces in this shallow-shelf environment. Additionally, the landward migration of shoals along the coast rework and redeposit shelf sediments. Sediments deposited across the shelf are reworked to varying depths and degrees of magnitude by ice gouging, as documented in the baseline study, and observed in high-resolution geophysical data.

In summary, the interaction of these geologic processes across the shelf precludes the survival of any prehistoric site within the sale area.

b. Historic Resources: Historic resources pertain "to the period of time for which written history exists" (MMS Manual 620.1-H). They would include, but not be limited to, shipwrecks. A review of the AHRS site files indicates that 95 sites with historic components have been recorded in the planning area. They are comprised of habitation, DEW station/research, cemetery, military debris, camp, hunting, reindeer herding, trapping, ice cellar, and lookout- tower site types (Dale, 1995, pers. comm.). These sites are located onshore.

A review of the MMS computerized shipwreck list (a literature search) for the Beaufort Sea Planning Area shows 14 known shipwrecks in the Sale 144 area (Burwell, 1995, pers. comm.; Tornfelt and Burwell, 1992). Of these, 11 were ships involved in whaling and 3 were involved in trading. Table III.C.4 shows the date wrecked, name, tonnage, type of ship, and reported wrecked location of these ships.

The final distribution of a shipwreck on the seafloor is governed by factors such as sediment depth and composition, sea currents, water depth, size and type of ship, and geologic processes. To date, no surveys have been made to locate these wrecks, and the information on their location is insufficient to assign them to specific lease blocks.

Rates of sedimentation sufficient enough to bury shipwrecks within recent history have not been identified for the Sale 144 area. Therefore, any surviving shipwrecks still would be exposed on the seafloor and capable of detection by sidescan sonar and other geophysical instruments during a site-specific geohazard survey. Because the locational information on the 14 known shipwrecks within the 144 sale area is insufficient to assign them to specific lease blocks, the geohazards-survey data from all lease blocks will need to be reviewed for evidence of shipwrecks prior to approving lease activities.

5. Land Use Plans and Coastal Management Programs:

a. Land Status and Use: Most land in the NSB is held by a few major landowners. The predominant landowner within the NSB is the Federal Government. Of the approximately 20 million ha in the region north of 68° N. latitude, over one-half is contained in the NPR-A and ANWR. Other major land-holders include the State of Alaska (1.4 million ha) and the eight Native village corporations and the Arctic Slope Regional Corporation (1.9 million ha). Complexity in land-ownership patterns is a result of the ANCSA provisions that only surface-estate rights are to be conveyed to Native village corporations; subsurface-estate rights can be conveyed to Native regional corporations. Moreover, in selected Federal holdings, such as ANWR and NPR-A, selection was restricted to surface estate for village corporations. The subsurface estate was reserved for the Federal Government; ASRC was required to select its subsurface estate outside these boundaries.

Major land uses on the North Slope are divided between traditional subsistence uses of the land and hydrocarbon-development operations. The traditional settlement patterns and subsistence uses of land are discussed in Section III.C.3. The extent and location of hydrocarbon exploration and development and production operations on the North Slope and offshore areas are discussed in the description of projects included for the cumulative case, Section IV.A.6.

Table III.C.4
Shipwrecks in the Proposed Sale 144 Area

Date Wrecked	Name	Tons	Type	Location
1851	**Bramin**	245	whaling ship	Arctic Ocean. Location Unknown.
1851	**Houqua**	339	whaling ship	Arctic Ocean. Location Unknown.
1851	**Mary Mitchell**	354	whaling ship	Beaufort Sea. Location Unknown.
1851	**Mexican**	226	whaling ship	Arctic Ocean. Location Unknown.
1857	**Indian Chief**	401	whaling ship	Arctic Ocean. Location Unknown.
1868	**Emeline**	?	whaling schooner	Arctic Ocean. Location Unknown.
1877	**Java**	309	whaling bark	Arctic Ocean. Location Unknown
1885	**Rainier**	52	bark	Arctic Ocean. Location Unknown.
1888	**Young Phoenix**	355	whaling bark	30 mi East of Point Barrow.
1889	**James A. Hamilton**	74	whaling schooner	Arctic Ocean. Location Unknown.
1894	**Reindeer**	340	whaling bark	Return Reef, Midway Islands.
1913	**Elvira**	109	gas schooner	Off Humphrey Point.
1925	**Duxbury**	28	gas trading schooner	Northeast of Cape Halkett.
1931	**Baychimo**	1,322	trading steamer	Arctic Ocean. Location Unknown. Reappeared on several occasions and was considered a ghost ship.

b. Land Use Planning Documents: Documents addressing land use in the NSB include the ANWR Report and Recommendation to Congress, the NSB Comprehensive Plan and Land Management Regulations, and the NSB Coastal Management Program (CMP). The NSB CMP and the Statewide Standards of the Alaska Coastal Management Program (ACMP) are described in the following section. This section describes the ANWR recommendation and summarizes and incorporates by reference the descriptions of the Comprehensive Plan and Land Management Regulations that are in Section III.D.3.c of the Beaufort Sea Sale 87 FEIS (USDOI, MMS, 1984), Section III.D.3 of the Beaufort Sea Sale 97 FEIS (USDOI, MMS, 1987a), and Section III.C.5 of the Beaufort Sea Sale 124 FEIS (USDOI, MMS, 1990).

(1) Arctic National Wildlife Refuge: The FWS, in cooperation with the U.S. Geological Survey and the Bureau of Land Management, prepared a resource assessment and legislative EIS to provide Congress with a recommendation on future management of the coastal plain. The report analyzed five management alternatives ranging from opening the entire coastal plain for leasing for oil and gas development to designating the entire area a wilderness. The alternative recommended to Congress by the Secretary of the Interior as preferred was that which opened the entire coastal plain to oil and gas leasing.

Congressional action is necessary before any of the area can be leased for oil and gas exploration and development. Several bills have been introduced into Congress to authorize such development; however, passage of a bill authorizing activity on the coastal plain is not expected during the 104th session of Congress.

(2) NSB Comprehensive Plan and Land Management Regulations: The North Slope Borough Comprehensive Plan and Land Management Regulations (LMR's) were adopted initially in December 1982. The LMR's were revised on April 12, 1990. The following description is based on the new regulations. The revisions simplified the regulatory process but did not alter the basic premise of the comprehensive plan—to preserve and protect the land and water habitat essential to subsistence living and the Inupiat character of life.

The new LMR's have five zoning districts—Village, Barrow, Conservation, Resource Development, and Transportation Corridor. All areas within the Borough are in the Conservation District unless specifically designated as within the limited boundaries of the villages or Barrow, as a unitized oil field within the Resource Development District, or along the Trans-Alaska Pipeline corridor within the Transportation Corridor. Therefore, new large scale development most likely would occur within the Conservation District. In that event, a Master Plan for the development must be submitted to the NSB and adopted by the NSB Assembly as an amendment to the Comprehensive Plan, and the land must be rezoned from Conservation District to Resource Development District. During the process for rezoning for the Endicott development, several stipulations were attached to the Master Plan to mitigate adverse effects and to encourage beneficial effects.

In the new regulations, uses are no longer categorized as (1) uses-by-right, (2) prohibited uses, and (3) conditional uses (those that were neither prohibited nor allowed by "right"). Rather, the process identifies (1) uses that can be administratively approved without public review, (2) uses that require a development permit and must have public review before they can be administratively approved, and (3) uses that are considered conditional development that must be approved by the Planning Commission.

Policy revisions in the LMR's incorporated the NSB Coastal Management Policies and supplemented these with several additional policy categories—Village Policies, Economic Development Policies, Offshore Development Policies, and Transportation Corridor Policies. Offshore policies are specifically limited to development and uses in the portion of the Beaufort Sea that is within the NSB boundary. All the policies address offshore drilling.

An automated Geographic Information System (GIS) is integrated into the NSB land use program. At a scale of 1:250,000, the GIS provides information on surface hydrology; political and administrative units; infrastructure; settlements and special features; energy and mineral resources; elevation provinces; historical and archaeological sites; NSB planning maps; regional subsistence-land use; and a composite of vegetation, soils, geology, slope, and land use features (called integrated terrain units [ITU's]). Limited areas, such as the Prudhoe Bay Unit, Endicott Unit, and portions of the Kuparuk Unit, are mapped at the 1:63,360 scale. Information on these areas includes ITU's, surface hydrology, infrastructure, political and administrative units, and habitats (adapted from the NSB planning maps). Data for the Dalton Highway corridor are mapped at the scale of 1:63,360 and are restricted to manmade changes along the corridor.

c. Coastal Management: The Federal Coastal Zone Management Act (CZMA) and the Alaska Coastal Management Act (ACMA) were enacted in 1972 and 1977, respectively. Through these acts, development and land use in coastal areas are managed to provide a balance between the use of coastal areas and the protection of valuable coastal resources. The provisions and policies of both the Federal and State CMP's are described in MMS Reference Paper 83-1 (McCrea, 1983), which is summarized in the following paragraphs and incorporated by reference in this EIS. Statewide standards of the ACMP may be refined through local coastal programs prepared by coastal districts. Coastal districts are encouraged to prepare local CMP's to supplement the Statewide standards in their district. District programs must be approved by the Alaska Coastal Policy Council and the Secretary of the U.S. Department of Commerce through the Office of Ocean and Coastal Resource Management (OCRM) before they are fully incorporated into the ACMP. The NSB is the only coastal district in proximity to the sale area; its CMP has been fully incorporated into the ACMP. A description of the NSB CMP follows that of the Statewide standards of the ACMP.

(1) Statewide Coastal Management Standards: The ACMP, as initially approved by OCRM, includes the ACMA, guidelines and standards developed by the CPC, a series of maps depicting the interim boundaries of the State coastal zone, and an EIS prepared by OCRM. The Statewide standards that may be relevant to activities hypothesized in this EIS are summarized in the following paragraphs under three headings: coastal habitats, coastal resources, and uses and activities.

(a) 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 (6 Alaska Administrative Code [AAC] 80.130[b] and [c]).

Activities and uses that do not conform to the standards may be permitted if there is a significant public need, no feasible prudent alternatives to meet that need, and all feasible and prudent mitigation measures are incorporated to maximize conformance. Habitat policies frequently are cited in State consistency reviews.

(b) 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 ACMP 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 (6 AAC 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" (6 AAC 80.150).

(c) Uses and Activities: Nine 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, energy-facility siting, transportation and utilities, and subsistence.

Both the Federal CZMA and the ACMP require that uses of State and Federal concern be addressed (CZMA Sec. 303[2][C], AS 46.40.060, and AS 46.40.070). The ACMA further stipulates that local districts may not arbitrarily or unreasonably restrict or exclude such uses in their CMP's. Among the uses of State concern is the siting of major energy facilities.

(2) NSB District CMP: 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 OCRM in May 1988. The coastal management boundary adopted for the NSB CMP 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-km 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 NSB CMP contains four categories of policies: (1) standards for development, (2) required features for applicable development, (3) best-efforts policies that include both allowable developments and required features, and (4) minimization-of-negative-impacts policies.

Standards for development prohibit severe harm to subsistence resources or activities or disturb cultural and historic sites. Required features 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 (1) there is "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."

Best-efforts policies allow development if all feasible and prudent steps are taken "to avoid the adverse impacts the policy was intended to prevent." Policies in this category address developments that could cause significantly decreased productivity of subsistence resources or ecosystems, displace belukha whales in Kasegaluk Lagoon, or 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.

Best-efforts policies also address features that are required by "applicable development except where the development has met the [two criteria identified above] 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.

Two "areas meriting special attention" (AMSA's) were identified in the CMP—Point Thomson and Kasegaluk Lagoon. Upon further examination, Point Thomson was dropped and the Colville River Delta was added. Planning for the Kasegaluk Lagoon AMSA and the Colville River Delta AMSA is proceeding.

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.

SECTION IV

ENVIRONMENTAL CONSEQUENCES

IV. ENVIRONMENTAL CONSEQUENCES

A. BASIC ASSUMPTIONS FOR EFFECTS ASSESSMENT:

In this EIS, the proposed action and the alternatives are analyzed on the basis of a field-development time profile called a scenario. The MMS traditionally bases the environmental impact statement (EIS) scenarios on both geologic possibilities and on what is expected to be leased, discovered, developed, and produced in the sale area under consideration. The location of any oil deposits is purely hypothetical until oil is proven to be there by drilling (Appendix A). The assumed location of these geologic possibilities is a key factor in the proposed scenario. The scenario forms the basis for the analysis of the anticipated effects. This subsection details the scientific, economic, geologic, and other assumptions upon which the exploration and development scenarios in this EIS are based.

1. Alternative I - The Proposal, Base Case - Basic Exploration, Development and Production, and Transportation Assumptions:

a. Description of the Proposal:

Alternative I (the proposed action) would offer for lease those parts of the Beaufort Sea Planning Area identified in Figure II.A.1. The Alternative I area consists of 1,879 whole and partial blocks encompassing approximately 4 million hectares (ha) (9.8 million acres). The area of the proposed action is located between about 5 and 120 kilometers (km) (3-75 miles [mi]) offshore in water depths that range up to 1,000 meters (m) (3,300 feet [ft]).

In addition to Alternative I, two other alternatives are recommended for consideration in the Sale 144 EIS: Alternative II, No Sale (Sec. IV.C), Alternative III, the Barter Island Deferral (Sec. IV.D), and Alternative IV, the Nuiqsut Deferral (Sec. IV.E).

b. Activities Associated with Alternative I - The Proposal, Base-Case Activities:

(1) Resource Estimates and Basic Exploration, Development and Production, and Transportation Assumptions for Effects Assessment:

(a) Assumed Base-Case Resources:

The environmental analysis in this section is framed by what is termed a base-case midpoint estimate. In this instance, the Minerals Management Service (MMS) assumes 1.2 billion barrels (Bbbl) of oil may be found within the boundaries of Alternative I. The 1.2-Bbbl estimate is a mid-point estimate of the range of base-case resources found in Section II.A. In Section II, it is explained that the resources of the proposal may range from a base-case low of 300 million barrels (MMbbl) to a base-case high of 2.1 Bbbl. In order to focus the environmental analyses in Section II so that understandable and finite conclusions could be presented, the resource level used for the analyses is a representative midpoint between the two base-case-resource extremes. Table IV.A.1-1 displays the levels of infrastructure and resources that have been assumed for the analyses of the effects of the proposed action. Although the development of natural gas resources is not considered economic for proposed Sale 144, the effects of any theoretical natural gas development and production are discussed in Section IV.K.

(b) Timing of Activities:

The level of activities and the timing of events associated with the base case for Alternative I are shown in Table IV.A.1-1. Exploratory drilling is expected to begin in 1997 and continue through 2001. During these years, a total of 22 exploration and delineation wells would be drilled, with a maximum of two drilling rigs operable in any one exploratory year. Eight production platforms are expected to be installed between 2001 and 2006, while pipeline laying is expected to begin in 2003 and conclude in 2006. Drilling of production and service wells is expected to begin in 2001 and continue through 2009, with a total of 273 wells drilled. Production is expected to begin in 2004 and continue through 2027. These calculations are based on a 45-day open-water season. In the Beaufort Sea, this season generally ranges from mid-August to early October.

Table IV.A.I-1
Summary of Basic Exploration, Development and Production, and Transportation Assumptions for Alternatives I, III and IV
Beaufort Sea Sale 144—Exploration
(Page 1 of 3)

PHASE Activity/Event	Alternative I						Alternative III[1]		Alternative IV	
	Low Case		Base Case		High Case					
	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframes
EXPLORATION										
Well Drilling		1997-2002		1997-2004		1997-2009		A[1]		A
Exploration Wells	4		8		24		A	A	5	A
Delineation Wells	2		14		41		A	A	9	A
Drilling Discharges										
Drilling Muds[2] (Short Tons)	3,780		13,860		42,210		A	A	8,593	A
Cuttings[2] (Short Tons)	4,920		18,040		54,940		A	A	11,185	A
Support Activities										
Helicopter Flights[3]	540		1,980		6,130		A		915	
Supply-Boat Trips[4]	48		110		277		A		68	
Shallow-Hazards Site Surveys										
Total Area Covered[5] (km^2)	138		507		1495		A		314	

Table IV.A.l-1
Summary of Basic Exploration, Development and Production, and Transportation Assumptions for Alternatives I, III and IV
Beaufort Sea Sale 144—Development and Production
(Page 2 of 3)

PHASE Activity/Event	Alternative I						Alternative III[1]		Alternative IV	
	Low Case		Base Case		High Case					
	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe
DEVELOPMENT AND PRODUCTION										
Number of Platforms			8		25		A		5	
Installation				2001-2006		2001-2010		A		A
Production- and Service-Well Drilling										
Number of Wells			273	2001-2009	850	2001-2012	A	A	158	A
Production										
Total (MMbbl)			1200	2004-2027	3900	2005-2030	A	A	720	A
Peak Yearly (MMbbl)			101	2008-2009	315	2012	A	A	63	A
Monthly Support Activities										
Helicopter Flights/Month[7]			64-334		150-456		A		38-200	
Supply-Boat Trips/Month[8]			See Footnote		See Footnote		A		See Footnote	
Drilling Discharges										
Drilling Muds[9] (Short tons)			40,950-185,640		127,500-578,000		A		26,208-118,810	
Cuttings[9] (Short tons)			322,140		1.0 mil		A		206,170	
Shallow-Hazards Surveys										
Total Area Covered[10] (km^2)			736		2300		A		456	
Total Days Required[11]			56		175		A		35	

Table IV.A.1-1
Summary of Basic Exploration, Development and Production, and Transportation Assumptions for Alternatives I, III and IV
Beaufort Sea Sale 144—Transportation
(Page 3 of 3)

PHASE Activity/Event	Alternative I						Alternative III[1]		Alternative IV	
	Low Case		Base Case		High Case					
	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe	Assumed Number or Value	Timeframe
TRANPORTATION										
Oil Pipelines										
Installation										
Offshore Length (km)			128		225		A	A	105	A
Onshore Length (km)			168	2003-2006	345	2004-2009	A	A	152	A
OIL SPILLS	See Table IV.A.2-2									

Source: Appendix A of this EIS.

1 The number, assumed value, or timeframe is assumed to be similar to that for Alternative I (base case).
2 Amounts are based on each exploration and delineation well using 630 tons (dry weight) of drilling muds and producing 820 tons (dry weight) of cuttings.
3 The number of helicopter flights is based on the assumption that there will be one flight per day per well; drilling of an exploration or delineation well is estimated to take 3 months.
4 The number of supply-boat trips is based on the assumption that there will be 1 trip per drill unit per week; drilling of an exploration or delineation well is estimated to take 3 months. Support-boat trips would be for offshore bottom-founded rigs only.
5 MMS's site-clearance seismic-survey requirements specify a minimum area of 23 km^2 (about 8.9 mi^2—an area that is about equal to one full OCS lease block) for a site-specific survey.
6 The time required to complete a site-clearance survey is estimated to be 2 days.
7 The number of helicopter flights is based on the assumption that after the conclusion of development drilling, there will be two flights per week per platform. During development drilling, the assumption is there will be one flight per drilling unit (rig) for each day of drilling.
8 For the production phase, it is assumed that platforms will resupplied by barge and that support/supply boats will be on standby for special or emergency use.
9 Amounts are based on each production or service well using between 150 and 680 tons (dry weight) of drilling muds and producing 1,800 tons (dry weight) of cuttings.
10 MMS's site-clearance seismic-survey requirements specify a minimum area of 92 km^2 (about 35.5 mi^2) for a blockwide survey.
11 The time required to complete a site-clearance survey is estimated to be 7 days.

(2) Activities Associated with Exploration Drilling:

(a) Seismic Activity: In support of the proposed exploration and production activities, the lessee/operator is required to conduct surveys of sufficient detail to define shallow hazards or the absence thereof; these surveys should incorporate seismic profiling. The projected level of seismic activity is based on the nature and extent of the surveys that may be required (NTL 89-2, Minimum Requirements, Shallow Hazards Survey) and the predicted number of wells that may be drilled. Surveys of the exploration- and delineation-well sites would be conducted during the ice-free seasons of the years of the exploratory phase. For this EIS, it is assumed that each of the 22 exploration and delineation wells would be covered by site-specific surveys. These surveys would cover an approximate area of 23 square kilometers (km^2) (8.9 mi^2) of data for each well; the total area covered by seismic surveys could equal 507 km^2 (196 mi^2). These surveys usually are conducted 1 year prior to drilling and would have to be conducted within the Arctic's brief open-water season. The average time needed to survey each site should range between 2 and 5 days, allowing for downtime for bad weather and equipment failure. It should be noted that NTL 89-2 allows some flexibility for waiving the seismic requirement if sufficient data are available that can "determine the presence or absence of sea floor and subsurface geological and man made hazards."

(b) Exploration Drilling: For the base case, the 8 exploration and 14 delineation wells are expected to be drilled between the years 1997 and 2001. Because of the short open-water drilling season in the Beaufort, it is likely that only one drilling rig will be used at a drilling site in any one year and that only one well will be drilled from that rig. In the event of a discovery, however, delineation wells are assumed to be drilled by the same exploration rig immediately afterwards. In such an event, two wells could drilled from a rig in a single drilling season. The type of units that may be used in exploration drilling will depend on the following: water depth, sea-ice conditions, ice-resistant capabilities of the units, and availability of drilling units. In the Beaufort Sea, most depths within the sale area range up to 1,000 m (3,300 ft). However, most of the sale area (in excess of 75%) is at ≤50 m (≤165 ft); approximately ≤25 percent of the proposed sale area lies <20 m (65 ft) below sea level. Artificial ice islands are likely to be employed as drilling platforms in shallow water, nearshore areas (<15 m [50 ft]). Construction and resupply operations for ice-island drilling platforms would be supported by ice roads. Bottom-founded platforms of various designs are most likely to be used to drill prospects farther offshore in water depths of 10 to 25 m (approximately 35-80 ft); and because of mobile ice conditions, these operations would be supported by supply boats during the open-water season. For water depths greater than (>)25 m (80 ft), floating drill rigs (drillships or floating concrete platforms) would be employed to drill exploration wells in open-water or broken-ice conditions. These far-offshore operations would be supported by icebreaker support/supply ships.

For the purposes of analysis, it is assumed that one-third of the exploration platforms (5) will be emplaced in nearshore waters and two-thirds (9) will be located in water depths between 10 and 25 m (approximately 35-80 ft). It is further assumed that in the former case, the exploration platforms used will be ice islands and that in the latter case the platform used will be a bottomfounded structure. A dredge would prepare the pad on which the bottom-founded structure would rest.

It is unlikely that gravel islands will be constructed for nearshore exploratory-drilling operations. However, if a gravel island were selected as a platform type from which to drill an exploratory well, construction is expected to take place during the winter. Gravel used to construct the island would be hauled over ice roads from onshore sources. If constructed, gravel islands would most likely be located east of Cape Halkett because of an apparent shortage of onshore gravel west of the Colville River (Schlegel and Mahmood, 1985). An island constructed in 15 m (50 ft) of water would require 645,000 m^3 (844,000 cubic yards [yd^3]) of fill material; it would have a surface diameter of about 122 m (400 ft), freeboard of 6 m (20 ft), side slopes of 1:3, and a base diameter of 248 m (815 ft). The area of the base would be about 48,300 m^2 (520,000 ft^2).

Drilling of each exploratory or delineation well would require the disposal of about 630 short tons of drilling muds and produce approximately 820 short tons of drill cuttings. These are dry-weight figures. The total amount of muds and cuttings estimated to be disposed of for all exploration and delineation wells is expected to be 13,860 short tons of drilling muds. The total amount of bore cuttings produced is expected to reach 18,040 short tons. Again, these are dry-weight figures. These materials would be disposed of primarily at the drill site under conditions prescribed by the U.S. Environmental Protection Agency's (USEPA's) National Pollution Discharge

Elimination System (NPDES) (Rathbun, 1986; Clean Water Act of 1977, as amended [33 U.S.C. 1251 et seq.). Exploration and development wells would average between 1,525 and 4,570 m (5,000-15,000 ft) in depth.

Support and Logistic Activities: Offshore exploration-drilling operations in the Sale 144 area would require onshore support facilities. Where possible, existing facilities within the Prudhoe Bay or Kuparuk unit areas would be used or upgraded. These onshore facilities would have to provide (1) a staging area for construction equipment, drilling equipment, and supplies; (2) a transfer point for drilling and construction personnel; (3) a harbor to serve as a base for vessels required to support offshore operations; and (4) an airfield for fixed-wing aircraft and helicopters.

Also, existing systems would be used to transport equipment, material, supplies, and personnel. The description of North Slope Transportation Systems as contained in Section III.D.2 of the Sale 87 Final EIS (FEIS) (USDOI, MMS, 1984) is incorporated by reference and updated where appropriate; a summary of this description follows.

The North Slope Borough (NSB) is linked to interior Alaska by the Dalton Highway. The Annual Average Daily Vehicle Traffic (AADT) vehicle counts on the Dalton Highway vary from 200 at the Yukon River bridge to approximately 100 at the Atigun River (State of Alaska, 1994). In the past few years, vehicle counts at the Atigun checkpoint (situated in the foothills of the Brooks Range near the beginnings of the coastal plane) have been at or below 100 AADT—well below the estimated capacity of 175 to 550 AADT. The AADT levels for the Dalton Highway have remained stable over the last several years. However, with the opening of the highway to noncommercial traffic, tourist-related traffic is expected to occupy an increasing percentage of Dalton Highway traffic. On the North Slope, regional surface transportation is accomplished via gravel roads within and between unitized oil fields and through an extensive system of trails, river drainages, and ice roads.

Barges transport most heavy and bulky cargo associated with petroleum-related activities in the NSB (NSB, 1989). Prudhoe Bay has three barge docks—one at the east dock and two at the west dock. Oliktok dock was constructed in 1982 to expedite shipping to Kuparuk Field. Barge traffic in support of continued development on the North Slope of Alaska typically has ranged from 10 to 15 barges per year. During the initial development of the Prudhoe Bay Unit in 1970, 48 barges were used. With the new generation of barges, an equivalent tonnage could be shipped on 32 barges (Louis Berger and Associates, 1984).

Air transportation is the primary means of travel into the NSB. All public airstrips, except those at Barrow and Deadhorse, are gravel. The NSB has been continuously upgrading local roads and airports.

The principal transportation mode for routine supplies and materials to be transported to ice islands and/or nearshore gravel islands is expected to be ice roads. For drilling platforms farther offshore in the broken-ice zone, material and supplies would be transported via support/supply boats (with icebreaking capacity if necessary) during the open-water season and by helicopter at all other times. For both types of drilling structures, personnel would be moved by helicopters, which would be certified for instrument flight. The number of helicopter trips flown in support of exploration- and delineation-well drilling is estimated to range from about 90 to 360 each year depending on the number of wells (1-4) that are drilled. This estimate is based on the assumptions that, for each well, there will be one flight per drilling unit for each day of drilling and, as noted previously, the time required to drill and test a well is about 90 days. During the period from 1997 to 2004, the total number of helicopter flights supporting drilling operations is estimated to be 1,980. The estimation of total helicopter flights does not include flights that may be necessary for rig demobilization or emergencies.

The number of required support vessels for each bottom-founded drilling unit will depend, at least in part, on the type and characteristics of the unit and the sea-ice conditions. If there are drilling operations during the open-water season, MMS requires the operator to maintain an emergency-standby vessel within the immediate vicinity of the drilling unit. (Immediate vicinity is defined as being within 8 km (5 mi) or a 20-minute steaming distance of the unit, whichever is less.) The primary reason for this requirement is to ensure emergency evacuation of personnel, but the standby vessel also could assist in the deployment of the oil boom in the event of an oil spill. Depending on ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units. The number of potential drilling units that might be operating during the open-water period could range from one to two.

Also during the open-water season, it is estimated that there will be 1 supply-boat trip per drilling unit per week; for exploration drilling, the total number of supply-boat trips per year is estimated to vary between 0 and 24. The level of support-boat traffic would depend on whether the drilling rigs are on road-supported ice islands or offshore bottom-founded platforms. The total of support-boat traffic estimated to occur between 1997 and 2004, assuming: 90 days is required to drill a well and two-thirds of the platforms require support vessels, is forecast to be approximately 110. The estimation of total support-vessel trips does not include operations that may be necessary for rig demobilization or for emergencies.

(3) Activities Associated with Development and Production: Assumptions associated with development and production strategies are highly speculative. Because of this, the scenario described here is meant to be characteristic of the type of development that could accompany production. Under this scenario, work on offshore and onshore production and transportation facilities would not begin until the engineering and economic assessments of the potential reservoirs had been completed and the conditions of all the permits had been evaluated. As shown in Table IV.A.1-1, the first delineation well is projected to be drilled in 1997, with production beginning by at least 2004. Production is assumed to peak approximately between 2008 and 2009 and cease in 2027.

(a) Seismic Activity: A three-dimensional, multichannel, seismic-reflection survey would be conducted for the production platforms. The survey would cover approximately 670 km^2 (245 mi^2). The platform sites may be surveyed several years prior to the installation of the platform; surveys would be conducted during open-water, ice-free periods. High-resolution seismic-reflection data for shallow hazards would be collected prior to laying the offshore pipeline. The total trackline distance, estimated to be four times the length of the offshore trunk pipelines assumed for the scenario, would equal approximately 515 km (320 mi).

(b) Production Platforms and Production Drilling: If commercial discoveries are made in the Sale 144 area, the hydrocarbons would be produced from platforms installed on the seafloor between 2001 and 2006. Depending on the water depth, seafloor conditions, ice conditions, and size of the reservoir, several types of platforms could be used. In water depths of ≤35 ft, artificial (gravel) and caisson-retained islands may be used as production platforms. Production platforms set in water depths between 11 and 38 m (35-125 ft) are likely to be bottom-founded structures designed for extreme ice conditions. Floating concrete structures anchored to the seafloor are the most feasible design for production facilities in water depths greater then 38 m (125 ft). For the sake of analysis, it is assumed that 3 of the 8 production platforms emplaced will be in nearshore waters (≤11 m), while the other 5 will be located in water depths between 11 and 38 m (35-125 ft).

A variety of steels are 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. These bottom-founded production platforms would be constructed and outfitted in ice-free harbors outside of Alaska. After staging, the platforms would be moved to the production site, where installation would be completed during the open-water season. These production platforms would have to be designed so that installation, which might require the assembly of modular units, could be accomplished within a relatively short time—probably <45 days. In addition to the vessels (8-10 tugs) used to tow the platform components to the site, installation also might require a large-capacity derrick barge and a vessel to accommodate the workers. The artificial and caisson-retained islands that may be used as production platforms would be larger than similar islands used for exploratory drilling. Each platform could employ two rigs to maximize development drilling and shorten startup times.

It is estimated that a total of 273 production and service wells would be drilled from the 8 production platforms between 2001 and 2006. In 2004 and 2005, the field maximum of 11 production drilling rigs would be in operation. The drilling of each production and service well would require 150 to 680 short tons of drilling mud per well (dry weight). This assumes that between 20 and 80 percent of the mud is recycled. Some of the muds used in drilling production and service wells may be recycled through each subsequent well drilled on the platform. Depending on the amount recycled, the amount of disposed drilling muds could range from 40,950 to 185,640 short tons (dry weight) for all wells drilled. Each well also is expected to produce approximately 1,180 short tons of rock cuttings (dry weight), with the total amount of disposed cuttings amounting to about 322,140 short tons (dry weight). The disposal of muds and cuttings would be in accordance with approved USEPA NPDES permits for development-well drilling; muds and cuttings also would be transported to shore and disposed of at approved sites. Production-well depth would average about 3,962 m (13,000 ft).

Support and Logistics Activities: For the purpose of this scenario, it is assumed that the infrastructure at Prudhoe Bay will provide the major support for construction and operation activities associated with the development and production and transportation of crude oil in the Beaufort Sea. The total number of annual helicopter flights to be flown in support of the drilling of production and service wells in the Sale 144 area is estimated to range from 360 in 2001 when 6 wells are drilled, to over 4,000 in 2004 and 2005, when a peak of 54 wells are expected to be drilled. These estimates are based on the assumption that there will be one flight per drilling unit for each day of drilling (maximizing at one flight for each day of the year). From 2009 to 2027, it is estimated the annual number of helicopter flights to production platforms will average about 2 per week per platform, or about 870 flights.

In regard to waterborne support, major resupply of offshore drilling platforms would occur during the open-water season from barges originating outside the sale area. Support/supply vessels would be on standby for specialty or emergency use during the open-water season; however, their use would be sporadic. Production islands emplaced nearshore in shallow waters may be resupplied during winter via ice roads. A significant number of nearshore platforms being supported by ice roads could reduce the number of helicopter flights, particularly during the years of peak drilling activity.

(4) Activities Associated with Oil Transportation:

(a) Pipelines: The installation of offshore pipelines between production platforms and onshore facilities would take 1 to 2 years, considering that route surveying, trenching, and pipeline laying would take place only during the relatively short open-water season. New onshore-pipeline sections would take 2 to 3 years to complete, with construction activities taking place simultaneously with the offshore-pipeline emplacement. Offshore, it is assumed that pipelines would be trenched, in water depths <45 m (<150 ft), as a protective measure against damage by ice keels. For the sake of analysis, it is assumed in the base-case scenario that all offshore pipeline emplaced will be trenched and brought to shore via gravel-filled jetty-like structures, approximately 90 m in length (100 yd) that would protect the pipelines from erosion. At the landfalls, the pipelines would be elevated (stilted) and insulated. Much of the pipeline and shore-facility construction would occur at the same time as offshore-platform installation and development-well drilling. Pipeline construction is expected to begin by 2003, finish by 2006, and result in the laying of 128 km (80 mi) of offshore pipeline and 168 km (105 mi) of onshore pipeline.

For economic and logistical reasons, future offshore developments would attempt to use the existing onshore infrastructure (processing facilities and pipeline networks) whenever possible. Consequently, produced oil would be gathered by existing pipeline systems within the Prudhoe Bay/Kuparuk Field areas and transported to Pump Station #1 of the Trans-Alaska Pipeline System (TAPS). For the base case, we assume landfalls will be made at Oliktok Point (using the Kuparuk Field infrastructure), in the Point McIntyre/West Dock area (using the Prudhoe Bay infrastructure), and at a point about 32 km (20 mi) east of Bullen Point. A summary of estimated new pipeline development as a result of Sale 144 is shown in Table IV.A.1-1. The hypothetical locations of the onshore pipelines are indicated in Figure IV.A-1-1.

(b) Tankers: Crude oil produced from Sale 144 leases would be transported via pipeline to the oil terminal at Valdez, where it would be comingled with crude produced from other North Slope sources. Once at Valdez, the oil would be loaded into tankers for transport primarily to the west coast of the United States, with smaller quantities traveling to the Kenai Peninsula, Hawaii, the Gulf of Mexico, the Far East, or refineries in the Virgin Islands. Tankers loaded with oil produced from the proposed action are assumed to depart Valdez at some point during 2004. Assuming tankers capable of transporting 100,000 deadweight tons of oil, during the first year the proposal would result in 38 loaded tankers. By the peak production years of 2008 and 2009, annual tanker traffic resulting from the proposal would reach 135 to 145 transits. By the year 2016, tanker traffic would decline to some 76 transits annually. Figure IV.A.6-2 shows the general movement patterns of Valdez tanker traffic to the west coast of the U.S. Figure IV.A.6-3 shows probable tanker routes to the Far East.

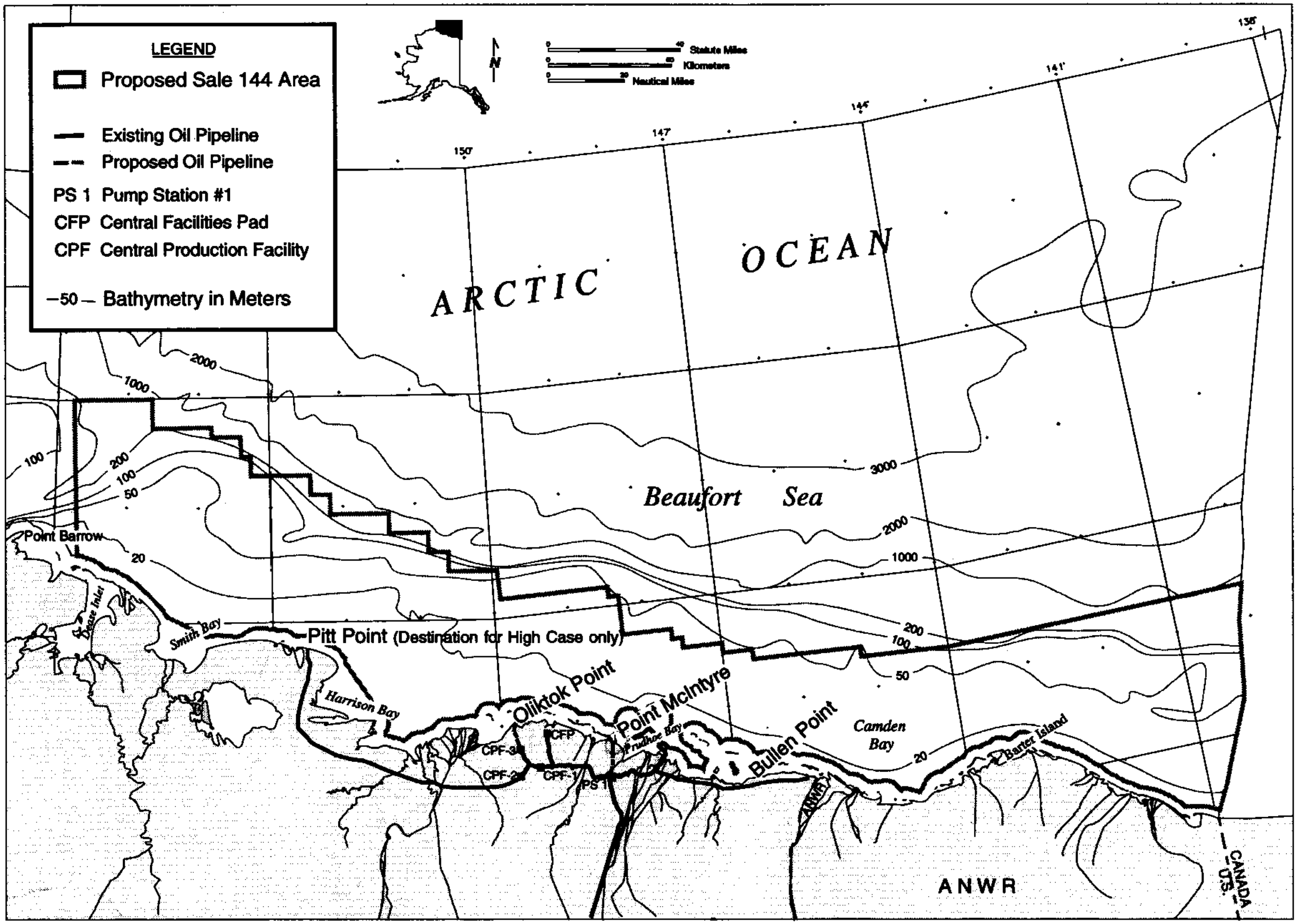


Figure IV.A.1-1. Hypothetical Onshore Oil Transport

2. Oil Spills:

a. Overview and Results of the Oil-Spill-Risk-Analysis (OSRA) Model for Oil Spills Greater Than or Equal to 1,000 Barrels: The MMS OSRA uses historical oil spills and statistical methods to derive a oil-spill rates, the likelihood of oil spills occurring, the estimated mean number of oil spills, and the estimated size of oil spills greater than or equal to (≥) 1,000 bbl from platforms, pipelines, and oil tankers (Anderson and LaBelle, 1988, 1990, 1994; LaBelle, 1990; Lanfear and Amstutz, 1983). Through oil-spill-trajectory modeling, the OSRA also addresses the movement of hypothetical oil spills (trajectories) and the chance of contact to land and boundary segments and environmental resource areas vulnerable to those spills (Anderson et al., 1995; LaBelle and Johnson, 1993; LaBelle and Anderson, 1985; Amstutz and Samuels, 1984; Samuels, LaBelle, and Amstutz, 1982-1983; Smith et al., 1982). The environ- mental resource areas include ice/sea segments, coastal areas, subsistence resource areas, whale feeding areas, and the spring lead system The OSRA-model-trajectory results are appropriate only for spills ≥1,000 bbl, and trajectories are used to estimate contacts over days, not hours; consequently, only those spills that are large (≥1,000 bbl) and can travel long distances or persist for several days are appropriate for the OSRA-trajectory model (Anderson et al., 1995).

Numerous assumptions are made for the purposes of oil-spill-risk analysis. Assumptions used as inputs to the OSRA model include: (1) the total estimated amount of oil produced as a result of exploration, development and production, and transportation from the Sale 144 proposal; (2) assumed locations of the oil assumed to be produced; (3) the assumed production processing and transportation scenarios for the proposal; and (4) land and boundary segments and environmental resource areas.

The OSRA model considers the entire production life (2004-2027, 24 years [Appendix A, Table A-4]) of the Sale 144 proposal and assumes (1) commercial quantities of hydrocarbons are present in the sale area; (2) these hydrocarbons will be developed and produced at the estimated resource levels; and (3) oil spills occur and move without consideration of oil spreading or weathering and without any cleanup.

Uncertainties exist, such as (1) the estimates required for the previously mentioned assumptions; (2) the actual size of the oil spill or spills if they did occur; (3) the wind, current, and ice conditions at the time of a possible oil spill; or (4) whether or not production occurs. // There is an estimated 100-percent chance that geologically recoverable hydrocarbons exist in the Sale 144 area. Offshore discoveries in areas adjacent to the Sale 144 area include Sandpiper, Northstar, Niakuk, Endicott, Hammerhead, and Kuvlum. Also, in areas leased as a result of previous lease sales, the MMS has determined that nine wells would be producible. The OSRA analysis assumes that commercial quantities of hydrocarbons are produced.

For Sale 144, the OSRA-model trajectory-study area is the Beaufort Sea and northern Chukchi Sea region of the Arctic Ocean (Fig. IV.A.2-1). For oil spills ≥1,000 bbl, the Sale 144 OSRA estimates the likelihood of one or more such spills (1) contacting land and boundary segments and environmental resource areas assuming a spill has occurred at a specific location (conditional probabilities); and (2) contacting land boundary segments and environmental resource areas from Sale 144 activities (combined probabilities), (Anderson et al., 1995).

(1) Location of Land and Boundary Segments and Environmental Resource Areas: Within the Sale 144 OSRA-model trajectory-study area, conditional and combined probabilities are calculated for 61 land segments, 38 boundary segments, 17 ice/sea segments, 6 coastal areas, 4 subsistence resource areas, 3 whale feeding areas, and the spring lead system (Table IV.A.2-1). One of the 31 environmental resource areas is all the 61 land segments combined and is designated "land." Land and boundary segments are identified in Figure IV.A.2-2; ice/sea segments in Figure IV.A.2-3; coastal, subsistence resource, and whale feeding areas in Figure IV.A.2-4; and the spring lead system in Figure IV.A.2-5.

(2) Location of Hypothetical Spill Sites: The Sale 144 OSRA-model trajectory-study area is divided into 20 potential oil-resource areas where platforms or pipelines might be located (Fig. IV.A.2-1). Thirteen lines labeled P1 through P13 represent hypothetical pipeline locations (Fig. IV.A.2-6).

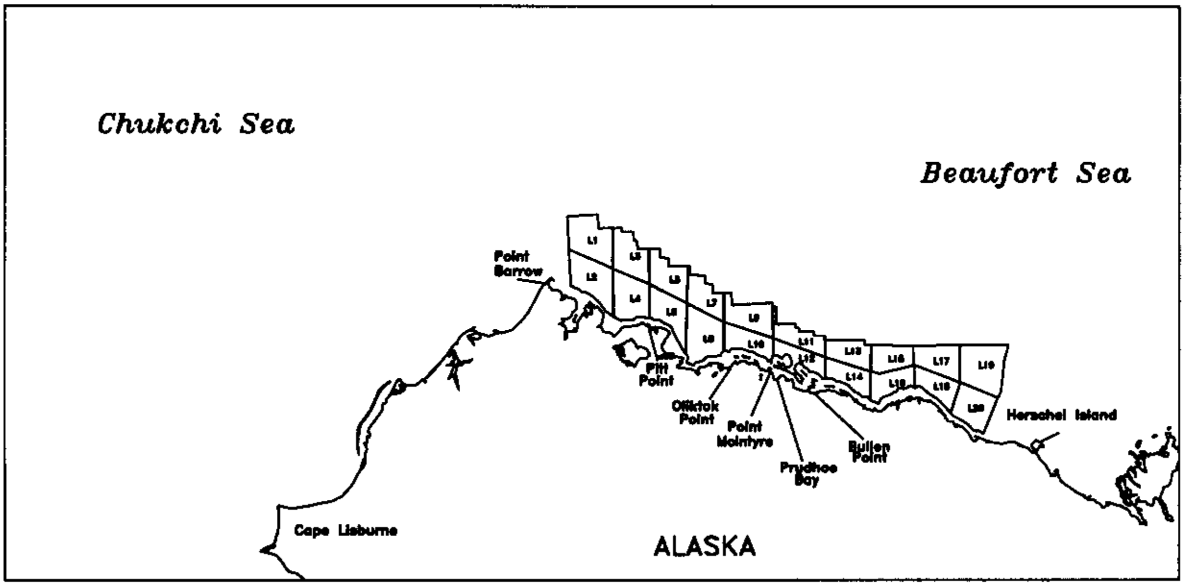


Figure IV.A.2-1. Location of Spill-Trajectory Study Area and 20 Hypothetical Spill Sites Used in the Oil-Spill-Risk Analysis for Sale 144

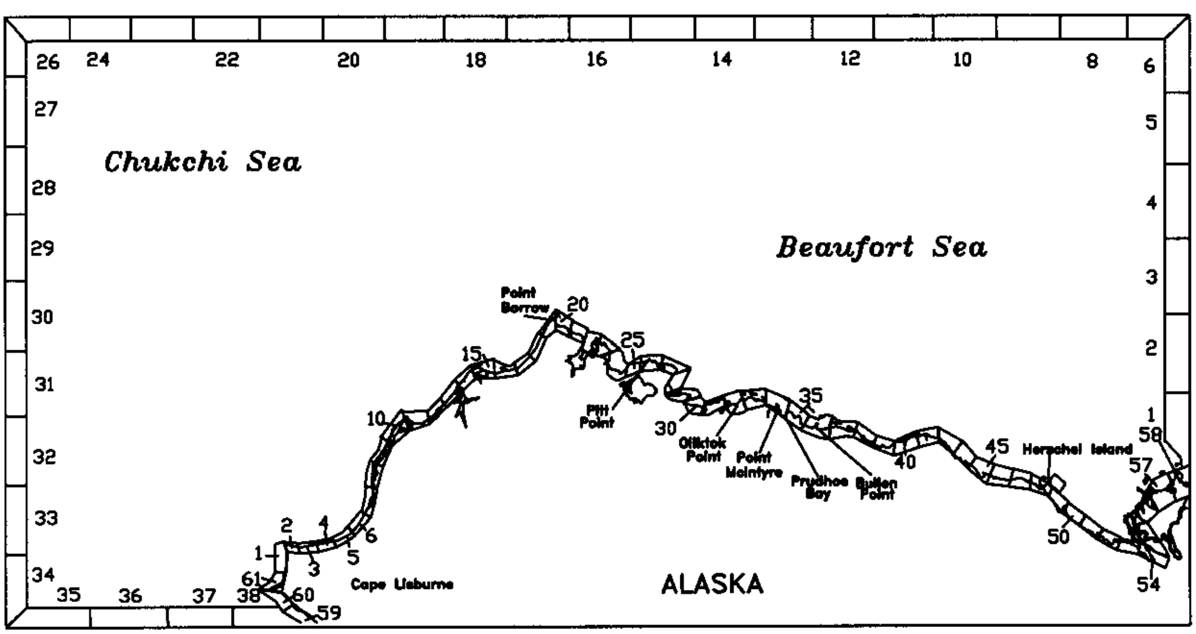


Figure IV.A.2-2. Location of Land and Boundary Segments Used in the Oil-Spill-Risk Analysis for Sale 144

Table IV.A.2-1
Environmental Resource Areas

Area Designation	Name	Geographic Areas
Ice/Sea Segments		
ISS1	Ice/Sea Segment 1	Chukchi Sea
ISS2	Ice/Sea Segment 2	Chukchi Sea
ISS3	Ice/Sea Segment 3	Chukchi Sea/Alaskan Beaufort Sea
ISS4	Ice/Sea Segment 4	Alaskan Beaufort Sea
ISS5	Ice/Sea Segment 5	Alaskan Beaufort Sea
ISS6	Ice/Sea Segment 6	Alaskan Beaufort Sea
ISS7	Ice/Sea Segment 7	Alaskan Beaufort Sea
ISS8	Ice/Sea Segment 8	Alaskan Beaufort Sea
ISS9	Ice/Sea Segment 9	Alaskan Beaufort Sea
ISS10	Ice/Sea Segment 10	Alaskan Beaufort Sea
ISS11	Ice/Sea Segment 11	Alaskan & Canadian Beaufort Sea
ISS12	Ice/Sea Segment 12	Canadian Beaufort Sea
ISS13	Ice/Sea Segment 13	Canadian Beaufort Sea
ISS14	Ice/Sea Segment 14	Canadian Beaufort Sea
ISS15	Ice/Sea Segment 15	Chukchi Sea
ISS16	Ice/Sea Segment 16	Chukchi Sea
ISS17	Ice/Sea Segment 17	Chukchi Sea
Coastal Areas		
C1	Peard Bay	Chukchi Sea
C2	Elson Lagoon	Alaskan Beaufort Sea
C3	Simpson Lagoon	Alaskan Beaufort Sea
C4	Gwydyr Bay	Alaskan Beaufort Sea
C5	Jago Lagoon	Alaskan Beaufort Sea
C6	Beaufort Lagoon	Alaskan Beaufort Sea
Subsistence Resources Areas		
SRAA	Subsistence Resource Area A	Chukchi Sea
SRAB	Subsistence Resource Area B	Chukchi Sea/Alaskan Beaufort Sea
SRAC	Subsistence Resource Area C	Alaskan Beaufort Sea
SRAD	Subsistence Resource Area D	Alaskan Beaufort Sea
Whale Feeding Areas		
FFA	Fall Feeding Area	Alaskan Beaufort Sea
SFA1	Summer Feeding Area 1	Canadian Beaufort Sea
SFA2	Summer Feeding Area 2	Canadian Beaufort Sea
Spring Lead System		
SLSN	Spring Lead System-North	Chukchi Sea/Alaskan Beaufort Sea
SLSS	Spring Lead System-South	Chukchi Sea

Source: USDOI, MMS, Alaska OCS Region, 1995.

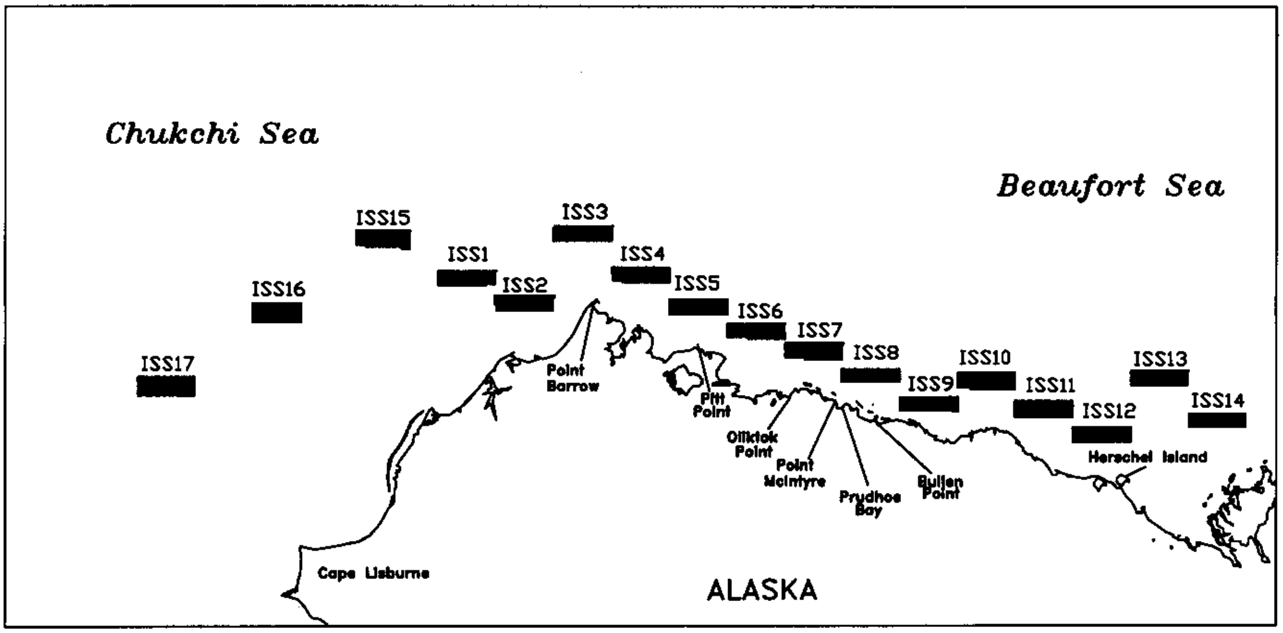


Figure IV.A.2-3. Location of Ice/Sea Segments Used in the Oil-Spill-Risk Analysis for Sale 144

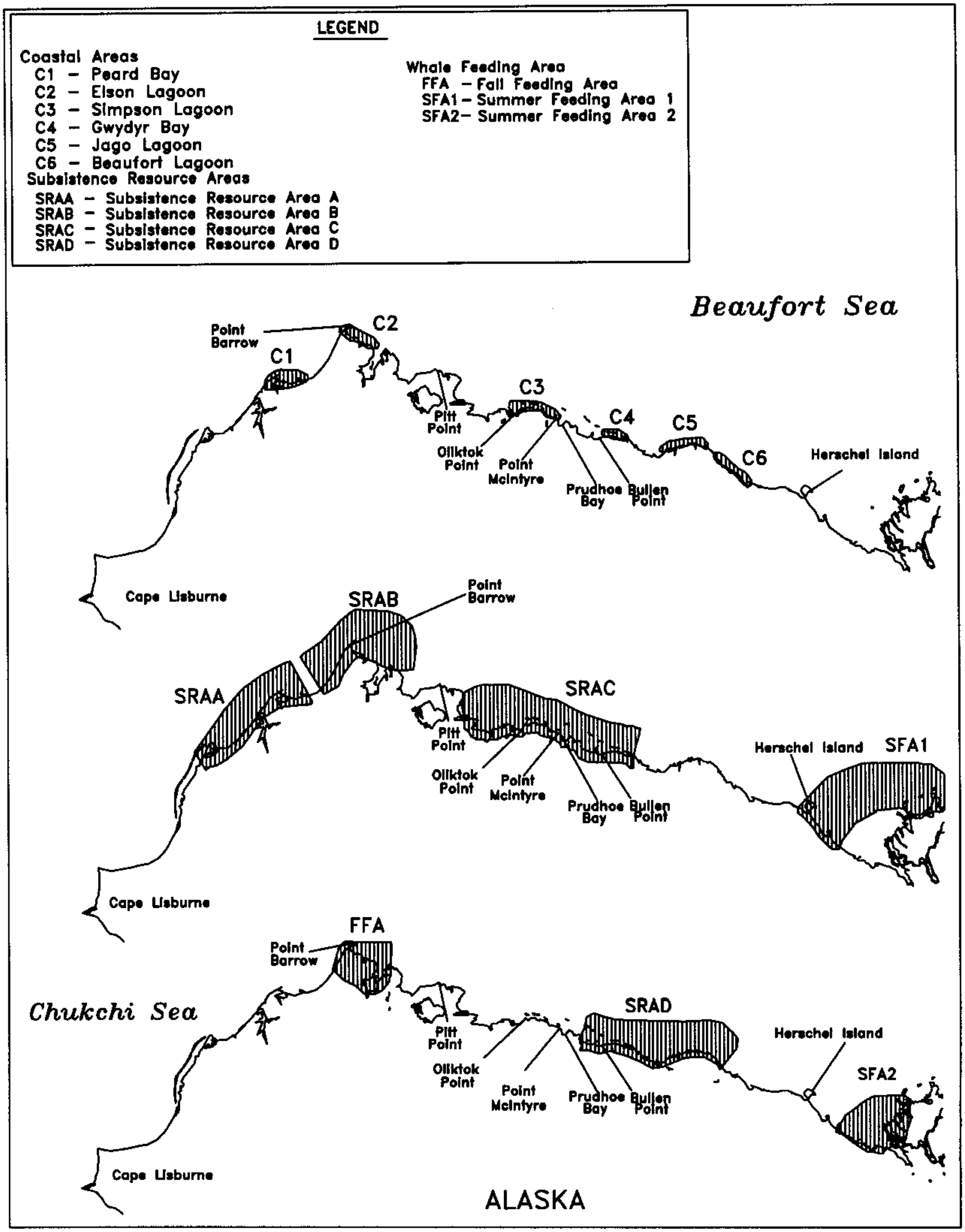


Figure IV.A.2-4. Location of Environmental Resource Areas for Oil-Spill-Risk Analysis for Sale 144

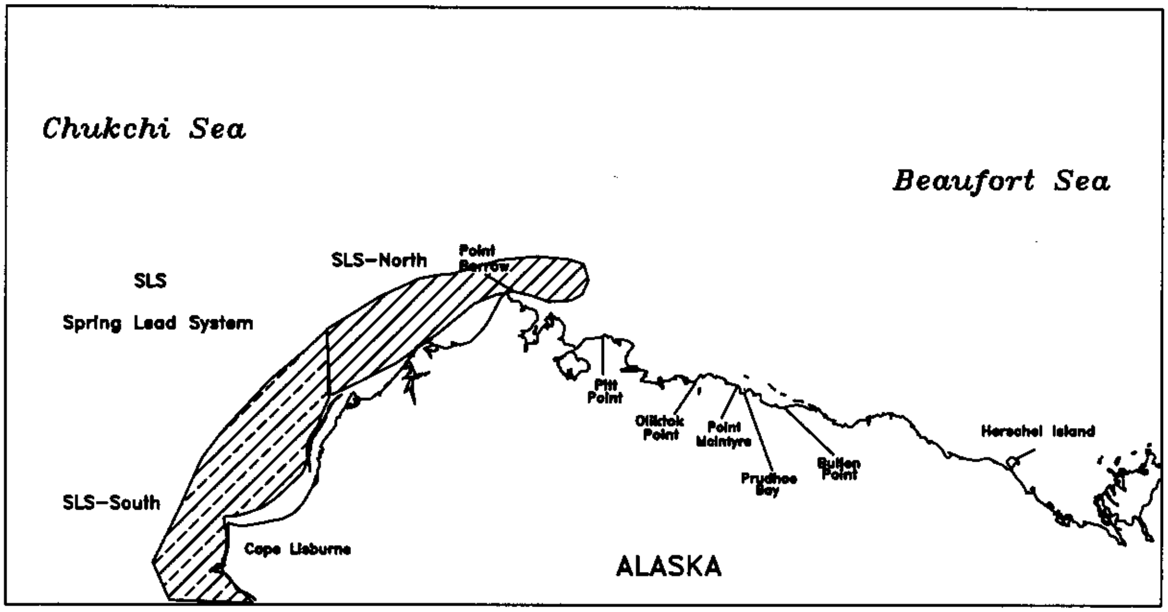


Figure IV.A.2-5. Location of Spring Lead System Used in the Oil-Spill-Risk Analysis for Sale 144

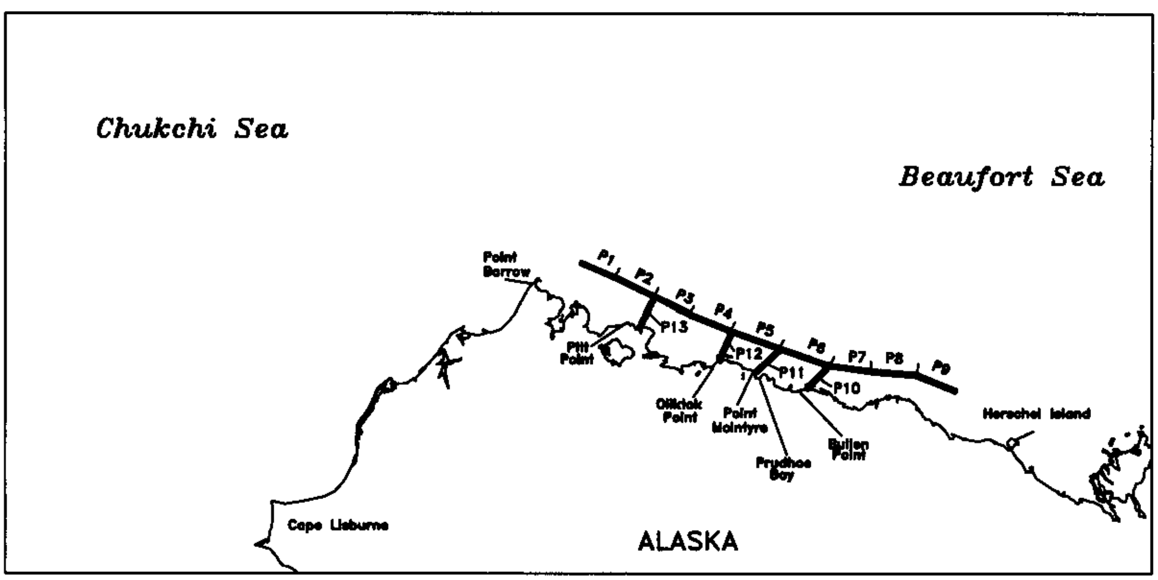


Figure IV.A.2-6. Location of Hypothetical Pipeline Routes Used in the Oil-Spill-Risk Analysis for Sale 144

(3) Probability of One or More Oil Spills Greater Than or Equal to 1,000 Barrels Occurring: The statistical methods the MMS uses to estimate ≥ 1,000-bbl oil spills occurring are based on historical oil-spill rates; they are described by Anderson and Labelle (1994) and are herein incorporated by reference. The probability of one or more ≥ 1,000-bbl spills occurring is derived from the mean spill number using a Poisson distribution governing rare, random events (Anderson and LaBelle, 1990, 1994; Smith et al., 1982). The mean spill number is derived by analyzing the oil-resource estimates, the transportation assumptions, and the historical oil-spill rates.

(a) Oil-Resource Estimates: For Sale 144, MMS uses low-, base-, and high-case, deferral-alternative, and cumulative-case oil-resource estimates. The estimates assumed for the (1) low case are 0.13 Bbbl (considered uneconomic); (2) base case, 1.2 Bbbl; (3) high case, 3.9 Bbbl; and (4) Barter Island Deferral Alternative, 1.08 Bbbl (Table IV.A.1-1).

For cumulative-case oil spills, two oil-resource estimates are used. One of these is used to estimate the number of potential spills ≥ 1,000 bbl from platforms and pipelines in both Federal and State waters of the Beaufort Sea (Table IV.A.2-2); State oil-resource estimates are shown in Appendix B, Table B-54. The total offshore Beaufort Sea resources are estimated to be 1.842 Bbbl of producible oil. This estimate is based on estimates of future production from (1) Federal Sale 144 (Alternative I, base case) of 1.2 Bbbl, (2) Federal tracts presently leased but not developed, 0.2 Bbbl, (3) State leases developed (Endicott), 0.262 Bbbl, and (4) State leases undeveloped, 0.262 Bbbl (Table IV.A.2-3a). The second estimate is used to estimate the number of tanker spills ≥ 1,000 bbl. In addition to the offshore resources, the second estimate includes an estimate of future North Slope (onshore) production. Beaufort Sea (offshore) and North Slope (onshore) oil are commingled for transport via TAPS to Valdez, Alaska, where the oil is loaded onto tankers for transport to locations noted in Section IV.A.1.b(4)(b) for refining. Future North Slope production is estimated to be 5.709 Bbbl (Appendix B, Table B-54). The total amount of Beaufort Sea and North Slope crude oil transported by tankers is estimated to be 7.551 Bbbl (Table IV.A.2-3b).

(b) Transportation Assumptions: For the OSRA model, a realistic hypothetical transportation scenario is created in the absence of existing infrastructure, indicating where platform and pipeline activity may occur. The actual transportation network will depend on finding commercial oil quantities, the oil location, and the subsequent environmental and economic transportation-mode analyses as well as planning and zoning requirements. For the analyses of the base, high, and cumulative cases (Federal off- shore) and the deferral alternative, an assumption is made that oil is transported from offshore platforms by pipeline based on the Transportation of Hydrocarbon stipulation described in Section II.F.

Base and High Cases and Deferral Alternative: The analysis for the base case and the deferral alternative assumes an Outer Continental Shelf (OCS) offshore pipeline system that makes landfalls at Bullen Point (P10), Point McIntyre (P11), and Oliktok Point (P12) (Fig. IV.A.2-6). For the high case, the analysis assumes a landfall at Pitt Point (P13) in addition to the base-case landfalls. Where they exist, onshore pipelines would be used to transport Sale 144 crude oil to TAP Pump Station 1; new onshore pipelines would be constructed where required. Prior to or at Pump Station 1, the Sale 144 crude oil would be commingled with other North Slope crude oil.

(c) Historical Oil-Spill Rates: Oil spills ≥ 1,000 barrel (bbl) from tankers, platforms, and pipelines were analyzed (Anderson and LaBelle, 1990; 1994). Platform- and pipeline-spill rates were derived from U.S. OCS spill-and-production data from 1980 to 1993. The U.S. OCS platform- and pipeline-spill rates are 0.45 and 1.32, respectively, per billion barrels (Anderson and LaBelle, 1994). Tanker-spill rates were derived from North Slope crude oil tankers from 1977 to 1992 (Anderson and LaBelle, 1994). Tanker-spill rates per billion barrels for North Slope crude oil transported from Valdez are 0.33 for in-port spills, 0.77 for at-sea spills, and 1.10 for all spills.

(d) Sale 144 Estimated Mean Spill Number and Probability of One or More Spills Greater than or Equal to 1,000 Barrels Occurring: For the Sale 144 base, high, and cumulative cases and the deferral alternative, the mean spill number is estimated by multiplying historical spill rates (Sec. IV.A.2.a(3)(c)) based on the assumed transportation scenario (Sec. IV.A.2.a(3)(b)) by the oil-resource-estimate volume (Sec. IV.A.2.a(3)(a)).

Table IV.A.2-2
Beaufort Sea Oil-Resource Estimates

Area	Resource Estimate Developed Fields (Bbbl)	Resource Estimate Developed Fields Percent of Total	Resource Estimate Undeveloped Fields (Bbbl)	Resource Estimate Undeveloped Fields Percent of Total	Total Resource Estimate (Bbbl)	Total Resource Estimate Percent of Total
Federal						
Sale 144 (Base Case)[1]	-	-	1.20	65.14	1.20	65.14
Leased and Undeveloped	-	-	0.20	10.86	0.20	10.86
Total Federal	-	-	1.40	76.00	1.40	76.00
State[2]						
Offshore	0.262[3]	14.22	0.18	9.77	0.442	24.00
Total						
Federal and State	0.262	14.22	1.58	85.78	1.842	-

Source: USDOI, MMS, Alaska OCS Region, 1995.

[1] Appendix A.
[2] State of Alaska, Department of Natural Resources, 1994.
[3] Endicott.

Table IV.A.2-3a
Oil-Spill-Occurrence Estimates and Probabilities for Spills ≥1,000 Barrels Occurring Over the Assumed Production Life of Proposed Beaufort Sea Sale 144 Sale 144 and Cumulative Case (Offshore Platforms and Pipelines)

Source	Estimated Volume (Bbbl)	Spill Rate (Number/Bbbl)[1]					Estimated Mean Number of Spills	Chance of One or More Spills (%)	Assumed Number of Spills for Analysis	Assumed Spill Size (bbl)
				Tankering						
		Plat-form Spills	Pipe-line Spills	All Spills	At-Sea Spills	In-Port Spills				
SALE 144										
ALTERNATIVE I										
Low Case	<0.13	-	-	-	-	-	-	-	-	0
Base Case	1.2	0.45	1.32	-	-	-	2.12	88	2	7,000
High Case	3.9	0.45	1.32	-	-	-	6.90	>99.5	6	7,000
ATERNATIVE III	1.08	0.45	1.32	-	-	-	1.91	85	1	7,000
ALTERNATIVE IV	0.72	0.45	1.32				1.27	75	1	7,000
CUMULATIVE CASE–OFFSHORE PLATFORMS AND PIPELINES										
Total	**1.842**	**0.45**	**1.32**	-	-	-	**3.26**	**96**	**3**	**7,000**
The following estimates are included to provide an indication of the contribution made by the various oil sources to the total.										
Federal—-Total[2]	1.40	0.45	1.32	-	-	-	2.48	92	2	7,000
Sale 144 (Base Case)	1.20	0.45	1.32	-	-	-	2.12	88	2	7,000
Leased & Undeveloped	0.20	0.45	1.32	-	-	-	0.35	30	0	0
State—-Offshore Total[3]	0.442	0.45	1.32	-	-	-	0.78	54	0	0
Developed	0.262	0.45	1.32	-	-	-	0.46	37	0	0
Undeveloped	0.180	0.45	1.32	-	-	-	0.32	27	0	0

Source: USDOI, MMS, Alaska OCS Region, 1995.

[1] Anderson and Labelle, 1994
[2] Table IV.A.2-2.
[3] Appendix B, Table B-54.

Table IV.A.2-3b
Oil-Spill-Occurrence Estimates and Probabilities for Spills ≥1,000 Barrels Occurring Over the Assumed Production Life of Proposed Beaufort Sea Sale 144
Cumulative Case (Tankering)

Source	Estimated Volume (Bbbl)	Tankering Spill Rate (Number/Bbbl)[1] All Spills	At-Sea Spills	In-Port Spills	Estimated Mean Number of Spills	Chance of One or More Spills (%)	Assumed Number of Spills for Analysis	Assumed Spill Size (bbl)
CUMULATIVE CASE--TANKERING								
All Spills								
Total	**7.551**	**1.1**	**-**	**-**	**8.32**	**>99.5**	**8**	**30,000**
The following estimates are included to provide an indication of the contribution made by the various oil sources to the total								
Federal Total[2]	1.40	1.1	-	-	1.54	79	1	30,000
Sale 144 (base case)	1.20	1.1	-	-	1.32	73	1	30,000
Leased and Undeveloped	0.20	1.1	-	-	0.22	20	0	0
State Total	6.151	1.1	-	-	6.77	>99.5	6	30,000
Developed[3]	5.567	1.1	-	-	6.12	>99.5	6	30,000
Undeveloped	0.584	1.1	-	-	0.64	47	0	0
At-Sea Spills								
Total	7.551	-	0.77	-	5.81	>99.5	5	30,000
Federal Total[2]	1.40	-	0.77	-	1.08	66	1	30,000
Sale 144 (base case)	1.20	-	0.77	-	0.92	60	0	0
Leased and Undeveloped	0.20	-	0.77	-	0.15	14	0	0
State Total	6.151	-	0.77	-	4.73	99	4	30,000
Developed[3]	5.567	-	0.77	-	4.29	99	4	30,000
Undeveloped	0.584	-	0.77	-	0.45	36	0	0
In-Port Spills								
Total	7.551	-	-	0.33	2.49	92	2	30,000
Federal Total[2]	1.40	-	-	0.33	0.46	37	0	0
Sale 144 (base case)	1.20	-	-	0.33	0.40	33	0	0
Leased and Undeveloped	0.20	-	-	0.33	0.07	7	0	0
State Total	6.151	-	-	0.33	2.02	87	2	30,000
Developed[3]	5.567	-	-	0.33	1.84	84	1	30,000
Undeveloped	0.584	-	-	0.33	0.20	18.	0	0

Source: USDOI, MMS, Alaska OCS Region, 1995

1 Anderson and Labelle, 1994
2 Table IV.A.2-2.
3 Appendix B, Table B-54.

Offshore Platforms and Pipeline Spills: The OSRA estimates a mean number of spills ≥1,000 bbl for the base and high cases of 2.12 and 6.90 (Table IV.A.2-3a), respectively, with an estimated 88- and >99.5-percent chance of one or more such spills occurring, respectively (Fig. IV.A.2-7). Based on the Poisson distribution of oil-spill probabilities, the most likely number of spills estimated for the base case is two and the high case is six (Fig. IV.A.2-7). The OSRA estimates a ≥1,000-bbl mean spill number of (1) 1.91 with an estimated 85-percent chance of one or more such spills occurring for the Barter Island Deferral Alternative (Fig. IV.A.2-7)—the most likely number of spills is 1, and (2) 1.27 with an estimated 75-percent chance of one or more spills occurring for the Nuiqsut Deferral Alternative—the most likely number of spills is one. For the cumulative case, the OSRA estimates a mean number of spills ≥1,000 bbl of 3.26 with an estimated 96-percent chance of one or more spills occurring for offshore platforms and pipelines (Fig. IV.A.2-7); the most likely number of spills is three.

For purposes of analysis, based on the estimated mean number of spills, this EIS assumes two spills will occur in the base case, six spills in the high case, and one spill will occur in the deferral alternative; in the cumulative case, three spills are assumed to occur for offshore platforms and pipelines (Table IV.A.2-3a and Fig. IV.A.2-7). For the base-case spills, one is assumed to be from a platform and the other from a pipeline. Four pipeline and two platforms spills are assumed for the high case. The single spill associated with the deferral alternative is assumed to be from a pipeline. Three spills are assumed for the cumulative case, two pipeline and one platform.

Tanker Spills: The number of spills associated with the tanker transport of North Slope and Beaufort Sea crude oil is based on future production from existing and undeveloped fields (discovered and undiscovered) which is estimated to be 7.551 Bbbl (Table IV.A.2-3b) and the tanker spill rates. The estimated mean number of all tanker spills ≥1,000 bbl for the cumulative case is 8.32, with an estimated >99.5-percent chance of one or more such spills occurring; the assumed number of tanker spills for analysis is 8.

Over the life of the proposal, the estimated future production from Federal leases (1.40 Bbbl) is about 20 percent of the total production (7.551 Bbbl) and from State leases (6.151 Bbbl) is about 80 percent. Based on the information assumed in the hypothetical production and tanker scenarios, about one-fifth of the commingled (for transport through TAPS) oil spilled in a tanker accident would be from Federal leases and about four-fifths from State leases.

(4) Spill-Size Assumptions: Spills on the U.S. OCS ≥1,000 bbl account for about 0.1 percent of the total number of OCS spills but about 77 percent of the volume spilled (Anderson and LaBelle, 1994). Between 1980 and 1993, there were six platform and pipeline spills ≥1,000 bbl; the average size of these spills was about 7,000 bbl.

In the cumulative case, oil spills ≥1,000 bbl are assumed to occur in two separate areas: (1) in the Beaufort Sea from platform and offshore-pipeline spills Table IV.A.2-3a) and (2) in the Gulf of Alaska/Pacific Ocean from tanker spills of North Slope/Beaufort Sea crude oil (Table IV.A.2-3b). For Beaufort Sea production, three spills of 7,000 bbl each are assumed for analysis. Future Beaufort Sea production includes estimates from Federal and State areas. Production from the Federal areas is estimated to be 1.40 Bbbl: 1.2 Bbbl from Sale 144 and 0.20 Bbbl from previously leased but undeveloped areas. State offshore Beaufort Sea production is estimated to total 0.442 Bbbl (0.262 Bbbl from developed areas and 0.180 Bbbl from undeveloped areas).

The number of assumed spills for tanker transportation from Valdez is based on estimates of future production from existing and undeveloped (discovered and undiscovered) North Slope fields and from the Beaufort Sea (Federal and State leases); total future production is estimated to be 7.551 Bbbl. For tankering, eight spills of 30,000 bbl each are assumed for analysis.

(5) Conditional Probability of Oil-Spill Contact Assuming a Spill Has Occurred: To estimate the conditional probability of oil-spill contact, MMS simulates oil-spill trajectories starting from hypothetical spill sites and tabulates contacts to environmental resource areas and land and boundary segments (Table IV.A.2-1). The conditional probability is the likelihood of a spill contacting land and boundary segments, ice/sea segments, coastal areas, subsistence-resource areas, whale feeding areas, and the spring lead system, assuming that an oil spill occurs from a hypothetical spill site. Annual and seasonal (summer and winter) conditional probabilities were estimated for the Beaufort Sea Sale 144 area.

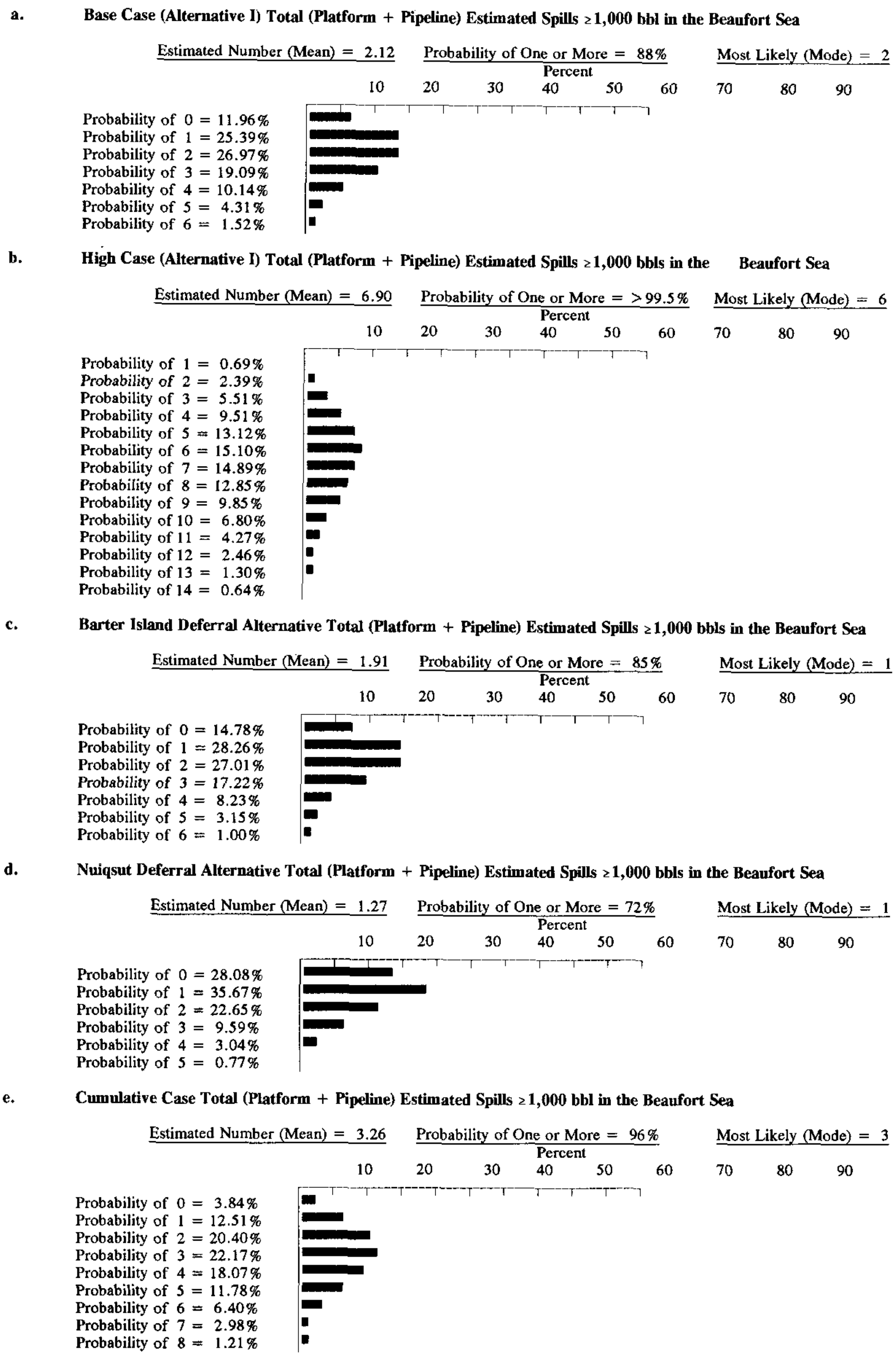


Figure IV.A.2-7. Poisson Distribution of Spill Probabilities for the Base and High Cases, the Barter Island and Nuiqsut Deferral Alternatives, and the Cumulative Case.

(a) Oil-Spill-Trajectory Simulations: The trajectory simulation consists of numerous hypothetical oil-spill trajectories that collectively represent the mean surface transport and the variability of the surface transport as a function of time and space. The trajectories represent the Lagrangian motion that a particle on the surface might take under given wind and ocean-current conditions. Multiple trajectories are simulated to give a statistical representation, over time and space, of possible transport under the range of wind and ocean-current conditions that exist in the Sale 144 area. Trajectories are constructed from simulations of tidal, wind-driven, and density-induced flow fields. The basic approach is to simulate these time- and spatially dependent currents separately and then combine them through linear superposition to produce an oil-transport vector that is then used to create a trajectory. Simulations are carried out for two seasons, winter (October through June) and summer (July through September). This seasonal division was chosen based on meteorological, climatological, and biological cycles, as well as consultation with MMS, Alaska OCS Region analysts. (Anderson et al., 1995) describes the modeling of each flow-field component.

For cases where the ice concentration is below 80 percent, each trajectory is constructed using the ocean- current field and 3.5 percent of the instantaneous wind field—a method based on work done by Huang and Monastero (1982), Smith et al. (1982), and Stolzenbach et al. (1977). For cases where the ice concentration is ≥80 percent, the model ice velocity is used to transport the oil. The wind data set used was from the National Weather Service Limited Fine Mesh (LFM) model (Gerrity, 1977), and the 9-year simulation covered both the low-frequency variability and interannual variability. A major assumption used in this analysis is that the ice-motion velocities and the ocean daily flows calculated by the coupled ice-ocean model adequately represent the flow components.

For each trajectory simulation, the start time for the first trajectory was the first day of the season (winter or summer) of the first year of wind data (1978) at 6 a.m. GMT (Greenwich Mean Time) (Johnson, Marshall, and Anderson, 1994). Each subsequent trajectory was started every 1.5 days on average, at 6 a.m. GMT. A total of 2,000 trajectories (1,500 in winter, 500 in summer) was launched from each of the >400 hypothetical spill sites over the 9 years of wind data (1978-1986). Results of these trajectory simulations were combined into 20 hypothetical launch areas (L1-L20) to represent platform risk (Fig. IV.A.2-1). Transportation risks were represented by 2,000 trajectories launched uniformly along hypothetical pipeline routes (P1-P13, Fig. IV.A.2-6).

The trajectories age while they are in the water/on the ice. For each day that the hypothetical spill is in the water, the spill ages—up to a total of 30 days (Anderson et al., 1995). While the trajectory is in the ice (≥80% concentration), the aging process is suspended. The maximum time allowed for the transport of oil in the ice is 180 days when oil melts out of ice. The 30-day limit is maintained in open water.

Summer trajectories are those that begin between July and the end of September (Anderson et al., 1995). Therefore, if contact to an environmental resource or land segment is made by a trajectory that began at the end of September, it is considered a "summer contact" and is counted along with the rest of the contacts from spills launched in the summer.

The spill trajectories for OCS Lease Sale 144, Beaufort Sea, show distinct variations in response to seasonal wind patterns and the strength of density-driven currents (Anderson et al., 1995). Hypothetical spills on the shelf show the wind-induced variability and the relatively important density-driven current along the Beaufort Sea coast. Landfall, or contact, of the trajectories generally is highest year-round for points located west of the launch areas, with contacts east of these areas occurring in the summer. As the simulated oil spills moved, any contacts with environmental resources were recorded. Spill movement continued until the spill contacted land, moved out of the study area, or aged >30 days in open water or 180 days in ice conditions.

(b) Sale 144 Conditional Probabilities: The estimated conditional probabilities (expressed as a percent chance) are presented as: (1) contacts with summer spills (spills originating between July and September) and (2) contacts with winter spills (spills originating between October and June) for 3, 10, 30, and 180 days for land and boundary segments, ice/sea segments, coastal areas, subsistence-resource areas, whale feeding areas, and the spring lead system. The estimated conditional probabilities of oil-spill contact from launch areas L1 through L20 and Pipeline segments P1 through P13 are presented in Appendix B, Tables B-2 through B-49. Annual conditional probabilities are presented in Tables B-2 though B-13. Winter and summer conditional probabilities of oil spills contacting (after 3, 10 and 30 days) (1) environmental resources are presented in Tables B-14 through B-25 and (2) land segments in Tables B-26 through B-37. Conditional

Probabilities of oil spills contacting environmental resources and land segments after 180 days are presented in Tables B-38 to B-49.

(6) Combined Probability of Oil-Spill Occurrence and Contact: Combined probabilities are estimated using the conditional probabilities, the historical oil-spill rates, the resource estimates, and the assumed transportation scenarios. These are combined through matrix multiplication to estimate the mean number of spills occurring and contacting land and boundary segments, ice/sea segments, coastal areas, subsistence resource areas, whale feeding areas, and the spring lead system. The estimated mean spill number is then applied to the Poisson statistical distribution to estimate the probability of one or more spills ≥ 1,000 bbl occurring and contacting environmental resource areas and land/sea segments over the lifetime of the Sale 144 proposal.

The combined probability is the likelihood of one or more ≥ 1,000-bbl spills from production and transportation activities occurring and contacting land and boundary segments, ice/sea segments, coastal areas, subsistence resource areas, whale feeding areas, and the spring lead system over the lifetime of the Sale 144 proposal. It is important that the distinction between conditional and combined probabilities is clear. Conditional probabilities assume a spill has occurred and refer only to the likelihood that a spill would follow a certain path; they have nothing to do with the chance that a spill would occur in the first place. Combined probabilities reflect both the estimated chance of a spill occurring and the likelihood that a spill would follow a certain path.

Sale 144 Combined Probabilities for Environmental Resource Areas: The combined probabilities are presented as the probability of one or more ≥ 1,000-bbl spills occurring and contacting environmental resource areas, sea segments, or land segments within 3, 10, 30, and 180 days over the assumed production life of the proposal. Combined-probability tables for the base and high cases and Barter Island Deferral Alternative are in Appendix B, Tables B-50, 51, 52, and 53.

b. Spills Less Than 1,000 Barrels:

(1) Spill Rates (Spills Less Than 1,000 Barrels):

(a) Outer Continental Shelf Spills Less Than 1,000 Barrels: Most United States OCS spills < 1,000 bbl usually are < 50 bbl. In fact, 99 percent of all United States OCS spills (including spills ≤ 1 bbl) have been ≤ 10 bbl in size (USDOI, MMS, 1994). Worldwide, < 50-bbl oil spills from platforms contribute 0.02 to 0.03 MMbbl annually to a total oceanic release from offshore petroleum production of 0.3 to 0.5 MMbbl (National Research Council [NRC], 1985). Therefore, worldwide, < 50-bbl spills make up 4 to 10 percent of the total industry discharge.

During exploration in Alaskan OCS waters from 1982 to 1991, 52 exploration wells were drilled with five spills > 1 bbl and a total spillage of 45 bbl. From the Alaskan OCS data, the spill rate is 11 spills per 100 wells drilled, with a 9-bbl-per-spill-average volume.

Spills < 1,000 bbl will be more frequent during the production years, but the anticipated spill volumes still will be small. In OCS-producing areas from 1964 to 1992, the offshore-oil industry spilled 14,080 bbl in 88 small spills (of at least 50 bbl but < 1,000 bbl) while producing 8.96 Bbbl (crude and condensate). The OCS data show an OCS production-spill rate of 9.8 spills ≥ 50 and < 1,000 bbl in size per billion barrels produced, with an average 160-bbl-spill size (Tracey, 1988; Francois 1993; Anderson, 1994, pers. comm.). In OCS producing areas from 1970 to 1992, the offshore-oil industry spilled 9,184 bbl in 1,812 small spills (of at least 1 bbl but < 50 bbl) while producing 7.7 MMbbl (crude and condensate) (Francois, 1993; Cotton, 1991; USDOI, MMS, 1994). The OCS data show an OCS production-spill rate of 234 spills ≥ 1 and < 50 bbl in size per billion barrels produced, with an average 5-bbl-spill size.

(b) North Slope and TAPS Spills Less Than 1,000 Barrels: The transportation of Sale 144 oil to market includes its flow through existing or newly constructed North Slope pipelines and the TAPS; spills < 1,000 also are assumed to occur during this phase. North Slope operations from 1989 through 1994 resulted in 3,465 petroleum spills; petroleum spills included products (such as gasoline, diesel, and hydraulic and lubrication oil) and crude oil (Appendix B, Table B-55). For petroleum spills <50 bbl, the average spill size was 0.61 bbl and for spills 50 to <1,000 bbl, the average size was 275.75 bbl. Crude oil spills of <1,000 bbl totaled 853. For crude oil spills of <50 bbl, the average spill size was 0.60 bbl; and for spills 50 to <1,000 bbl, the average spill size was 324.42 bbl. The North Slope spill data is based on spills from operations of all facilities except those that are part of the TAPS. The North Slope facilities include drill sites, production facilities, separation centers, gas plants, and pipelines.

The TAPS operations from 1989 through 1994 resulted in 167 petroleum and 17 crude oil spills <1,000 bbl (Appendix B, Table B-55). The TAPS facilities include Pump Stations 1 through 12, the entire pipeline, and the 3-mi corridor associated with the pipeline. For petroleum spills <50 bbl, the average spill size was 0.52 bbl; and for spills 50 to <1,000 bbl, the average size was 86.31 bbl. For crude oil spills <50 bbl, the average size was 0.56 bbl. There were no crude oil spills >50 bbl during the 1989-1994 period.

The North Slope spill rate for (1) petroleum <50 bbl is 1,003 spills/Bbbl and 50 to <1,000 bbl is 6 spills/Bbbl and (2) crude oil <50 bbl is 247 spills/Bbbl and 50 to <1,000 bbl is 5 spills/Bbbl (Appendix B, Table B-56). The TAPS spill rate for (1) petroleum <50 bbl is 232 spills/Bbbl and 50 to <1,000 bbl is 1 spill/Bbbl and (2) crude oil <50 bbl is 25 spills/Bbbl.

(2) Spills Less Than 1,000 Barrels: Table IV.A.2-4 presents small-spill (<1,000) estimates for the low, base, and high cases; the deferral alternative; and the cumulative case-small spills. Additional information regarding spills <1,000 bbl can be found in the tables in Appendix B.

3. Spilled Oil Fate and Behavior in Marine Waters: The spilled-oil fate and behavior description, in general, and in specific regard to surface spills, subsurface spills, summer broken-ice spills, and winter broken-ice or under-ice spills is discussed in this section This section also addresses oil-spill concerns for proposed Sale 144 related to the Beaufort Sea Planning Area ice conditions. In this section, oil-weathering rates are calculated from the weathering model described in Payne (1984) and Kirstein and Redding (1988).

a. General Weathering Processes: Several processes alter the chemical and physical characteristics and toxicity of spilled oil. Collectively, these processes are referred to as weathering or aging of the oil and, along with the physical oceanography and meteorology, the weathering processes determine the oil's fate. The major oil-weathering processes are spreading, evaporation, dispersion, dissolution, emulsification, microbial degradation, and sedimentation to the seafloor or stranding on the shoreline (Payne and McNabb, 1985; Payne et. al., 1987; Boehm, 1987) (Figs. IV.A.3-1 and IV.A.3-2).

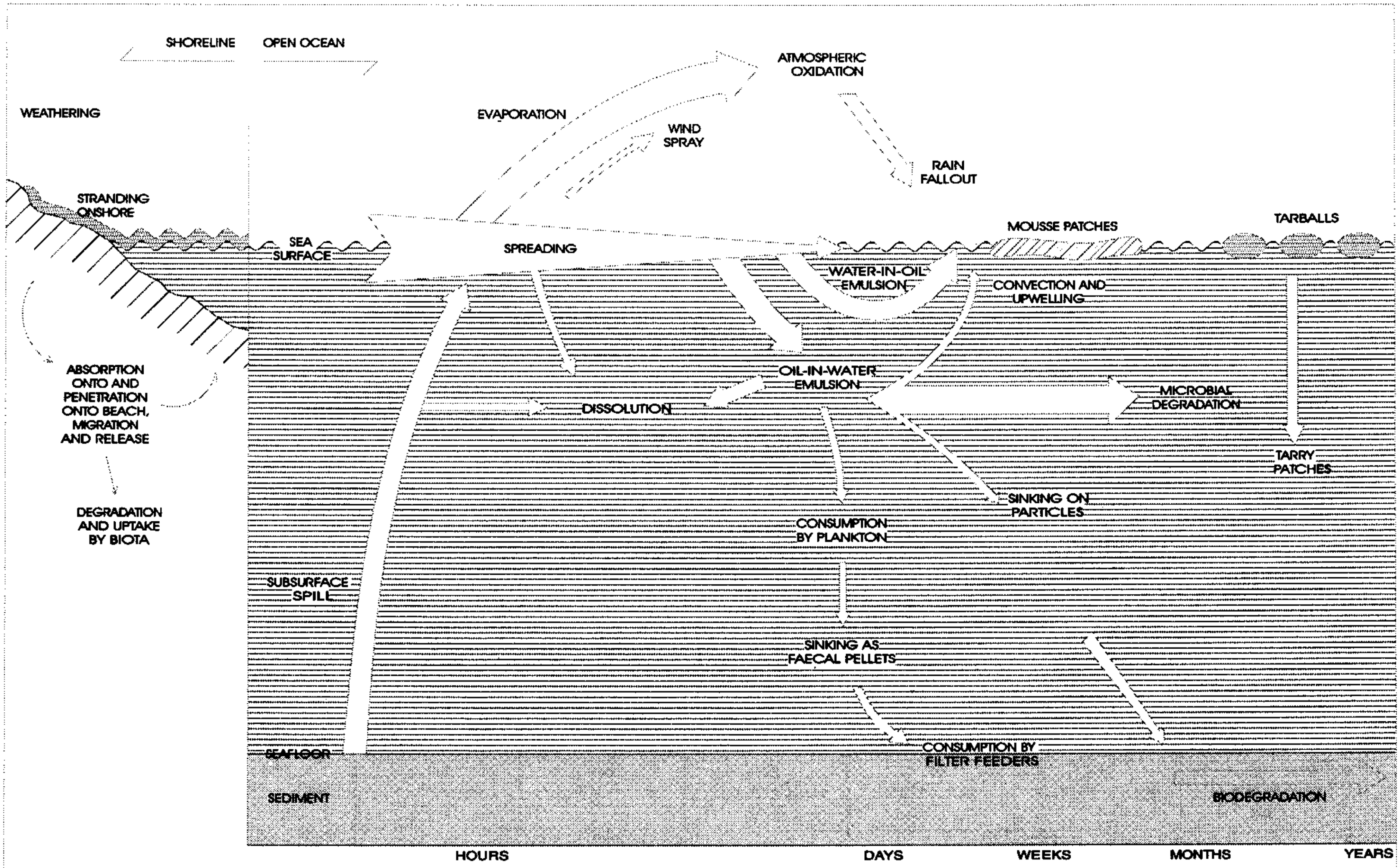
After a spill occurs, spreading and advection begin. The slick spreads horizontally in an elongated pattern oriented in the direction of wind and currents and nonuniformly into thin sheens (0.5-10 micrometers [μm]) and thick patches (0.1-10 millimeters [mm]) (Elliott, 1986; Elliott, Hurford, and Penn, 1986; Galt et al., 1991). In the cooler arctic waters, oil spills spread less and remain thicker than in temperate waters because of differences in the viscosity of oil. The presence of broken ice tends to slow the rate of spreading. Oil spilled beneath a wind-agitated field of pancake ice would be pumped up onto the surface of the ice or, if currents are slow enough, bound up in or below the ice (Payne et al., 1987). Once oil is encapsulated in ice, it has the potential to move distances from the spill site with the ice.

Evaporation results in a preferential loss of the lighter, more volatile hydrocarbons, increasing density and viscosity and reducing vapor pressure and toxicity (MacKay, 1985). Evaporation of volatile components accounts for 30 to 50 percent of crude loss, with approximately 25 percent occurring in the first 24 hours (Fingas, Duval, and Stevenson, 1979; National Academy of Sciences, 1985). The initial evaporation rate increases with increasing wind speeds, temperatures, and sea state. Evaporative processes occur on spills in ice-covered waters, although at a lower rate (Jordan and Payne, 1980). Fuel oils (diesel) evaporate more slowly than crude, on the order of 13 percent within 40 hours at 23 °C, but a larger overall percentage of diesel eventually will evaporate. Evaporation decreases in the presence of broken ice and stops if the oil is under or encapsulated in the ice (Payne et al., 1987).

Table IV.A.2-4
Small Spills <1,000 Barrels

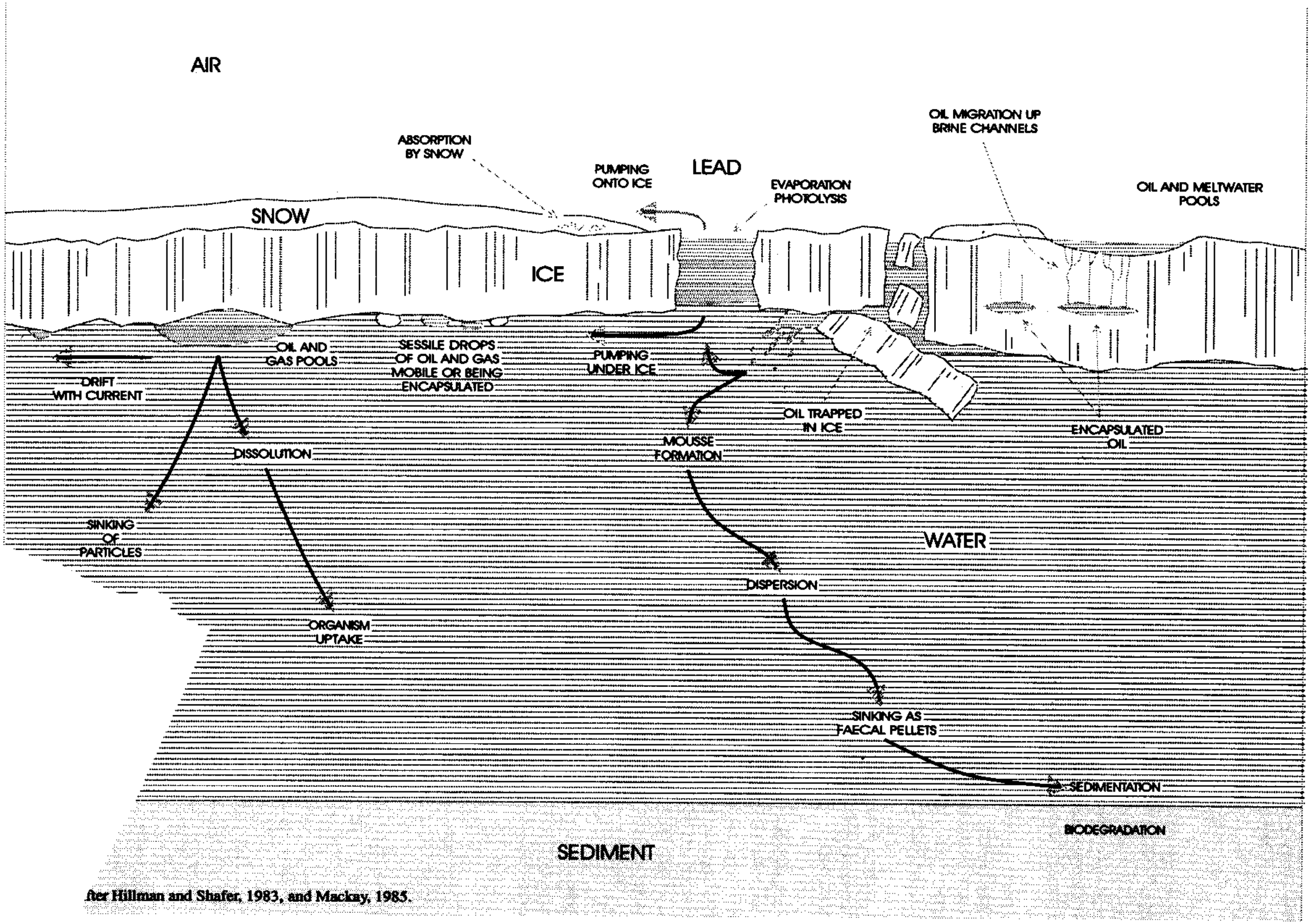
	Estimated Exploration Spills[1]		Estimated Production Spills[2]						Estimated North Slope and TAPS Spills[3]--Total Petroleum (Products + Crude Oil)					
	≥1 and <1,000 bbl		≥1 and <50 bbl		≥50 and <1,000 bbl		**Total[4] ≥1 and <1,000 bbl**		≥1 and <50 bbl		≥50 and <1,000 bbl		**Total ≥1 and <1,000 bbl**	
	Estimated Number of Spills	Total Volume (bbl)	Estimated Number of Spills	Total Volume (bbl)	Estimated Number of Spills	Total Volume (bbl)	**Estimated Number of Spills**	**Total Volume (bbl)**	Estimated Number of Spills	Total Volume (bbl)	Estimated Number of Spills	Total Volume (bbl)	**Estimated Number of Spills**	**Total Volume (bbl)**
ALTERNATIVE I														
Low Case	1	9												
Base Case	2	18	281	1,405	12	1,920	**295**	**3,343**	1,551	929	9	2,292	**1,560**	**3,221**
High Cese	7	63	913	4,565	39	6,240	**959**	**10,868**	5,040	3,019	29	7,288	**5,069**	**10,307**
ALTERNATIVE III--BARTER ISLAND DEFERRAL ALTERNATIVE														
	2	18	253	1,265	11	1,760	**266**	**3,043**	1,397	846	8	1,968	**1,045**	**2,814**
ALTERNATIVE IV--NUIQSUT DEFERRAL ALTERNATIVE														
	2	18	168	840	7	1,120	**177**	**1,978**	931	558	5	1,189	**936**	**1,747**
CUMULATIVE CASE[5]														
	3	27	431	2,155	19	3,040	**453**	**5,222**	9,761	5,847	56	14,164	**9,817**	**20,012**

1 Spill rates and average spill sizes for exploration spills ≥1 and <1,000 bbl are shown in Table B.57.
2 Spill rates and average spill sizes for production spills ≥1 and >50 bbl and ≥50 and <1,000 bbl are shown in Table B.57.
3 Spill rates and average spill sizes for North Slope and TAPS spills ≥1 and >50 bbl and ≥50 and <1,000 bbl are shown in Table B.59.
4 Totals include exploration spills.
5 Estimated cumulative-case small spills are shown in Tables B.58 and B.60.



Source: After MacKay, 1985, and Rasmussen, 1985.

Figure IV.A.3-1. Fate of Oil Spills in the Ocean During Summer



fter Hillman and Shafer, 1983, and Mackay, 1985.

IV.A.3-2. Fate of Oil Spills in the Ocean During Winter

Dispersion is an important breakup process that results in the transport of small oil particles (0.5 μm-several mm) or oil-in-water emulsions into the water column (Jordan and Payne, 1980; NRC, 1985). Droplets <0.5 mm rise slowly enough to remain dispersed in the water column (Payne and McNabb, 1985). The dispersion rate is directly influenced by sea state; the higher the sea state and breaking waves, the more rapid the dispersion rate (Mackay, 1985). The presence of broken ice promotes dispersion (Payne et al., 1987).

Dissolution results in the loss of soluble, low-molecular-weight (LMW) aromatics such as benzene, toluene, and xylenes (NRC, 1985). The LMW aromatics, which are acutely toxic, rapidly dissolve into the water column. Dissolution, however, is very slow compared with evaporation; most volatiles usually evaporate rather than dissolve. Dissolved-hydrocarbon concentrations underneath a slick, therefore, tend to remain < 1 parts per million (ppm) (Malins and Hodgins, 1981). Dissolved-hydrocarbon concentration can increase due to the promotion of dispersion by broken ice (Payne et al., 1987).

Emulsified oil results from oil incorporating water droplets in the oil phase and generally is referred to as mousse (Mackay, 1982). The measurable increases in viscosity and specific gravity observed for mousse change its behavior, including spreading, dispersion, evaporation, and dissolution (Payne and Jordan, 1988). The formation of mousse slows the subsequent weathering of oil. The presence of slush ice and turbulence promotes oil-in-water emulsions (Payne et al., 1987).

Most of the oil droplets suspended in the water column eventually will be degraded by bacteria in the water column or deposited on the seafloor. The rate of sedimentation depends on the suspended load of the water, the water depth, turbulence, oil density, and incorporation into zooplankton fecal pellets.

Subsurface blowouts or gathering-pipeline spills disperse small oil droplets and entrained gas into the water column. With sufficient gas, turbulence, and the necessary precursors in the oils, mousse forms by the time the oil reaches the surface (Payne, 1982; Thomas and McDonagh, 1991). For subsurface spills, oil rises rapidly to the water surface to form a slick. Droplets <50 microns in size, generally 1 percent of the blowout volume, could be carried several kilometers downcurrent before reaching the water surface (Environmental Sciences Limited, 1982). Blowout simulations show that convective cells set up by the rising oil and gas plume result in concentric rings of waves around the central plume. Surface currents within the ring should move outward, and surface currents outside the ring should move inward, resulting in a natural containment of some oil.

The subsurface release of oil droplets increases slightly the dissolution of oil, but the rapid rise of most oil to the surface suggests that the increase in dissolution—as a percentage of total spill volume—is fairly small. The resulting oil concentration, however, could be substantial, particularly for dispersed oil in subsurface plumes.

b. Oil Spills: Spills ≥1,000 bbl from pipelines and platforms pose the greatest spill risk to the study area. In the Beaufort Sea scenario, the pipeline-spill rate is assumed to be 1.32 spills/Bbbl of oil produced and the platform-spill rate is assumed to be 0.45 spills/Bbbl (Table IV.A.2-3).

A pipeline spill would almost always be a subsurface spill. Most platform spills—because platform spills are much more likely to occur during production than during exploration—would occur as surface spills. Pipeline and platform spills are more likely to be crude oil but could be fuel oil. In the OCS, 7 of 12 ≥1,000-bbl plat- form spills were of stored oil, either stored crude or fuel oil (Anderson and Labelle, 1994). Stored-oil spills could be as large as blowout spills.

A winter spill that resulted from the proposed action most likely would be into moving pack ice; and during the winter, most of the proposed sale area is covered with pack ice.

(1) Surface Spills: Oil spills spread less in cold water than in temperate water due to the increased oil viscosity. In the Sale 144 area, an oil spill would spread less, remaining 100-fold thicker than a slick in a more temperate climate. In the Beaufort Sea, a 7,000-bbl open-water spill (average size ≥1,000-bbl pipeline or platform spill) may physically cover about 1 to 2 km^2 in an area of about 20 to 400 km^2 (discontinuous area) (Table IV.A.3-1); a spill that occurred in winter may cover about 820 to 1,300 km^2 after meltout.

Table IV.A.3-1
Sale 144 Platform and Pipeline Assumed-Spill-Size Examples for the Beaufort Sea Planning Area[1]

Assumed Spill Size (bbls)	19,500					
	Summer Spill[2]			Meltout Spill[3]		
Time After Spill in Days	3	10	30	3	10	30
Oil Remaining (%)	81	70	55	72	56	44
Oil Dispersed (%)	6	14	26	12	27	36
Oil Evaporated (%)	13	16	19	16	17	20
Thickness (mm)	1.5	0.07	0.04	2	0.92	0.48
Area of Slick (km^2)[4]	1.7	2.9	4.4	1.1	1.8	2.7
Discontinuous Area (km^2)	34	161	670	1,400[5]	1,600[5]	2,200[5]

Source: USDOI, MMS, Alaska OCS Region, 1995.

1 Calculated with the SAI oil-weathering model of Kirstein, Payne, and Redding (1983). These examples are discussed in the Fate and Behavior portion of Section IV.A. The examples are for a Prudhoe Bay crude type.

2 Summer (July through September), 12-kn wind speed, 2 °C, 0.4-m-wave height.

3 Meltout Spill. Spill is assumed to occur in May into first-year pack ice, pools 2 cm thick on ice surface for 10 days at 0 °C prior to meltout into 50-percent ice cover, 11-kn wind speed, and 0.1 wave heights.

4 This is the area of oiled surface.

5 Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Note that ice dispersion occurs for about 60 days prior to meltout.

The oil spill, however, would not remain as one continuous slick over such a small area. Winds ≥4 to 5 m per second would cause a slick to break into windrows. Waves, slick movement, and changes in winds and ocean currents all tend to spread the slick discontinuously over the ocean surface. In open water in the Beaufort Sea, within 30 days the slick could spread discontinuously over an area 200-fold greater than the actual oiled surface area. As weathering and spreading forces continued, the oil would separate further into individual tarballs or pancakes.

The composition of the oil affects just how an oil slick would weather. Composition and resulting characteristics of known North Slope and Beaufort Sea crudes vary considerably, but generalizations can be made. Evaporation of volatile components accounts for the largest percentage of loss from most crude-oil spills, on the order of 25 percent within the first 24 hours. Over the life of an oil slick, evaporation accounts for about one-sixth to two-thirds of slick mass. For an oil such as Prudhoe Bay crude, with a high resin content, only about 9 percent of a spill would evaporate in 1 day at 1 °C and a 6-m-per-second (11-knot [kn]) wind (calculated from Payne et al., 1984b). Higher wind speeds or warmer temperatures would increase the initial rate of evaporation but would not appreciably increase the percentage of slick mass that eventually escapes into the atmosphere. Volatile components total only 18 percent of Prudhoe Bay crude.

A diesel fuel spill would behave similarly, but diesel is missing both the most volatile and least volatile components found in crude oil. Under the conditions assumed above for a Prudhoe Bay crude, a light diesel initially would evaporate more slowly than the crude, on the order of 3.2 percent over the first day; but overall, a larger percentage of diesel would evaporate.

Competing with evaporation is dissolution, which chiefly involves the volatile aromatic fraction. Compared with evaporation, dissolution is very slow; usually most volatiles evaporate rather than dissolve. Dissolved hydrocarbon concentrations underneath a slick, therefore, tend to remain low (see Sec. IV.B.1 of this EIS). Over time, about 5 percent of a slick would dissolve.

Winds, waves, and currents break off oil droplets from a slick and mix them into the underlying water. The greater the turbulence, such as in a storm, the more rapidly oil is lost from the slick. Oil-droplet dispersion into the water, not dissolution, is the major mechanism for getting oil into the water column. Mousse formation (water-in-oil emulsion) slows but does not stop dispersion from a slick.

For Prudhoe Bay-like crude, with a relatively small volatile component, dispersion could be important in removing oil from a slick. For a 7,000-bbl spill of Prudhoe Bay crude, dispersion would remove about 7 percent of the oil slick over 3 days, about 19 percent over 10 days, and about 28 percent over 30 days (Table IV.A.3-1). Storm winds and waves could greatly increase dispersion rates.

At the same time that oil is being lost from the slick, the character of the slick changes. Many crudes, including Prudhoe Bay crude, form mousse. Most Canadian Beaufort Sea crudes, however, do not (Bobra and Fingas, 1986). After initial weathering of Prudhoe Bay crude, roughly 40 percent of the spilled oil could be expected to remain in the form of tarballs, pancakes, or mats. For arctic open waters, tarballs can form within days to within many months, depending on weather, mixing energy, oil type, and availability of nucleation sites to initiate tarball formation (Payne, 1982, 1984b; MacGregor and McLean, 1977).

(2) ***Subsurface Spills:*** Subsurface spills could occur from leaks through the seafloor pipelines or from subsea-well blowouts. Blowouts or pipeline spills would disperse small oil droplets and entrained gas into the water column. A trunk pipeline—with gas removed—would emit only oil droplets.

Most oil would rise rapidly to the water surface to form a slick. Droplets <50 microns in size, a category including about 1 percent of total spill volume, could be carried several kilometers downcurrent before reaching the water surface. Buist, Pistruzak, and Dickins (1981) found that 90 percent of the oil reached the surface within 50 m of the discharge point in a simulated subsurface gas-and-oil blowout at a 20-m-water depth in the Canadian Beaufort Sea.

Oil-droplet release allows some increase in the oil dissolution, but the rapid oil rise to the surface suggests that this increase in dissolution must be fairly small. Oil that reached the surface would weather and behave similarly to a surface spill.

(3) Summer Broken-Ice Spills: Most of the acreage of proposed Sale 144 is covered by pack ice in summer. Therefore, a summer spill would most likely be into first-year or multiyear broken ice.

An oil spill in broken ice would spread between ice floes into any gaps greater than about 8 to 15 centimeters (cm) (Free, Cox, and Schultz, 1982). A large, instantaneous spill would push loosely packed ice floes away from the spill, creating a larger gap at the spill site. In more closely packed ice—because fresh crude oil is less dense than sea ice—crude oil would have a tendency to overflow rather than underflow ice (Thomas, 1983). Any waves within the ice pack also would tend to pump oil onto the ice. Approximately 25 percent of the oil spilled in pancake ice would be present on the pancake top due to pumping (Stringer and Weller, 1980). More viscous and/or weathered crudes may adhere to porous ice floes, essentially concentrating oil within the floe field and limiting the oil dispersion. Such concentration was observed in the *Ethel H.* (Deslauriers, 1979) and *Kurdistan* (Reimer, 1980) spills.

Initial spillage could entrain some oil on the underside of the ice floes; however, because of its buoyancy, most oil would remain in the water between floes. Differences in velocities of ice and underlying water would have to be on the order of 15 to 25 centimeters per second (cm/sec) to move oil along the underside of first-year ice (Cox and Schultz, 1981). Velocities would have to be >20 cm/sec to move oil underneath the rougher relief of multiyear ice. Strong surface currents are found at times in the Beaufort Sea Planning Area, and differential velocities of such magnitude are possible.

In broken, first-year ice, brine channels allow relatively rapid oil movement from underneath the ice to the ice surface. Thomas (1983) calculates a maximum 0.4-mm-per-hour oil-flow rate through decaying first-year ice. Any wave/ice oscillation, slight floe uplifting from collisions, overturning, or tilting that results from uneven melting tends to remove oil from underneath the ice. Multiyear ice does not contain continuous brine channels. Release of entrapped oil from multiyear ice would be slower than from first-year ice but still would occur.

Oil between or on ice floes is subject to normal evaporation. Some additional oil dispersion occurs in dense, broken ice through floe-grinding action (Reimer, 1980). This floe-grinding action also promotes mousse formation. With floe grinding, Prudhoe Bay crude forms a mousse within a few hours, an order of magnitude more rapidly than in open water (Payne, 1984).

(4) Winter Under-Ice Spills: A winter spill under unbroken, landfast ice or pack ice would most likely be a pipeline spill. The oil would rise to the ice underside as described for a summer pipeline spill rising to the water surface.

Oil spreading along the ice underside is controlled by several factors. Separate oil droplets or small pools of approximately 0.2-mm thickness would not coalesce or flow into hollows underneath the ice (see Buist, Pistruzak, and Dickins, 1981). Approximately 2 mm of additional oil could be accommodated in the skeleton ice crystals beneath the solid-ice layer. Thicker oil layers coalesce or spread under the ice until an equilibrium 0.8-cm thickness is reached (Rosenneger, 1975). If a sufficient oil volume is instantaneously spilled, oil would spread into hollows underneath thinner ice. In first-year, late-winter ice, such hollows could store 150,000 to 300,000 bbl per km^2 (Stringer and Weller, 1980). Multiyear ice, which is rougher, could store 1.8 MMbbl per km^2 in under-ice relief (Kovacs, 1977).

More than 90 percent of the proposed sale area lies in the pack-ice rather than the landfast-ice zone (Roberts, 1987). A spill into winter ice would, therefore, more likely be into multiyear pack ice than landfast ice. The greater multiyear ice-storage capacity would not be well-used in a real spill situation due to ice movement over the spill.

A pipeline spill of 1,000 to 25,000 bbl per day might be spread as a ribbon, approximately 100 m wide and 0.3 to 8 mm thick, on the underside of the moving pack ice. Spills of greater size would pool within the ribbon into hollows on the underside of the ice. Only a spill rate >900,000 bbl per day would fill the underside storage capacity of the ice and result in a somewhat wider ribbon. The length of the ribbon would depend on the duration of the spill; and the ribbon would grow at the speed of ice movement, usually about 5 km per day in the Beaufort Sea Planning Area (see Sec. III.A.3.a). Faster movement of the ice, as may occur in a storm, would result in a longer, but thinner, ribbon of oiled ice.

Differential velocities between ice and underlying water need to be >20 to 25 cm/sec to move oil out of hollows on the underside of winter pack ice. Such velocities are possible in the Beaufort Sea Planning Area. Even in the presence of such differential velocities, oil likely would not move more than a few kilometers from its original location on the underside of the ice. New ice would form beneath the under-ice oil within 5 to 10 days, isolating it from currents and further weathering. Grease ice and also slush ice beneath the ice cover should retain spilled oil and limit its spread and movement (Martin, 1981; Truett, 1985).

Because of these and other factors, a winter spill (or whatever part of a winter spill that is not cleaned up) would become a fresh, unweathered spill when the ice melts.

To get into a lead or a polynya earlier than breakup, oil would have to be spilled in a polynya or a polynya would have to form through the ice-entrapped spill; that is, it would have to break the ice in the middle of the frozen spill. If such breakage occurred in the latter case, appreciable quantities of oil could not be released unless breakage occurred through a relatively rare, thicker oil pool. Such pools would be isolated and small; therefore, only minimal quantities of oil would be released into the forming polynya.

Oil released into the polynya would be blown to its downwind edge, where it would accumulate in a band. The oil would then be either frozen into the ice or contained behind accumulating brash ice (floating ice fragments not >2 m across). It is possible that the cold, saline water formed as the polynya freezes could incorporate relatively high dissolved-hydrocarbon concentrations into a sinking, denser water plume. This plume would then spread out at some equilibrium depth in deeper water as a relatively stable and distinct layer.

In the Beaufort Sea Planning Area, oil would start melting out of first-year ice in June; oil spilled earlier in winter would melt out earlier. Oil in multiyear ice would be released more slowly, perhaps 1 to 3 months later, with 10 percent of the oil taking >1 year for release.

(5) Winter Broken-Ice Spills: The most likely winter spills from platforms in the proposed Sale 144 area would be spills into broken pack ice. Spills from platform-stored oil would collect in open water or broken ice in the lee of bottom-founded production platforms.

Blowouts provide a mixed spill mode. A subsea blowout would place oil into the broken ice in lee of the platform. The subsequent fate of winter-spilled oil would be similar to a subsea-pipeline leak under ice. Rather than underneath the ice, a surface blowout would place oil into broken ice and on top of the ice. Such surface release would likely result in appreciable, but incomplete, volatile hydrocarbon evaporation prior to breakup. Thus, a surface blowout—or any other spill on top of the ice—would be partially weathered during winter.

Most oil spilled into winter broken ice would be rapidly frozen into the pack ice. Because the oil would be frozen into new ice, brine channels would be present and would allow most oil to be released during breakup.

c. Extent and Persistence of Oiled Shoreline: If an oil spill occurred and contacted shore, two important but nonbiological questions arise: (1) how much shoreline would be contaminated and (2) how long would the contamination persist? In winter, landfast ice along the shorelines of the Beaufort and Chukchi Seas would keep spills offshore, away from the shoreline, and any oil that did reach shore would not penetrate into the frozen beach. For these shorelines, the relevance of these questions is much greater for spills during the open-water season than for spills during the winter.

(1) Extent of a Shoreline Spill: An offshore spill that reached shore is not likely to reach the shoreline in its entirety; contact could occur with the shoreline in several locations, or the spill could be "smeared" along a single location, depending on the winds and longshore current. How long a stretch of coastline could be coated by an oil spill is difficult to quantify but could be estimated on the basis of a study by Ford (1985).

Ford used multiple regression and 39 spill case histories in which coastline was oiled to develop empirical equations predicting how much coastline would be oiled if oiling occurred. (Note that not all spills reach shore.) Ford found the volume spilled accounted for 59 percent of the variance in the historical record. Volume and latitude were slightly more precise estimators, accounting for an additional 6 percent of the variance. Wind speed, water temperature, and wave height did not significantly correlate to the amount of shoreline oiling.

The Equation 13 (Table 4 in Ford, 1985) relating shoreline oiling to volume alone is a more appropriate predictor than the equation relating oiling to both spill volume and latitude. Obviously, increasing latitude would not directly cause a spill to spread over more shoreline. The correlation with latitude must be an artifact caused by a secondary relationship such as an increase in shoreline complexity as latitude increases. However, the historical spill record used by Ford encompassed only a relatively narrow range of latitude; and the unidentified, indirect relationship should not be assumed to continue outside of that range.

Based on Equation 13, if a 7,000-bbl spill occurred and contacted land, about 30 km of coastline would be oiled. However, it would be possible for a spill to contact severalfold longer or shorter stretches of coastline than these averages or, alternatively, not contact any shoreline at all.

Note, however, that there are additional constraints on the degree of oiling of any specific stretch of shoreline. The tidal range for this region is quite low (10-30-cm average), and habitats such as marshes or delta tidal flats would have to be inundated by seawater during a storm surge to allow appreciable inland stranding of oil. These dual restraints on stranding of oil reduce the likelihood and degree of oiling to such habitats to less than that implied by probabilities from the oil-spill-risk analysis.

(2) Persistence of Stranded Oil: 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, which together form most of the Beaufort Sea coast, may be areas where most cleanup operations—removal of contaminated soil and vegetation or even heavy foot traffic—could cause permanent scars on the landscape and ecosystem. Newer techniques, such as low-pressure hosing coupled 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 problems caused by shoreline oiling and oil persistence.

Persistence of oil on various types of shorelines has been investigated both experimentally through small, deliberate spills on test plots and by monitoring oil persistence following accidental spills of various compositions and magnitudes. In these studies, the persistence of oil always is highly correlated with shoreline type, largely because of the importance of physical processes in both weathering and natural removal of oil.

Based on these empirical data, several studies have rated the oil-retention potential of the coastline bordering the Beaufort Sea Planning Area. Most of the Beaufort Sea coast is considered to have moderate to high retention potential, with less than half of the coast in the high category. Stranded oil, if not cleaned up and if in a zone of high oil-retention capacity, could persist for decades along at least part of the oiled shoreline. In many locations, persistence would be less because of the rapid rate of retreat of much of the Beaufort Sea coast; stranded oil would be eroded along with the shoreline.

4. Aspects of Spill Prevention and Response: The petroleum industry and government have separate responsibilities for oil-spill prevention, contingency planning, and response. The MMS has established stringent requirements for spill prevention and response and employs an inspection program to ensure industry compliance. To complement the regulatory programs in place, the petroleum industry uses state-of-the-art technology for prevention equipment and the most current operating procedures while conducting operations on the OCS. Additionally, the petroleum industry must maintain a constant state of readiness for oil-spill response to meet the MMS's stringent response requirements. If an oil spill should occur, it is the responsibility of the spiller to respond to the spill with the oversight of the Federal and, depending on the location of the spill, State Governments.

a. Prevention:

(1) Exploration: By the close of 1994, 81 exploratory wells had been drilled on the Alaskan OCS, including 28 wells in the Beaufort Sea. A total of 12.8 bbl of crude and refined oil were spilled from these drilling activities. There were no blowouts or spills resulting from the loss of well control. The relatively small amount of oil spilled while drilling the 81 wells may be attributed to MMS's comprehensive regulations for preventing spills from drilling operations on the Alaskan OCS and the petroleum industry's commitment to clean and safe operations.

Specific regulations covering exploratory operations are found in 30 CFR 250, Subsections B and D, which cover exploration and drilling operations, respectively. The MMS regulations incorporate numerous industry standards, recommended practices, and technical specifications that outline standard engineering practices and procedures adopted by the petroleum industry. The MMS prevention program begins when the Exploration Plan (EP) is submitted.

The purpose of the EP is to provide the Government and the public with general information about the proposed exploration program. The EP contains general information pertaining to the operator's overall drilling plan and is reviewed by the MMS; the public; and other State, Federal, and local government organizations. If the EP meets MMS requirements, it may be approved. The MMS prepares an Environmental Assessment on each EP. If major environmental effects are identified that are not addressed by existing regulatory requirements, the MMS may restrict the activity or adopt additional mitigation. No exploratory drilling may be conducted unless an EP has been approved and deemed consistent with the Alaska Coastal Zone Management Plan (ACMP). The EP may describe single-well or multiwell drilling programs that are contingent on the results of each subsequent well. The EP outlines the scope of the proposed activities as well as the equipment, personnel, and a general timeline to be used for the drilling operation. An analysis of the potential environmental effects likely to occur during the drilling operations also is presented in the EP. In general, the EP provides the MMS and the public with the information necessary to ensure that the operator will use the appropriate equipment and trained personnel to safely conduct the drilling operation and to determine if the activity will have any significant environmental effects. An Oil Spill Contingency Plan (OSCP) is submitted as supporting information for the EP. The OSCP provides information pertaining to the operator's planned response should an oil spill occur from the drilling operation. The OSCP includes information on site- or situation-specific oil-spill-response strategies, equipment, trained personnel, and the logistical support necessary to conduct a spill response.

Before any drilling can begin, the operator must submit an Application for Permit to Drill (APD) to the MMS. The APD may be submitted before, during, or after submission of the EP but may not be approved until an EP has been approved and deemed consistent with the ACMP.

The APD outlines a drilling plan specific to a single well and provides proprietary geologic and engineering information. The APD is reviewed by MMS petroleum engineers, geologists, and geophysicists to ensure that all drilling operations meet MMS's stringent requirements and are conducted in an environmentally sound manner. The APD includes well-specific information such as casing, cementing and mud programs, well-control-equipment-operating limitations, expected pressure gradients, surface and bottomhole locations, drilling-unit-operating limitations, shallow-hazards data, and other engineering and geologic information. Site-specific seismic and geologic information is analyzed to determine the presence of shallow hazards (i.e., shallow gas, faulting, and other such hazards). The APD includes a Critical Operations and Curtailment Plan that describes the procedures for shutting down operations prior to environmental conditions that approach the operating limitations of the drilling unit.

Once the EP and APD are approved, MMS's exploratory permit requirements are fulfilled and the operator may begin drilling. It should be noted that there are numerous additional State (depending on the location of the drill site) and Federal permits that require approval before drilling may begin.

Once drilling is under way, the MMS monitors operations through daily drilling reports and onsite MMS activities inspection. If the operator determines the need to deviate from the plans described in the APD, a sundry notice, which contains detailed engineering information pertaining to the proposed changes, must be submitted to the MMS for review and approval.

Offshore exploratory wells are generally used only for exploration and, therefore, require abandonment once the operator has extracted all the necessary information. When the well is ready for abandonment, the operator must submit an abandonment plan to the MMS. Abandonment plans outline well-specific procedures to abandon the well so that permeable formations are isolated with cement plugs to prevent potential formation fluid (oil, gas, or water) migration to the surface.

The MMS also requires that drilling personnel successfully complete an MMS-approved well-control training course. The course is designed to ensure that all drilling personnel understand and can detect signs of potential well-control problems as well as the actions necessary to prevent loss of well control. As an additional preventive measure, the MMS requires complete redundancy in Blow Out Prevention (BOP) equipment. The MMS also requires the BOP equipment to be actuation and pressure tested on a regular basis to ensure its integrity. To reduce the likelihood of the loss of well control, the MMS requires the operator to conduct specific procedures for monitoring the mud system during activities that are known to have a high kick- (influx of formation fluids into the well bore) occurrence rate.

(2) Production, Workover, and Pipelines: The EP process ends once a discovery has been made and delineation drilling is complete. Before any production facilities or platform may be placed on the OCS, the designated operator must prepare and submit a Development and Production Plan (DPP). Similar to an EP, the DPP includes information on potential environmental effects and an activity-specific OSCP. The DPP must undergo a public-review process and a separate environmental review by the MMS. The OCS Lands Act also requires that at least one DPP in a frontier area, which would include the Sale 144 area, be subject to a complete EIS. Every development well is required to have an approved APD prior to being drilled. Although no production, workover, or pipeline operations currently exist on the Alaskan OCS, the MMS has extensive regulatory experience for offshore production in both California and the Gulf of Mexico. The MMS regulations for preventing spills from production operations are found in 30 CFR Part 250, Subsections E, F, H, and J and 30 CFR 254. The regulations cover completion, workover, production, and pipeline operations, respectively. To make the regulations as comprehensive as possible, the MMS has incorporated by reference numerous industry standards, recommended practices (RP), and technical specifications. Primary among the American Petroleum Institute (API) documents for prevention is API RP 14C, Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms.

A platform-surface-safety system is a group of safety devices that are intended to automatically detect and prevent the occurrence of common production-system hazards and, thereby, protect the facility, personnel, and environment from injury. The major threat to safety on a production platform is the release of hydrocarbons. Thus, the analysis and design of a production-platform-safety system must focus on preventing hydrocarbon releases by stopping their flow to a leak, thereby minimizing the volume of hydrocarbons that are released. To accomplish this, safety systems use protection concepts to prevent the occurrence of undesirable events. An undesirable event is an adverse occurrence in a process component that may result in the accidental release of hydrocarbons. There are five undesirable events around which the surface-safety system is designed:

- ***Overpressure:*** An overpressure condition occurs when the pressure in a process component exceeds the normal operating pressure range.
- ***Leak:*** A leak occurs following a breach in a process component, resulting in an accidental escape of oil, water, and/or gas to the atmosphere.
- ***Liquid Overflow:*** A liquid overflow occurs when the accumulation of liquid within a process component becomes greater than the design accumulation, causing a discharge of liquids through a gas or vapor outlet.
- ***Gas Blowby:*** Gas blowby occurs when the liquid level within a process component becomes less than the design accumulation, causing a discharge of gas from a process component through a liquid outlet.
- ***Underpressure:*** Underpressure occurs when the pressure in a process component becomes less than the design collapse pressure, causing the process component to collapse.

Because the undesirable events may occur, the production-safety system is designed to prevent them, isolate the problem to minimize or prevent the effect, contain any spillage, and shut in the process in the event of a fire. The platform-safety system provides two levels of protection to prevent or minimize the effects of an equipment failure within the process. The two levels of protection are independent of and in addition to the control devices used in the normal process operation. In general, these two levels of protection are provided by different types of safety devices and give a broader spectrum of coverage for the five commonly occurring undesirable events. These protective measures are common industry practices and are proven through many years of experience.

In a production-safety system, undesirable events are detected by various types of sensors that initiate a shutdown action to prevent or limit the release of hydrocarbons from a well or process component. These sensors are installed on the specific well or process vessel or as part of the Emergency Support System (ESS). The ESS includes (1) the combustible gas-detection system to sense the presence of escaped hydrocarbons and to initiate alarms and platform shutdown before gas concentrations reach the lower explosive limit; (2) the containment system to collect escaped liquid hydrocarbons and to initiate platform shutdown; (3) the fire-loop system to sense the heat of a fire and to initiate platform shutdown; (4) the Emergency Shutdown System (ESD) to provide a method to manually initiate platform shutdown by personnel observing abnormal conditions or undesirable events; and (5) the subsurface safety valves, which may be self-actuated or actuated by an ESD system and/or a fire-loop system located within the well bore of every well.

Prior to installation of the production-safety system, the MMS must review and approve the plans. To ensure proper installation and the functionality of the system, the MMS conducts a preproduction inspection to test each of the safety devices prior to allowing production to commence.

(3) MMS Inspection Program: The MMS inspection program plays an integral role in the prevention of oil spills. The program is designed to provide effective monitoring and enforcement of operator compliance with the requirements set forth in the OCS Lands Act, applicable Federal laws and regulations, lease terms, conditions of permit approval, and other directives. Compliance is ensured through a rigorous inspection program that uses comprehensive inspections before, during, and after commencement of drilling operations. The MMS uses an inspection staff composed of highly trained technicians and engineers to implement this multifaceted inspection program.

Prior to the use of a drilling unit that previously has not been approved for use on the Alaskan OCS, the drilling unit must undergo a rigorous inspection to ensure compliance with MMS regulations. The MMS technicians inspect electrical systems, BOP systems, ventilation systems, alarm systems, and other safety and prevention systems to ensure compliance with MMS regulations. Any system found not in compliance must be corrected prior to commencement of drilling operations.

For exploratory drilling operations in Alaska, inspectors witness operations critical to the safety and stability of the well, including but not limited to cementing; blowout drills; and pressure-testing blowout preventers, chokes, and diverters. In addition to witnessing such operations, inspectors conduct detailed and partial inspections using the Potential Incident of Non-Compliance (PINC) checklist.

The PINC lists are composed of items the inspector must examine to ensure that the operator is complying with the regulations, lease stipulations, and permit conditions. Partial inspections are completed on a daily basis, provided the inspector remains on the drilling unit for >1 consecutive day, and consist of inspecting items on the partial PINC list. Detailed inspections are generally conducted on a weekly basis and use the detailed PINC list as well as special PINC lists specifically generated for each operation. In addition to inspecting for compliance with MMS requirements, MMS inspectors, under a Memorandum of Agreement with the U.S. Environmental Protection Agency (USEPA), conduct inspections for compliance with the USEPA's National Pollutant Discharge Elimination System permits for operational discharges.

In the event of a commercial discovery and subsequent development and production, the MMS, Alaska OCS Region, would develop an inspection strategy commensurate with the scope and nature of the activities as well as the operating environment.

b. Oil-Spill-Contingency Measures: The goal of the MMS oil-spill program is to ensure that the lessee is prepared to respond to any size spill—from a small operational spill to a large worst-case spill. To achieve this goal, MMS requires OSCP's for all operations. Further, MMS uses inspections, equipment deployment, and tabletop-communication exercises to ensure that the lessee has trained, knowledgeable crews and well-maintained equipment to respond to a spill.

(1) Contingency Plans: Before conducting exploratory-drilling operations, MMS's oil-spill regulations (30 CFR 250.42 and 30 CFR 254) require each lessee to submit an OSCP to the MMS Regional Supervisor, Field Operations, for approval with, or prior to, the submission of an EP or DPP. The OSCP is developed for the site-specific operations, based on the type, timing, and location of the proposed activities. The OSCP must satisfy the content requirements and provisions identified in 30 CFR 250.42 and 30 CFR 254 and the Planning Guidelines for Approval of Oil Spill Contingency Plans developed jointly by the MMS and U.S. Coast Guard (USCG).

(2) Applicability of Oil-Spill-Response Technology in the Sale 144 Area: The technical capability to contain and clean up offshore oil spills in ice-covered waters and broken sea ice depends on the oil type; amount of oil spilled; and sea, ice, and meteorological conditions at the time of the spill. Many of the spill-response measures developed for arctic areas have been evaluated in test facilities and/or demonstrated during field trials and oil-spill-response exercises. However, there has not been a major crude oil spill of any significant magnitude in Arctic ice-covered waters or in broken sea ice to provide historical data on the effectiveness of this technology for a major spill event. For this reason, there continues to be a diversity of opinions among industry, regulatory, and environmental groups on the actual effectiveness of oil-spill response in ice-covered waters and in broken sea-ice conditions.

(a) Solid Ice: Most would agree that current technology can successfully clean up oil spilled onto solid landfast-ice areas during the winter months (typically from mid-November through mid-May). Solid-ice recovery operations center on the removal of oil and oil-contaminated snow that can be scraped from the surface of thick ice sheets with hand tools and earth-moving equipment such as loaders, graders, and plows. If a spill occurred early in the winter before the ice is solid enough to support response equipment, then the response could be delayed until the ice thickens. For spills that occurred late in the winter when the ice is beginning to thaw, the oil would pool and collect in melt ponds on the surface of the ice where it could easily be burned using in situ burning equipment such as the helitorch.

Oil spilled under the ice in solid landfast-ice regions is more difficult to locate and clean up than surface spills; however, it is technically viable under many conditions. Oil spilled under solid ice usually will rise to the bottom of the ice sheet and be contained in a relatively small area, providing that there are no strong currents (>.5 kn) under the ice. It has been estimated that the mean storage capacity of oil under the ice is 195,000 barrels per km^2 inside the barrier islands and on the order of 1.8 MMbbl per km^2 under multiyear ice (Kovacs, 1977). Several techniques have been demonstrated in field trials over the years and include physically removing the ice, boring into or channeling the ice to allow the oil to move to the surface where it can either be mechanically recovered or burned, and burning the oil when it migrates to the surface through brine channels and collects in melt pools during the spring thaw. It has been shown that oil easily migrates to the surface of annual or first-year ice during the spring and can be burned very effectively. Oil encapsulated into multiyear ice, however, may take several years to surface through brine channels; and recovery operations would be much more difficult.

(b) Broken and Moving Pack Ice: Oil spilled in broken ice usually can be expected to spread between ice floes. In closely packed ice, the movement of the ice in response to wind and waves could force some of the oil onto the surface of ice floes; however, most of the oil is expected to remain on the water between the ice floes. Mechanically recovering spilled oil in moving pack ice, dense broken ice, and newly forming ice under dynamic sea states is a difficult task. Current technology is limited to the deployment of skimmers in small open-water areas, leads within the ice pack, and in the lee of drilling/icebreaking vessels. Access to these areas generally is limited to ice-strengthened ships and barges. When the oil is highly concentrated in leads and small open-water areas within the ice pack, mechanical recovery can be very effective if deployed from ice-strengthened vessels that are capable of maneuvering in the ice pack. As the oil becomes spread over a larger area, intermixes with the ice, and becomes emulsified or solidified, mechanical recovery of a spill becomes ineffective.

The oil and gas industry almost unanimously has adopted in situ burning as the primary response technique for oil trapped and intermixed with ice. In situ burning reduces or eliminates the need for recovery, storage, transportation, and disposal of a large percentage of the spilled oil.

(c) In Situ Burning: In situ burning is defined as the burning of oil on the surface of the water in situ (in place). Because of the high removal rate and efficiency of this technique, it is becoming more widely accepted as a response technique. In situ burning also has been demonstrated to be an extremely useful spill-response tool in open water with the use of fire-resistant containment boom. The effectiveness of the technique has been demonstrated in the laboratory, test tanks (Evans et al., 1993), and in the field during the *Exxon Valdez* spill (Allen, 1991). Because of the validity of this response tool the Alaska Regional Response Team (ARRT) has provided conditional preapproval for the Federal On-Scene Coordinator (FOSC) to approve in situ burning in Cook Inlet, Prince William Sound, and the Beaufort Sea. While the effectiveness of in situ burning is generally accepted, there remain some unanswered questions regarding the tradeoff of air quality versus potential shoreline/biologically sensitive-area contamination from the slick. The MMS, in conjunction with Environment Canada and others, is continuing research to quantify this tradeoff (Evans et al., 1993).

In situ burning likely would be used for a large spill in the Sale 144 area because it greatly reduces the need for recovery, storage, transportation, and disposal of spilled oil; and it is effective and efficient (Allen and Ferek, 1993). *Additionally, suitable equipment is in place as is the avenue for approval of in situ burning.* However, until additional information is available concerning the transport of the smoke plume, this technique is not likely to be used if the trajectory of the smoke plume is predicted to move toward populated areas, depending on the distance away from said populated area.

Tests have shown that in situ burning can be very effective, providing the oil is concentrated and nonemulsified. Ice actually can be a benefit to in situ burning because oil tends to concentrate in leads, small open-water areas, and melt pools and against large ice floes. Wind and air temperature are factors that can reduce the effective- ness of in situ burning, primarily by restricting initial combustion of a slick. Winds >20 kn and winter temperatures increase the amount of effort and energy required to ignite spilled oil.

One of the major concerns expressed in the past has been that a large oil spill in moving pack ice would result in hundreds of thousands of small pools of oil, each requiring ignition. Industry has responded to this need by obtaining and testing an air-deployable ignition system, the Helitorch. The Helitorch is deployed from a helicopter and emits globs of ignited gelled gasoline or diesel fuel. It can operate from altitudes of 15 to several hundred feet with forward speeds of 40 to 60 mi per hour. The Helitorch is very suitable for use in responding to a large spill spread over a wide area.

(d) Open-Water Containment and Recovery: During the short summer season, mechanical containment and recovery generally is accepted as the primary means for containing and recovering an oil spill in open-water conditions. Equipment employed in a mechanical response generally consists of a boom for spill containment; skimmers for spill recovery; and vessels to tow the boom, act as operating platforms, and store the recovered oil and water.

The purpose of containing spilled oil is to prevent spreading and to concentrate the oil for more efficient mechanical recovery or in situ-burning operations. Oil-spill-containment booms are the primary tool used for offshore containment during open-water or limited broken-ice conditions (less than approximately 25% ice coverage). Booms are classified according to their containment capabilities. Calm-water booms can be used to contain oil through an International Sea State (ISS) of 1 (significant wave height to 1 ft), harbor booms through an ISS of 2 (significant wave height to 0.9 m [2.9 ft]), and offshore booms with some success through an ISS of 4 (significant wave height to 2.1 m [6.9 ft]). Other booms, such as sorbent booms, fire-resistant booms, and ice-deflection booms, are categorized by their special use. For operations in the Sale 144 area, industry would be expected to maintain or have available a state-of-the-art offshore-containment boom as well as an offshore fire-resistant containment boom for in situ-burn operations.

Recovery is defined as the mechanical removal of oil from the shoreline, water, or ice environment. For oil on water, recovery techniques can be divided into two groups—the use of skimmers and the use of sorbents. Because in situ burning generally is not regarded as a recovery technique, it is discussed separately.

Sorbents are made of oleophilic materials designed to absorb up to 30 times their weight in oil. Sorbents are available in a number of forms and are primarily used to recover small oil spills and films from the water surface. Other sorbent applications include spill recovery in small melt pools, on shorelines, and around industrial equipment; they also have been used to recover burn residue after in situ-burn testing. It is expected that sorbents would be used, as described above, in the Sale 144 area.

Skimmers are mechanical devices designed to float on the surface of the water and recover oil. They are generally categorized as suction devices, weir devices (blocking the water so oil flows over the top), centrifugal devices, oleophilic devices (the oil adheres to the material), and hybrid devices (which use a combination of the above principles). The effectiveness of a skimmer depends on the characteristics of the oil, slick thickness, oceanographic conditions (especially sea state), oil-encounter rate, throughput efficiency, and recovery efficiency. As a general rule, optimum efficiency is reached when the slick is thick and the sea is calm. Increasing the oil's viscosity, the amount of debris encountered, and/or the sea state reduces the effectiveness of the skimmer, causing increased water recovery and downtime. Local oil-spill cooperatives, such as Alaska Clean Seas, maintain a number of each type of skimmer. In the event of a large spill in open water or limited broken ice, any or all such skimmers would be expected to be used in the Sale 144 area.

(e) Detection and Tracking: There are a number of methods and devices that may be used in the Sale 144 area for spill detection and tracking. Among the most widely used is visual detection by trained personnel from the drilling structure, support vessels, or spotter aircraft. When the oil is at the surface, it is usually visible from the air, although its appearance has wide variations in color depending on the thickness of the slick, the viewing angle and altitude, and light conditions. To the untrained eye, naturally occurring materials such as silt-on-ice, seaweed, cloud shadows, and ocean-surface ripples may be confused with oil slicks. Additionally, oil may be difficult to visually detect on dark-colored shorelines, when mixed with biogenic materials and when located under ice or snow. Sophisticated remote-sensing equipment can help discern the differences between naturally occurring anomalies and oil slicks and recently has been used to enhance the information gathered by visual means.

Remote-sensing systems include still and video cameras, scanners, infrared sensors, ultraviolet and fluorosensors, radar, microwave, and satellite imagery. A number of remote-sensing systems currently are available. The USCG maintains an aircraft-deployed oil-spill-surveillance system known as the "Aireye." The Aireye is an airborne, real-time, all-weather, day/night, remote-sensing system. The Aireye system's primary sensor is a Side Looking Airborne Radar with an oil-slick-detection range of 24 to 40 km (15-25 mi). Other Aireye sensors include infrared/ultraviolet scanners and an aerial-reconnaissance camera and low-light-video equipment. In a large-spill event, it is likely that this system would be used to detect the extent of the oil.

In addition to remote sensing, real-time-tracking and -trajectory modeling are extremely important tools for monitoring spill movement and for spill-response planning. Spill-tracking buoys that are designed to move with the oil are commercially available. The spill-tracking buoys use either a radio-tracking device or a satellite to detect their position. The buoys are deployed in the leading edge of the slick and used to monitor spill movement and to determine resources that may be at risk. Real-time-trajectory models, such as the National Oceanic and Atmospheric Administration's (NOAA's) Oil Spill Simulation Model, also may be used in the Sale 144 area to determine what resources are at risk and to target areas for the most efficient use of spill-response equipment. Once the spill is located, spill-specific-containment and -recovery operations may be planned and initiated.

(f) Dispersants and Other Chemicals: The term "chemical agents" is an all-encompassing term that describes chemicals that may be used during an oil-spill response. Numerous chemical agents have been commercially produced and sold over the past 2 decades. These chemical agents include dispersants, gelling agents, emulsion breakers and preventers, biodegradation agents, and several other miscellaneous products.

Dispersants are chemical agents that contain surfactants for breaking up oil into small droplets in the water column. They are the most common of all the chemical agents available for spill response. Dispersants decrease the interfacial tension between the oil and the water, thus reducing the cohesiveness of the slick. Aided by wind and waves, the oil is dispersed into the water column in the form of small droplets. Breaking the slick into small droplets increases the surface area available for natural degradation and reduces the concentration of the oil. Dispersants are not widely accepted, despite their claimed benefit, primarily because of biological concerns and because their effectiveness has not been proven in field trials or actual spill events. The ARRT has conditionally preapproved the use of dispersants in the Cook Inlet and Prince William Sound areas but not for the Sale 144 area. Cold air and water temperatures tend to reduce the effectiveness of dispersants; and for this reason, dispersants probably would not be used in the Sale 144 area.

Gelling agents, emulsion breakers, oil herders, and several other chemicals have been marketed for spill response but are not widely used during offshore-spill responses. None are currently anticipated for use in the event of a large spill in the Sale 144 area.

(g) Shoreline Response: If a large spill occurred in the Sale 144 area, some shoreline contacts probably would occur. The techniques for removing oil from shorelines in Alaska are varied depending on the physical properties of the oil, the extent of shoreline oiling, environmental conditions, the type of shoreline to be cleaned, and the logistical requirements. In general, the shoreline-response methods expected to be used in the Sale 144 area include direct suction, small skimmers for pooled oil, the use of sorbent material, cool- and warm- high- and low-pressure-water flushing, direct removal of contaminated material and sediments, mixing/aeration of oiled sediment, burning, bioremediation, chemical treatment, and natural degradation (i.e., no response where cleanup action would cause more damage than the oil itself).

(h) Storage/Disposal: An important consideration for both planning and executing an oil-spill response is the interim storage and disposal of recovered oil and oil-contaminated debris. While recovered oil and oil-contaminated debris may be stored in small, collapsible containers that are normally stored as part of the onsite equipment, the problem becomes much larger as the spill size increases. For larger spills, limited storage is available on work boats and drilling units, and additional storage can be made available by using barges in the area of operations. Flexible bladder-type tanks are available from local cooperatives and may be in the inventory of the lessee's onsite-spill-response equipment. For extraordinary spills, additional barges could be moved to the Sale 144 area from other areas of Alaska to facilitate the necessary storage.

Once the oil and debris are collected, disposal options include the use of incinerators, flare burners, and transport to refineries for fluid processing or landfills approved to accept oily waste. Currently, there are no incinerators or disposal sites approved in Alaska that can accept large amounts of oil or oily debris.

(3) Response Deficiencies: There are several conditions for which current technology cannot effectively clean up an oil spill in the Arctic. The most obvious deficiency would be when both mechanical recovery and in situ burning are not effective. If the oil becomes emulsified, it is difficult to burn. Ignition of an oil slick also is difficult in strong winds. If a spill contaminates an extremely large area of broken or pack ice, and the oil is not concentrated in leads or open areas between the ice, only a very small percentage of the oil can be expected to be recovered by mechanical means. A few skimming systems have been proposed that use ice-strengthened hulls to break up oiled ice and recover the oil. While prototypes of some of these systems have been built and others are planned, they have not been extensively field tested in the Arctic.

In extremely dynamic conditions, especially during early winter storms, freezing ice particles may break an oil slick up into fine droplets and incorporate them into a freezing ice sheet spread over a very large area. Both burning and mechanical recovery would be difficult if not impossible in this condition. In general, if the oil becomes intermixed with the ice and widespread over a large area, and if the oil cannot be burned, then only a very small percentage of the oil could be expected to be recovered.

There is also a need to improve remote-sensing capabilities for oil spilled under ice and in broken-ice conditions. Remote sensing would be a crucial element for successful response to a large spill.

c. *Oil-Spill Response:*

(1) *Locally Available Spill-Response Equipment:* The Alaska OCS Region policy requires that spill-response equipment be staged at the site of operations and that additional equipment be available in the area of operations for a worst-case spill. The onsite equipment is used to clean up operational spills and to serve as the first response effort for a large spill event. The response teams normally are composed of personnel assigned to the platform, drilling vessel, support boat, or barges serving the offshore facility. For a large spill, additional equipment, response personnel, and other resources would be obtained through oil-spill cooperatives and other companies working on the North Slope and throughout Alaska.

Currently, there are three oil-spill cooperatives located in Alaska that have equipment inventories and personnel for mechanical, dispersant, and in situ-burning response. Alaska Clean Seas serves the North Slope, Cook Inlet Spill Prevention and Response Inc. (CISPRI), serves the Cook Inlet Region, and Alyeska Pipeline Service Company/ Ship Escort Response Vessel System is responsible for the pipeline corridor and the tanker traffic in Prince William Sound. All three oil-spill cooperatives have substantially increased their equipment inventories since the *Exxon Valdez* ran aground in March 1989. A list of the current equipment inventories of these cooperatives is located in the administrative record on file at the MMS, Alaska OCS Region, Library. Alaska Clean Seas is well equipped to deal with an offshore spill from OCS operations, although equipment from CISPRI or Alyeska could be used. The USCG also maintains a small cache of equipment in Anchorage that may be used in the event of a spill.

(2) *Response Time:* The Guidelines for Approval of OSCP's set a 6- to 12-hour target-response time for initiating recovery operations with prestaged or onsite response equipment if local conditions and geography permit. Response time is defined by the guidelines as the time interval between when the spill occurs and when the response equipment initiates recovery at the spill site. When reviewing OSCP's for possible approval, MMS takes numerous factors into account, such as slick location with proximity to land or sensitive resources and the predicted spill trajectory from the site of operations. The MMS may increase or decrease the required response time depending on the outcome of the analysis. Additionally, while neither the guidelines nor the 30 CFR 250.42 contingency-planning regulations require onsite equipment, requirements outlined in the guidelines for onsite oil-spill-response equipment usually are necessary for operators to achieve the response time. Such a requirement, in conjunction with trained spill-response teams at the site of operations, reduce the probability that sensitive areas will be contacted should a spill occur.

(3) *Effectiveness of Oil-Spill Cleanup in the Open Ocean:* There are four accepted approaches for responding to an oil spill in the open ocean—mechanical containment and recovery, chemical dispersion, in situ burning, and the monitor-and-wait/natural-dispersion and evaporation approach. The monitor-and-wait approach may be used during an oil spill because the meteorologic and sea conditions preclude safe response operations, or because the spill does not and is not predicted to persist or cause effects. However, if the monitor-and-wait response is used because of environmental conditions, some of the natural weathering processes may be increased (i.e., dispersion, evaporation, dissolution, and biodegradation). The effectiveness of each, however, depends on timing, weather, and sea conditions; available manpower and equipment; and a trained response team. Several of the listed factors that affect spilled-oil recovery cannot be changed by spill responders. However, the remaining factors—response timing and the availability of equipment and manpower—may greatly affect the effectiveness of a spill response in the open ocean.

Once oil is spilled onto the surface of the water, it spreads by gravity, wind, and currents. As the oil spreads, the slick breaks up into smaller, thinner pieces that cover an increasingly larger area. As such, the most effective mechanical response would be conducted during the early hours following a spill, while the slick is still relatively thick and small in areal extent. Under these conditions, mechanical equipment could spend the majority of time booming and skimming oil rather than chasing individual slicks. Historically, mechanical response has removed 5 to 15 percent (USDOI, MMS, Gulf of Mexico Region, 1983) of the spilled oil from the water surface. For example, during the *Exxon Valdez* oil spill, at-sea recovery of oil was estimated by Exxon at 0.01 percent through the first 2 weeks and 7 percent through the first 3 weeks (Oil Spill Intelligence Report, 1989a,b). The USCG Pollution Reports (USDOT, USCG, 1989) indicate a minimal mechanical-response effort during the first 24 hours of the spill, when the slick was thick, small in areal extent, and conditions were near ideal for a mechanical response. Had a sufficient amount of equipment and personnel been available to respond to this incident during the early hours of the spill before a large amount of spreading had occurred, the initial volume of oil recovered mechanically could have been much higher.

While in situ burning may remove a large quantity of oil from the sea surface with high efficiency (>90% in laboratory and tank tests), it is limited by wind speed (approximately 20 kn), the degree of emulsification of the oil (oil will burn if it contains less than approximately 20-30% water), the current and wave constraints for conventional containment boom, and to a lesser extent—time (Allen and Ferek, 1993). In situ burning also may be limited by permit restrictions, such as the direction of the wind and the proximity of the potential burn site to populated areas. Such limitations likely would be established during the permitting process. The 5- to 15-percent recovery figure referenced above does not include the use of in situ burning. Oil-spill-response capabilities have advanced considerably since the 1983 reference providing for improved detection, containment, recovery, and removal options (USDOI, MMS, Alaska OCS Region, 1991). Recent advances in fireproof containment-boom technology have made the in situ-burn response a much more attractive option for spill responders. Such advances in spill-response technology, coupled with the increased state of readiness in the sale area and evaporation and natural dispersion, could increase the overall oil removal from the water surface to >50 percent, provided meteorologic and oceanographic conditions allowed a mechanical response. Areas with states of readiness and equipment caches similar to those available in the sale area have experienced such removal during spills. During the *American Trader* spill offshore Huntington Beach, NOAA and the USCG estimate that 69 percent of the spilled oil was removed mechanically, naturally dispersed, and evaporated. In this case, a mechanical response was initiated within 12 hours of the spill, and conditions favorable for mechanical response occurred for 6 days (Card and Meehan, 1991). While cases such as the *American Trader* are not common, the nationwide increase in equipment and readiness likely will cause an increase in such successful responses.

(4) The Role of the Federal Government During an Oil-Spill Response: The Federal Government may become involved in an oil-spill response depending on the size and location of the spill. The Federal mandate for Federal involvement is set forth in the National Contingency Plan, 40 CFR 300. The plan sets forth requirements for an Alaskan Regional Response Team comprised of representatives of Federal Government agencies with jurisdiction over the resources at risk. The primary task of the ARRT is to ensure that in the event of an oil or hazardous-material spill, a prudent cleanup effort is launched and spill cleanup is balanced with environmental effects. The policies and procedures that guide the ARRT are set forth in the Alaska Regional Contingency Plan.

In the event of a spill, a FOSC would be appointed based on the location of the spill—for all offshore areas, the FOSC is appointed by the USCG. If the spill threatened State resources, a State On-Scene Coordinator would be appointed by the State of Alaska and would be consulted by the FOSC for all decisions that potentially affect State resources. Prior to OPA 90, it was the FOSC's mandate to ensure that the spill was being removed in the best possible manner. If the FOSC determined that the spiller was not providing an effective response, the FOSC would either require the spiller to commit additional resources or federalize the spill (the Federal Government takes over direction of the response). If the spill were federalized, it would be the Federal Government's responsibility to clean up the spill to the best of its abilities. The OPA 90 changed the FOSC's authority to allow Federal Government spill mitigation prior to any determination of responsibility or adequacy of the response currently under way.

Included in the FOSC's duties is the regulation of chemical and in situ-burning use. Such regulation includes bioremediation chemicals, dispersants, herding agents, and a host of other chemical agents listed on the National Contingency Plan (NCP) Product Schedule. According to the NCP, potential approval of the use of chemical agents or burning, where feasible, must be reviewed by the ARRT. While such ARRT approval is prudent, it is time-consuming and may preempt the spiller's use of a chemical or burning response. To avoid such delays, the ARRT created dispersant and in situ-burn preapprovals for selected areas within Alaska, one of which includes Prince William Sound. The preapprovals provide the FOSC with ARRT concurrence for dispersant or in situ-burning use, depending on the location of the spill and the time of the year. The ARRT continues to examine these and other areas of preapproval to enhance spill response.

5. Constraints and Technology: This section discusses those environmental features that are considered hazards to petroleum exploitation in the Beaufort Sea Planning Area and the strategies and technologies used to mitigate their effects. The environmental features identified as potential hazards include sea ice, permafrost, waves and currents—especially during storm surges, faults and earthquakes, unstable surface sediments, natural gas hydrates, shallow gases, and erosion. These features are part of the physical environment described in Section III.A of this EIS.

a. Sea Ice: Sea ice is the principal environmental factor affecting the offshore development of petroleum resources in the planning area. The large, lateral forces that can be exerted by moving icefloes and sheets, ridges, floebergs, and ice islands are a major concern in the design and operation of offshore facilities associated with petroleum exploration and production. The force that moving sea ice exerts on a structure is limited by the strength, size, and shape 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 theoretical ice 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.

(1) Exploration: The drilling units that have been used to drill exploration wells in the 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 and the Concrete Island Drilling System, and (5) floating units such as the ice-strengthened drillships and the Conical Drilling Unit. Sea-ice forecasting has developed as a strategy to maximize drilling time and to 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 if weather and sea-ice conditions become severe enough to threaten the operation.

To reduce the threat that sea ice poses to the floating drilling units, icebreakers and icebreaking supply boats perform ice-management tasks that 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 continuously steam 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, MMS requires placement of the 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. The BOP is designed to close the top of the well, control the release of fluids, permit pumping fluids into the hole, and allow movement of the drill pipe.

(2) Development and Production: If economically recoverable petroleum resources are discovered, structures designed for the recovery of oil will be placed in the lease-sale area. The experiences gained from exploration units would contribute to the design and construction of these production platforms. Production platforms would 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 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, and ice islands. Placement 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 a 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 are 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-Offshore Pipelines:*** Transportation of oil from the production sites to refineries may be by pipelines. A considerable amount of experience has been derived from pipeline operations in many other offshore areas. As with other techniques, some of this experience would be used to design, construct, and operate petroleum-transportation systems in the planning area. Experience with arctic petroleum-transportation systems is very limited and, thus, a number of new problems would have to be solved.

The threat that sea ice poses to a marine-pipeline system in the Sale 144 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 would afford protection from moving ice.

Offshore pipelines could 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 by bottom or surface tows. Only the ice in the landfast zone may be thick and stable enough to support the equipment used to lay pipe in the winter. Short pipelines and shallow-water sections of longer pipelines probably would be installed by the bottom-pull method. Longer pipelines probably would be installed by a vessel that can lay pipe at a rate of about 2 km per day.

Pipeline-burial depth would 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 phenomenon, it is difficult to predict maximum gouge events that might occur within some time interval for specific segments of the seafloor.

Those segments of offshore pipelines that cross the shoreline also must be protected from such sea-ice hazards 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. Continuous, solid-fill causeways would alter the nearshore circulation and sediment-transport patterns and, if located near river mouths, affect the distribution of the freshwater that floods the nearshore ice during spring runoff. The nature of the changes would be site specific and depend on the length and orientation of the causeway.

b. Other Constraints:

(1) ***Permafrost:*** The geotechnical effects that must be considered in the design of structures that are to be placed in areas underlain by subsea or subterranean permafrost are, in many respects, similar. However, studies to date indicate that the subsea permafrost usually is warmer and more saline than the subterranean permafrost and is, thus, more easily disturbed by thermal disruptions. Potential hazards associated with the presence of permafrost include thaw subsidence and frost heave.

Thaw subsidence may be caused by activities that disrupt the thermal balance of the permafrost. Such activities include: (1) drilling wells through existing permafrost layers, (2) laying and maintaining crude-oil pipelines, (3) placing and operating bottom-founded gravity structures, and (4) constructing artificial islands and berms.

The most common cause of thaw subsidence may be associated with the production of crude oil. The flow of oil from multiple wells that are relatively close together in the permafrost zone may lead to greater settlement. As a result of the permafrost thawing, the well casing may be subjected to increased loads as the pore pressure and the stiffness of the surrounding sediments are reduced.

However, if the well were shut in and the flow of hot oil stopped, the pore water in the surrounding sediments may refreeze. The freezeback expansion of the refrozen pore water may cause large radial pressures against the well casing. By adapting drilling-mud composition and hydraulics, drilling rates, cementing techniques, and casing designs to arctic conditions, wells that pass through permafrost zones are being successfully drilled, completed, and produced.

Pipelines may cause thaw subsidence if they are located in regions where ice-bonded permafrost is near the surface of the seafloor. Some thawing of the permafrost is acceptable if it does not result in excessive deformation of the pipe. Submarine pipelines have substantial buckling resistance and can tolerate more deformation than terrestrial pipelines. Methods to prevent thaw subsidence during the life of the pipeline include insulation, refrigeration, and overexcavation and backfill. Pipeline parameters that can be adjusted to reduce thawing include (1) increasing the thickness of insulation or pipeline separation (if > 1 line) and (2) decreasing pipeline temperature, pipe diameter, or depth of cover.

Pipeline routes may be selected to avoid areas of thaw-unstable permafrost near the surface. A relatively thick layer of unfrozen soil provides a thermal and mechanical buffer between the pipeline and ice-bonded permafrost. Artificial islands and causeways would be subject to seasonal freezing and permafrost formation as are the natural geomorphological features of the arctic environment.

(2) Natural Gas Hydrates: Natural gas hydrates have been encountered in boreholes drilled not only in the arctic offshore and onshore environments but also in holes drilled in the seafloor in many other areas throughout the world in recent years. During drilling, the rapid decomposition of the hydrates may cause a rapid increase in pressure in the wellbore, gasification of the drilling mud, and the possible loss of well control. If the release of the hydrate gas were too rapid, a blowout may occur, and there is the potential danger that the escaping gas may be ignited.

However, the hydrate zone can be detected by continuously monitoring the drilling muds for gas increases. Also, the rate of hydrate decomposition can be reduced by (1) lowering the temperature or controlling the density of the drilling mud, (2) drilling at controlled penetration rates, or (3) using insulated high-strength casing opposite the hydrate-bearing formation. Hydrate zones also may be detected by seismic surveys prior to drilling.

In addition to permafrost thaw, the flow of hot petroleum hydrocarbons past a hydrate layer would result in hydrate decomposition around the wellbore and the loss of strength of the affected sediments. Also, the freezeback of a well during shut-in periods may cause reformation of the hydrates and induce high pressures on the casing string.

(3) Waves, Currents, and Storm Surges—Flooding and Erosion: There is a considerable amount of coastal and offshore engineering experience from other areas that can be adapted to the arctic marine 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.

(4) Faults and Earthquakes: Faults and earthquakes are considered to be a high hazard for all the facilities that rest on the seafloor. However, as noted in Section III.A.1.b(5), seismic activity in the Sale 144 area occurs mainly off Camden Bay. Data indicate that the magnitude of the seismic events in this area may not be sufficient to cause structural failure of properly designed platforms or pipelines buried in the seafloor sediments. But if such movement occurred, and was severe enough, it could damage part or all of an entire bottom-founded structure. Movement along fault surfaces may destroy the integrity of producing wells located within or near the fault zone and could produce a seep if the fault extended to the surface or a blowout if the rupture were at or near the surface.

Because fault surfaces can be detected by seismic surveys, facilities could be located away from potentially active faults or fault systems. The risk of locating facilities near faults is greatly reduced if they are no longer active. The determination of active faults or fault systems would have to be made, at least in part, by correlating faults with known earthquake epicenters.

Structures must be designed to withstand the upper limit of ground motion associated with seismic activity; and there is considerable experience associated with the design, construction, and operation of offshore facilities in areas of more intense seismic activity (e.g., southern California and Cook Inlet, Alaska).

(5) 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 are important considerations. 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. On the continental shelf inshore of the 50-m isobath, the slope of the seafloor generally is very low, except in the vicinity of the Barrow Sea Valley. Except in the vicinity of Camden Bay, ground motions associated with earthquakes generally are low. Thus, mass movement in waters <50 m generally would not be hazard that would significantly affect offshore operations. Hazards associated with mass movement are most likely to be found (1) in the Camden Bay area during an earthquake; (2) in the deeper parts of the lease-sale area, particularly in the vicinity of the shelf break; and (3) possibly in the vicinity of the Barrow Sea Valley.

Pipelines are susceptible to 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 adaptions to mudslide problems include using flexible joints, which allow some movement, and safety couples, which activate immediate shut off of the line flow if the line is moved.

(6) Shallow-Gas Deposits: Sediments in which gas has accumulated are a potential hazard if they underlie manmade structures or are penetrated during drilling. The presence of gas may lower the shear strength of the sediments and reduce their ability to support structures. If the pressure is high enough, the gas may cause a blowout during drilling. The presence of shallow gas in the sediments of the continental shelf can be determined from seismic profiles. Measures can be taken to reduce the threat that low-shear-strength sediments may have to the integrity of manmade structures and that gas may have to drilling operations.

6. Major Projects Considered in the Cumulative Case: The analysis for the cumulative case is based on the potential effects associated with (1) exploitation of known or estimated resources from onshore and offshore State and/or Federal leases, (2) major potential and ongoing resource-development projects, (3) major potential and ongoing construction projects, and (4) other facilities whose activities may affect the proposed sale area. This section focuses on those oil and gas projects that can be hypothesized to have some reasonable chance of occurrence during the life of the proposed action. The discussion in this section is not assumed to be definitive. Each of the analysts contributing to this EIS also may focus on other issues that they feel to be particularly germane to their resource topics.

Past and Projected State Oil and Gas Lease Sales: Since the first State of Alaska lease sale in December 1959, the State has leased 4,688 tracts of land totaling 29.03 million hectares (ha). Of that amount, 13.19 million ha were leased through State sales that primarily offered North Slope/Beaufort Sea leases. In the past 10 years, the State has conducted 21 lease sales in the North Slope/Beaufort Sea area, leasing some 7.88 million ha. Currently, there are 816 State leases active north of the Brooks Range totaling approximately 6.65 million ha. Of this amount, 934,038 ha are offshore leases, 5.11 million ha are onshore leases, and 609,643 ha are leases composed of both on- and offshore-properties. In their current 5-year plan (extending through 1999), the State plans to offer five lease sales on lands north of the Brooks Range. Offered lands will approximate 13.03 ha. Three of these sales are to be in State waters and lands along the Beaufort Sea coast (State of Alaska, Dept. of Natural Resources [DNR], 1995a).

Current and Projected State Oil Production: Since the first production well drilled on the Prudhoe Bay structure, North Slope fields have produced a cumulative total of 10.483 Bbbl of oil (until 1994). Production output on the North Slope peaked in 1988 at 2.0 MMbbl of oil per day and has subsequently declined to 1.5 MMbbl per day. Of the 11 producing fields on the North Slope, Prudhoe Bay, Kuparuk River, and the Endicott, in that order, have been the most productive. Figure IV.A.6-1 indicates the location of some of the producing fields as well as recent discoveries within the North Slope petroleum province. The State of Alaska estimates that the combined production from the presently operating and to-be-developed fields will rise slightly to 1.6 MMbbl per day in 1995 and then decline to 1.1 MMbbl per day in 2000, eventually reaching a daily output of 159,000 bbl in 2015. The State expects that cumulative production during 1995-2015 will be 5.9 MMbbl (State of Alaska, DNR, 1995b).

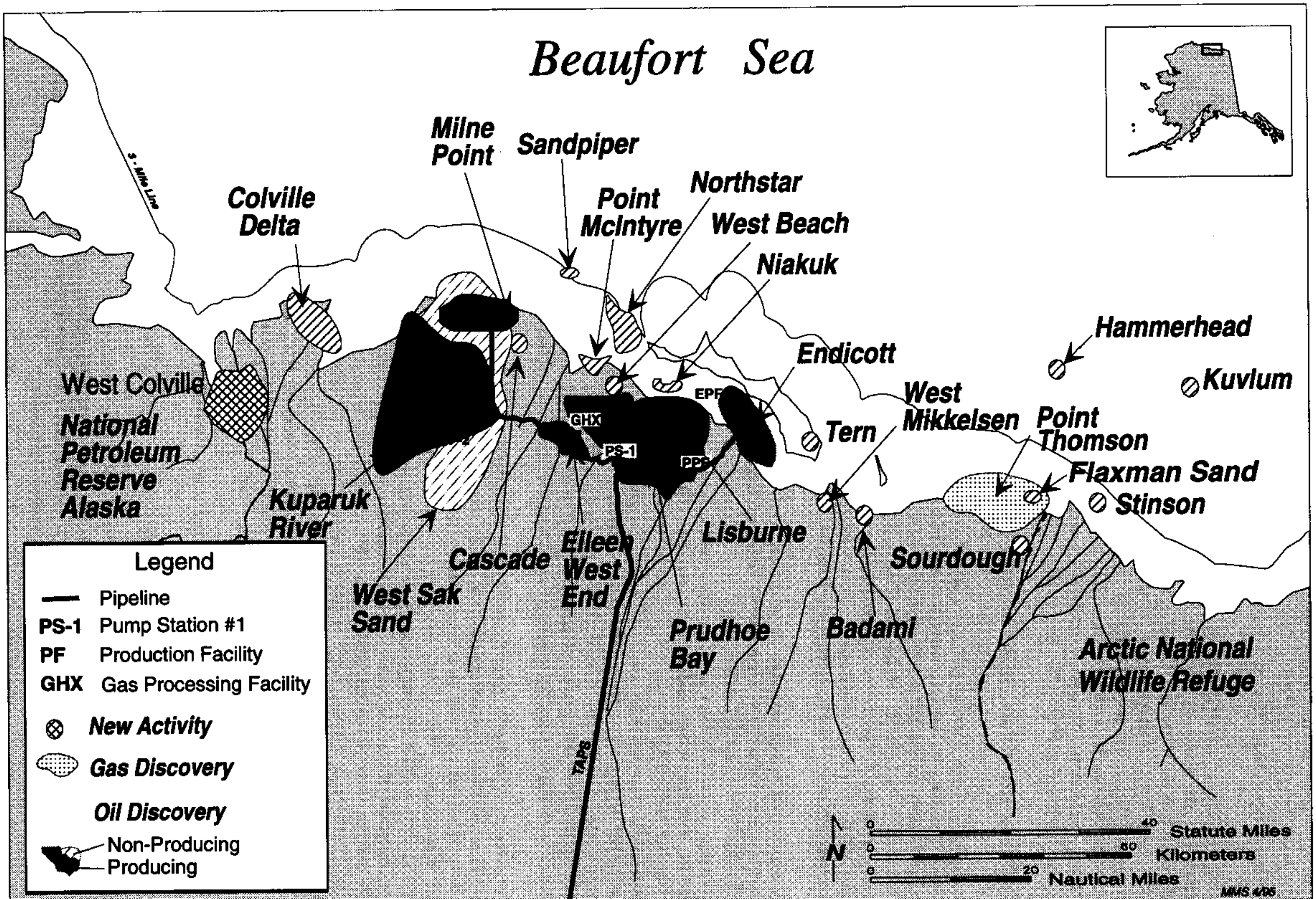


Figure IV.A.6-1. North Slope Oil and Gas Fields, New Discoveries, and Proposed Activities

Presently, there are 1,404 oil wells in operation in and around the Prudhoe-Kuparuk and satellite units' infrastructure. Of these wells, 714 are free-flowing wells. The remaining wells produce either by gas lift or submersible pump. Of the 561 service wells, 162 are gas-injected wells, and the balance are water-injected wells.

There are a number of ongoing drilling efforts in the Prudhoe-Kuparuk region. Figure IV.A.6-1 indicates some of the locations of new wells. In the future, industry also may produce the hydrocarbon reserves contained in formations such as the West Sak, Colville, and Ugnu Sands formations. These are shallow oil-bearing formations containing viscous low-temperature oil. The extraction of resources from the sands may require more intensive and creative methods of extraction that may not be supported by the prevailing economic climate. The State DNR estimates that total North Slope reserves within developed fields are 5.9 Bbbl. Reserves in undeveloped fields are estimated at 380 MMbbl. However, this figure is misleading because the total amount of recoverable reserves actually has increased over the years due to improvements in drilling technique.

Past OCS Lease-Sale Activity: Since December 1979, the USDOI has conducted five lease sales in Beaufort Sea Federal waters. The most recent was Sale 124 in June 1991. During this time, 631 leases have been sold totaling 1.13 million ha. Some 28 wells have been drilled on Federal Leases, with 9 wells determined as producible. All wells have been plugged and abandoned because field economics have not been favorable for production. At present, potentially producible prospects within Federal waters lie in the Northstar, Kuvulm, and Hammerhead Units (see Fig. IV.A.6-1). It is estimated that the Northstar Unit contains approximately 180 MMbbl of recoverable reserves; however, no adequate assessment is available for the Hammerhead or Kuvlum units. Currently, there are 62 active leases on Federal submerged lands. Should these prospects be developed, one or two pipeline causeways may be constructed to protect the pipe from nearshore ice forces.

Infrastructure and Transportation: At its present level of decline, unless reversed, North Slope oil production will reach a point around 2010 when, due to falling oil output and raising operational costs, the TAPS will be forced to shut down (perhaps earlier, depending on operational costs). In 2010, the TAPS will have a flow rate of approximately 300,000 bbl per day. For the system to carry this reduced flow, extensive modifications will be required for both the pipeline and the pump stations. The proposed action, should it come to fruition, would extend the life of the TAPS; however, if more fields were not brought on to support and expand upon the resources of the proposed action, the TAPS would become nonoperational sometime between 2015 and 2020, or perhaps earlier depending on operational costs. This time- frame is well before the sale 144 estimated field-termination date of 2027. Given the decline of the North Slope fields and the uncertainty of the North Slope's output being replaced by any other oil formation, it is more than likely that as long as the TAPS is operational the system will have surplus capacity to process and transport any hydrocarbons produced by the Sale 144 proposal.

Valdez tanker-transport traffic from the proposal is expected to vary from 38 tanker loadings in 2004 (field startup) to 135-145 in 2008 (field maximum) to 76 in 2016 (late maturity/decline). Currently 700-800 tanker trips issue annually from Valdez. Should there be no other new North Slope production, apart from that due to the proposal, by 2008, tanker traffic from the Sale 144 lease area would equal 20 percent of all oil transported by tanker from Valdez. Tankerage from the proposed action would then make up an increasing percentage of all tanker traffic until the shutdown of the TAPS. By 2014, the transport of oil produced from the proposed Sale 144 area would equal 27 percent of all oil moved from Valdez. Should all sources (including those from currently undeveloped sources) be recovered, the percentage of tanker traffic related to the proposed action would fall slightly, but it still would remain a significant portion of all oil-related traffic. (See Fig. IV.A.6-2 for oil-tanker routings.) In addition to the TAPS shipments, crude oil also is transported from the Drift River terminal in Cook Inlet to the west coast of the U.S. (California). Drift River production is in a steady decline with annual shipments of crude at 9 MMbbl or less, and tanker loadings at 25 to 29 per year. Because the Drift River shipments are <4 percent of the total TAPS tanker traffic bound for the west coast of the U.S., the cumulative effects of Drift River tankering are subsumed within the general cumulative case discussion of the effects of TAPS tankering.

The potential crude-oil tankering from Valdez to the Far East will join existing Liquefied Natural Gas (LNG) tanker traffic from the Nikiski, Alaska, LNG plant. The Nikiski plant is the U.S.'s only facility that liquefies natural gas. Every 10 days, the Nikiski facility loads an 80,000 m^3 LNG tanker for a round trip to Tokyo. The Nikiski facility has been transporting LNG via tanker to Japan since 1968 without significant spillage. Because LNG would boil off and disburse quickly when exposed to normal air temperatures and North Pacific winds, it is not considered a substantive environmental threat along the tanker route.

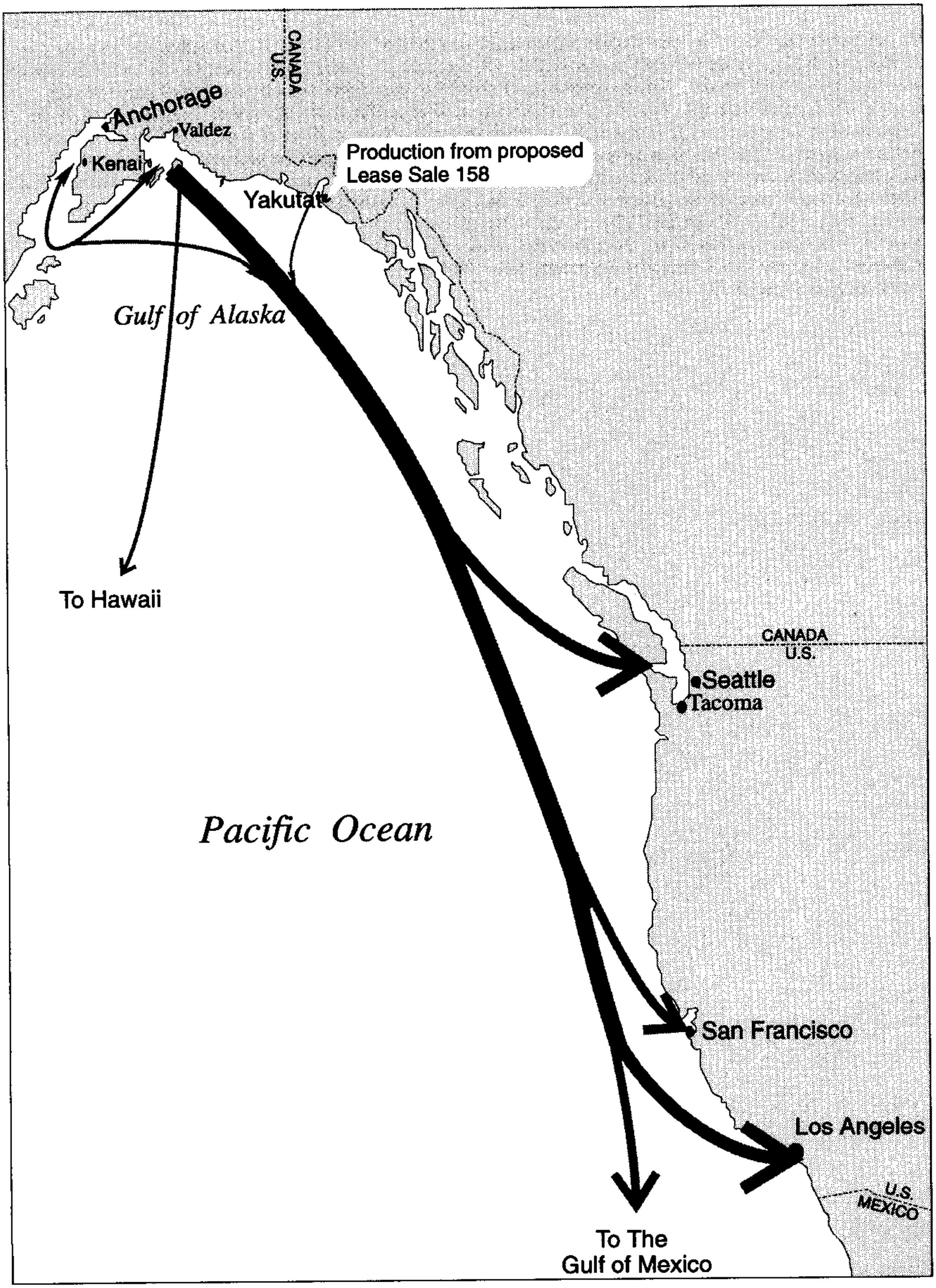


Figure IV.A.6-2. General Tanker Routes and Ports of Entry

On November 28, 1995, President Clinton signed legislation (S.395, Pub.L.104-58) that authorizes the export of Alaskan North Slope crude oil when transported in U.S. flag tankers, unless the President should find such exports are not in the national interest. The determination of national interest (to be completed by April 28, 1996) is to consider the potential effects of this oil on the environment using an environmental review being prepared by the Department of Commerce. The lifting of the oil-export ban raises the possibility of some tanker traffic to the Far East from production generated under the proposal. Figure IV.A.6-3 indicates the probable route that tankers, including tankers carrying oil produced under the proposal, bound from Valdez to the Far East would be traveling. Alaska-generated crude oil being shipped to the Far East along the indicated tanker route is expected to range between 60 and 90 MMbbl during 1996. By 2000, the annual transported quantity of crude oil could drop to 9 MMbbl. The routing indicated in Figure IV.A.6-3 would bring the tankers more than 200 mi offshore of the Aleutian Islands. At such a distance, any pollution event is expected to have a minimal effect on the biological resources of the Aleutian Chain.

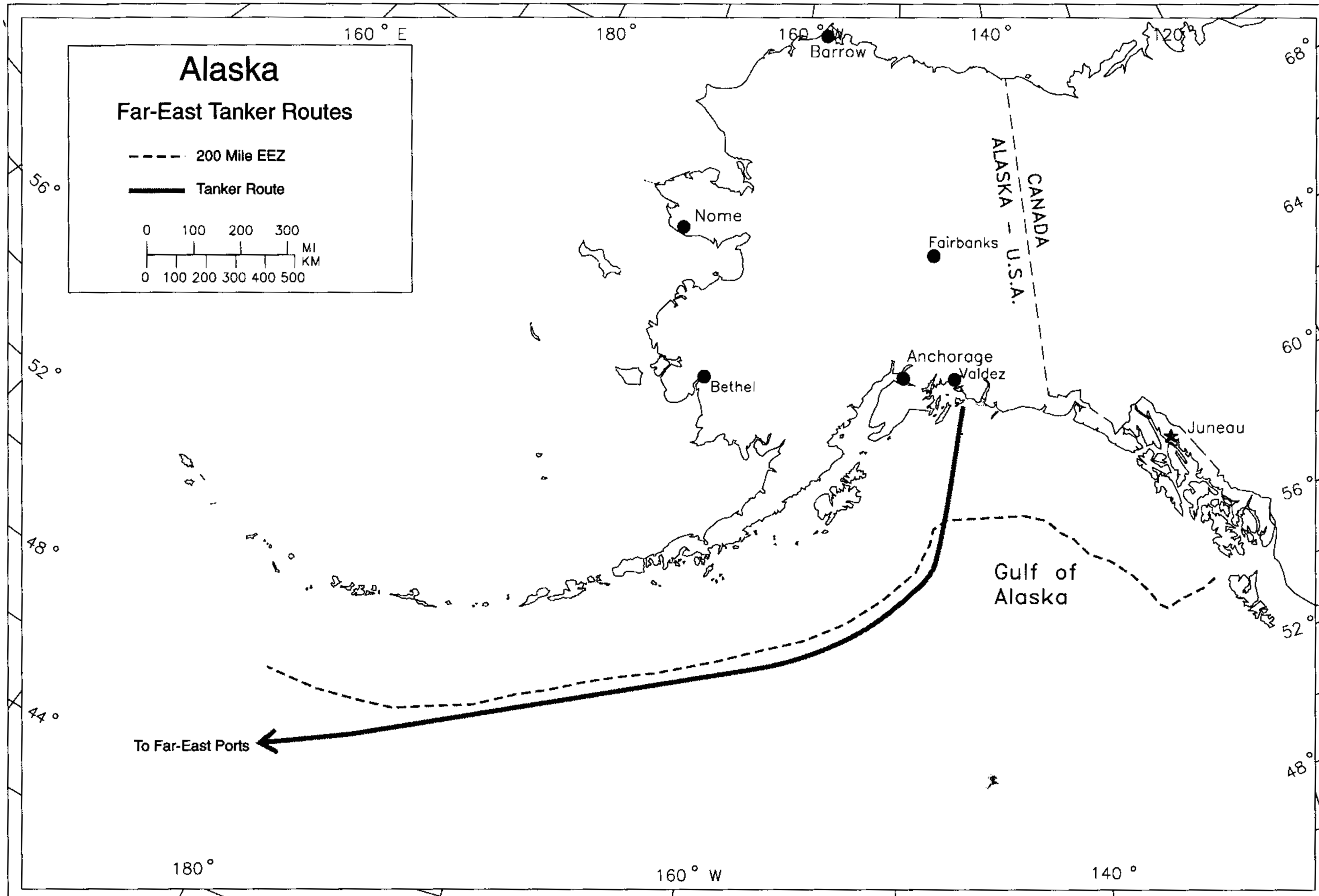


Figure IV.A.6-3. Potential Valdez to Far-East Tanker Route

B. EFFECTS OF ALTERNATIVE I - THE PROPOSAL, BASE CASE - ON:

1. ***Water Quality:*** Agents that are most likely to affect water quality in the Beaufort Sea sale area are oil spills, dredging, and deliberate discharges from platforms. Generic effects of these agents on water quality are described in Sections IV.A.2.a and IV.J.5 of the Sale 100 FEIS (USDOI, MMS, Alaska OCS Region, 1985) and Sections III.A.5 and IV.B.1.a of the Sale 149 DEIS (USDOI, MMS, 1995). This information is incorporated by reference into this DEIS; a detailed summary of these descriptions, as augmented by additional material, as cited, follows. In the context of this analysis, "Regional" effects are those encompassing at least 1,000 km^2 (292 nautical mi^2 [nmi^2), and "Local" effects are those encompassing smaller areas, most frequently a few or less square kilometers [km^2 = 0.29 nmi^2].

a. Oil Spills: The more volatile compounds in an oil slick, particularly aromatic volatiles, usually are the most toxic components of the slick and are, therefore, of more concern. In situ, cold-water measurements by Humphrey et al. (1987), Kirstein and Redding (1987), Payne (1981, 1982, and 1987), Payne and McNabb (1984), and Payne et al. (1984a) demonstrate for individual dissolved compounds or bulk dispersed oil from a slick that significant decreases in water concentrations take from hours to tens of days. However, the bulk of these volatile compounds are lost in <3 days; and 3-day trajectories have been judged the appropriate length to approximate the initial, higher toxicity of spills in Alaskan waters. Over time, only about 5 percent of a slick can be expected to dissolve (Jordan and Payne, 1980).

Aromatic compounds are the most toxic constituents of crude oil, partly because the are the most soluble constituents. The highest rates of dissolution of aromatics from a slick and, consequently, accumulation in underlying water occur in the first few hours after a spill (Payne, 1987). At sea, water depth and shoreline do not restrict movement of 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 m (5 fathoms) in the water column, it would have spread horizontally and been diluted over a distance of perhaps 10,000 m (33,000 ft). 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. Thus, at sea, the water under the slick changes continuously; and aromatics do not continue to accumulate in the same water.

Following spills, water-column concentrations of hydrocarbons are difficult to compare to Federal water-quality standards because of ambiguity in the standards. Federal standards are set at 0.01 of the applicable LC_{50}: no absolute Federal concentration standard exists for hydrocarbons (USEPA, 1986). The LC_{50} is the continuous- flow, 96-hour lethal concentration at which half the organisms die. "Applicable" in this case refers to lifestages of species identified as the most sensitive, biologically important species in a particular location. Applicable ambient-water-quality standards for marine waters of the State of Alaska are 0.015 ppm (15 micrograms per liter [μg/l) total hydrocarbons and 0.010 ppm (10 μg/l) aromatic hydrocarbons (State of Alaska, Department of Environmental Conservation [DEC], 1995). The State of Alaska criterion of a maximum of 0.015 ppm of total hydrocarbons in marine waters—about 15-fold background concentrations—provides the readiest comparison and is used in this discussion of water quality. This analysis considers 0.015 ppm to be a chronic criterion and 1.5 ppm—a 100-fold higher level—to be an acute criterion.

Major spills generally result in peak dissolved-hydrocarbon concentrations that are only locally and marginally at toxic levels—parts per million or more. The concentration of oil from the *Argo Merchant* spill ranged relatively low, from 0.090 to 0.170 ppm at the surface and up to 0.340 ppm in the water column (NRC, 1985), despite the presence of 20 percent by volume of more-soluble cutting stock. At several of the sampling stations, the concentrations were uniform to a water depth of 20 m (11 fathoms). Concentrations of oil in water from the *Amoco Cadiz* spill ranged from 0.002 to 0.2 ppm in the nearshore area to 0.03 to 0.5 ppm in the estuaries (Gundlach et al., 1983). Volatile liquid hydrocarbons in the *Ixtoc* spill decreased from 0.4 ppm near the blowout to 0.06 ppm at a 10-km (5.4-nmi) distance and to 0.004 ppm at a 19-km (10-nmi) distance (NRC, 1985). Similarly, relative and rapid decreases also were found for specific toxic compounds such as benzene and toluene. Concentrations of volatile-liquid hydrocarbons—present mostly as oil-in-water emulsion—within 19 km (10-nmi) of the *Ekofisk Bravo* blowout in the North Sea ranged up to 0.35 ppm (Grahl-Nielsen, 1978). Lesser amounts of oil (probably <0.02 ppm) were detectable in some samples at a 56-km (30-nmi) distance but not at an 89-km (48-nmi) distance.

In the *Exxon Valdez* spill, concentrations of hydrocarbons in the water were not measured in the first 6 days of the spill. However, Wolfe et al. (1994) have used an earlier version of the MMS weathering model (Payne et al., 1984b) to estimate water concentrations after passage of the storm on the third day of the spill, arriving at an average value of 0.8 ppm within the top 10 m (5 fathoms) of the water, within the "effective" or discontinuous spill area. Wolfe et al. also summarize the actual measurements made in Prince William Sound. Seven to 11 days after the spill, residual concentrations ranged from 0.067 to 0.335 ppm petroleum hydrocarbons, 0.0015 ppm volatile organic analytes (mostly mononuclear aromatics), and 0.001 to 0.005 ppm polynuclear aromatic hydrocarbons (PAH). Concentrations in Prince William Sound decreased to levels below the chronic criteria levels of concern, to between 0.001 and 0.006 ppm petroleum hydrocarbons and 0.0001 ppm PAH after 21 to 41 days. The concentration decreases within these timeframes were attributable to advection and dilution, not decomposition.

In restricted waters under very calm seas, lack of vertical mixing and dilution can result in higher concentrations within a thin layer. A test spill under such conditions during the Baffin Island Oil Spill Project (BIOS) resulted in maximum dispersed hydrocarbon concentrations in the water column of 1 to 3 ppm (Humphrey et al., 1987). These concentrations were reached within 2 hours of the spill and persisted through 24 hours. No oil was detected deeper than 3 m (2 fathoms), and the most oil and highest concentrations were in the top meter (half fathom).

These concentrations of oil in the water column are relatively low for two reasons. First, oil is only slightly soluble in water. Second, even if a slick were completely mixed into the same watermass 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 (see Mackay and Wells, 1983; Humphrey et al., 1987). For spills of the magnitude of the *Exxon Valdez* spill— 258,000 bbl—hydrocarbon concentrations could remain elevated above chronic criteria for as long as 10 to 20 days. The volume of water contaminated would increase in direct proportion to the decrease in concentration, however, because in terms of the first few days of a spill, especially for both arctic waters (Humphrey et al., 1987) and subarctic waters (Wolfe et al., 1994), oil concentrations decrease initially through dilution, not degradation.

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-bbl spill could be above ambient standards and detectable over the low background levels for perhaps 100 km (50 nmi) or possibly 500 km (300 nmi), if ice cover blocked evaporative losses (Cline, 1981). 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 the (discontinuous) slick over a smaller area and for a shorter duration. For the size spills assumed in this EIS, two of 7,000 bbl each (37-fold less than the *Exxon Valdez* spill), elevated concentrations above chronic criteria could persist for perhaps 3 to 10 days in summer, affecting an area of 20 to 100 km^2 (5.8 to 29 nmi^2) for each spill (Sec. IV.A.2).

Only a small portion of the oil from a spill would be deposited in the bottom sediments in the immediate vicinity of the spill or along the pathway of the slick. The empirical range in deposition of oil in sediments following offshore spills is 0.1 percent of slick mass to a high of 13 percent for the *Exxon Valdez* spill (Jarvela, Thorsteinson, and Pelto, 1984; Wolfe et al., 1994). Offshore, where suspended-sediment loads are low, only about 0.1 percent of a crude would be incorporated into sediments within the first 10 days of a spill (see Manen and Pelto, 1984). Generally, the higher percentages of deposition occur in spills that occur near shore or that reach shore, where surf, tidal cycles, and other inshore processes can mix oil into the bottom.

In cold climates, the slower weathering and, therefore, greater persistence and of oil stranded on shorelines result in an anomaly not reported for shoreline oiling in warmer climates. This anomaly is an increase in amount but not necessarily concentration of oil in the subtidal sediments offshore of contaminated shoreline through the first 2 to 3 years after a spill. About 13 percent of the *Exxon Valdez* spill was deposited in subtidal sediments by fall 1992, 3.5 years after the spill. This high deposition is attributable to sedimentation of oil initially stranded but then resuspended by winter storms and beach washing during spill response (Wolfe et al., 1994). Despite the deposition of an estimated 34,000 bbl of *Exxon Valdez* oil—13 percent of the total spill—in subtidal sediments, chemists have not been able to detect the oil's chemical signature in deep sediments, indicating that the oil is present in low concentration and is degraded.

In the BIOS experiments, on the other hand, subtidal sediment concentrations of petroleum hydrocarbons ranged from 1 to 10 ppm dry-weight sediment 2 weeks after test spills, but concentrations increased at least over the ensuing 2 years, reaching up to 400 ppm dry weight and accounting for 10 percent of the initially stranded oil (3% of total test spill; Boehm et al., 1987). (Similar sediment accumulation of hydrocarbons did not occur in the BIOS experiments using a dispersant/oil mix.)

If the spilled oil were of a composition similar to that of Prudhoe Bay crude, about 40 percent of the spilled oil could persist on the water surface, dispersed into individual tarballs, after the slick disappeared. 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 tarballs would sink, with an additional 20 percent of slick mass persisting in the remaining tarballs (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980). Because of the drift of the oil over distances of hundreds or thousands of kilometers (1000 km = 540 nmi) during the slow process of sinking, individual, sunken tarballs would be extremely widely dispersed in the sediments, at concentrations on the order of some fraction of a tarball per hectare (per 2 acres). The "average" levels of local or regional contamination in sediments would be insignificant. Suspended loads of sediment away from the shoreline (< 100 ppm dry weight) are not high enough to significantly enhance oil removal from the slick or water column (see Payne et al., 1989; Boehm, 1987). Only if oil were mixed into the shoreline and then dispersed offshore could elevated concentrations of hydrocarbons locally occur. Regional contamination of offshore sediments would not be detectable.

Under ice, the volatile compounds from a spill would be more likely to freeze into the ice within hours to days rather than dissolve or disperse into the water underneath the ice. After onset of melt, oil spilled under ice generally tends to reach the ice surface in an unweathered state—that is, with its volatile fraction intact. However, once formed, a hydrocarbon plume in the water column underneath the ice would persist above ambient standards and background over about a 5-fold greater distance than under open water (see Cline, 1981).

Decomposition and weathering processes for oil are much slower in Alaskan OCS waters 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 (Barsdate et al., 1980). 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.

In the Sale 144 area, no isolated embayments exist. The lead system off of Barrow, mostly to the west of the sale area, would be the most susceptible exception because Barrow Canyon could funnel pollutants downslope (Payne et al., 1991). A spill in the lead system during a period of rapid ice growth could leach water-soluble aromatics into the sinking brine waters. 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-m-(55-fathom)-water depth. Stability of the stratified watermass 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 (Thomas, 1981).

It is likely that accidental oil spills will occur as a consequence of the proposed sale: the oil-spill-risk analysis estimates a most likely number of two spills of at least 1,000 bbl, and two have been assumed to occur for this analysis. In addition to these large spills, more chronic spillage of smaller volumes also is estimated (see Sec. IV.A.1). During drilling of 22 exploration and delineation wells over 8 years, on the order of two such chronic spills could occur, but the total oil spilled would amount to only about 18 bbl. For production, an additional 295 small spills < 1,000 bbl each, totaling 3,343 bbl, are projected over the life of the field. Small spills of this magnitude (average size = 11 bbl) are relatively common in western and northern Alaska. Such small spills could result in local, chronic hydrocarbon contamination of water within the margins of the oil field.

Regional, long-term degradation of water quality to levels above State and Federal criteria because of hydrocarbon contamination is very unlikely. Two spills of 7,000 bbl each could temporarily contaminate water over no more than 200 km^2 (58 nmi^2) above the chronic criterion of 0.015 ppm, but concentrations above the 1.5-ppm-acute criterion are not anticipated. The large number of very small spills anticipated over the production life of the field could result in local, chronic hydrocarbon contamination of water within the margins of the oil field.

b. *Shore-Access Structures:* No new causeways are projected in the base case. Causeways already exist at Oliktok Point and West Dock, two access points in the base case. Tie-in of an offshore pipeline to these offshore points would be best accomplished through a subsea buried pipeline to avoid damage to pipeline from both ice gouging and existing ship/barge operations. Such subsea tie-in would have no effect on ambient salinity and temperature regimes. The third access point for the base case, the ≤90-m-long (300-ft) raised gravel structure just west of the Arctic National Wildlife Refuge (ANWR) boundary, would have to be constructed. The structure would be too short to affect coastal circulation. Turbidity could be increased within 3 km (2 nmi) of the access point during construction; however, turbidity would cease with end of construction. The effect on turbidity would be local and persist for only for a few days.

The Alaska Department of Environmental Conservation has listed the area near the Endicott Causeway—the most massive and longest existing causeway—on its 303(d) list of impaired water bodies because of temperature and salinity exceedances. Additional long causeways such as that at Endicott are not anticipated in the U.S. Beaufort Sea because of (1) the cost of construction (including that for breeches), (2) difficulties in getting causeways approved by regulatory agencies because of concern over causeway effects, and (3) improvement of long-reach drilling techniques that allow nearshore structures to be drilled from land. If a discovery were made offshore of the Endicott Causeway, any pipeline tie-in to the Endicott Causeway pipeline would be expected to have a subsea buried approach to the causeway to avoid ice gouging. Thus, even a direct tie-in to the Endicott Causeway would not exacerbate the restricted circulation causing impairment of local water quality near this causeway.

c. *Dredging:* Dredging would be used primarily for trenching and burial of subsea pipelines. Dredging also might be used to prepare foundations for the eight projected production platforms, but this latter use would be comparatively small. Pipeline installation would involve greater volumes of dredged materials and greater areal disturbance. The greatest effect on water quality from dredging would be related to turbidity.

Suspended sediments have very low direct toxicity for sensitive species, with expected toxicity somewhere between that of a clay such as bentonite (LC_{50} [=concentration at which half the test organisms die within 3 days] >7,500 ppm for the eastern oyster) and that of calcium carbonate (LC_{50} >100,000 ppm for the sailfin molly) (see NRC, 1983). These are very low toxicities, falling into the ranges generally described as slightly toxic to nontoxic. Direct toxicity from suspended sediments, therefore, has not been considered a regulatory issue, and toxic or acute marine standards have not been formulated by either the State of Alaska or USEPA.

For the purpose of analysis, this EIS uses 7,500-ppm suspended solids as an unofficial, acute (toxic) criterion for water quality. This value is the lowest (most toxic) LC_{50} for a clay or calcium carbonate reported in the NRC (1983) assessment of drilling fluids in the marine environment. Note that USEPA limits drilling mud effluent to a 30,000-ppm LC_{50} limit prior to discharge dilution in its Arctic General National Pollutant Discharge Elimination System (NPDES) permit (USEPA, 1995). Thus, exploration drilling mud will necessarily fall into the slightly toxic to nontoxic range and will not pose an acute toxicity risk to the Beaufort Sea.

The State of Alaska standards and Federal criterion for marine waters that do exist are considered chronic standards and a chronic criterion in this analysis. Both State standards and the Federal criterion are directed toward protecting biota from chronic stresses rather than from acute toxicity, but the limits are very different in formulation. One State standard is 25 nephelometric-turbidity units, and the Federal criterion and a second State standard are no more than a 10-percent decrease in the seasonally averaged compensation depth for photosynthetic activity. A third State standard is no more than a 10-percent reduction in maximum secchi disk depth.

If oil is found, 128 km (69 nmi) of offshore pipeline could be emplaced in the planning area and inshore waters over a 4-year period (Sec. II.A .2). With multiple short pipelines and one dredge, about 65 km (35 nmi) of pipe could be placed offshore in a single summer, with an on-site dredging rate of about 1.3 km (0.7 nmi) per day. Trenching and dumping of dredged spoils would disturb 650 ha (1,600 acres) in the Beaufort Sea Planning Area and inshore waters, or somewhat less if the spoils were used to backfill the trench (see the Sale 124 FEIS, Appendix H, Table H-4 [USDOI, MMS, 1990]).

Experiences with actual dredging or dumping operations in other areas show a decrease in the concentration of suspended sediments with time (2-3 hours) and distance downcurrent (1-3 km) [0.5-2 nmi] 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 shortly after operations ceased; they generally extended a few hundred meters to a few kilometers [km = 0.54 nmi] (Pessah, 1982).

The size, duration, and amount of turbidity depend 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. However, turbidity would not be expected to extend farther than 3 km (2 nmi) from the trenching and dumping operations.

Because dredging occurs at a rate of 1.3 km (0.7 nmi) per day, the extent of the turbidity plumes would be about 3.9 km^2 (390 ha) [960 acres] at any one time (a 1.3- by 3-km [0.7- by 2-nmi] plume). 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 contaminants. Beaufort Sea Planning Area sediments do contain elevated levels of hydrocarbons, but these levels appear to be natural background and are not derived from atmospheric or North Slope industrial contaminant sources (Sec. III.A.5).

Based on the analysis in this EIS, the increased turbidity from dredging (and dumping) would be local and short term, exceeding the chronic criterion of a 10-percent temporary change in photocompensation depth over a distance of ≤3 km (≤2 nmi), a local water quality effect.

d. Deliberate Discharges During Exploration: Exploratory vessels would discharge drilling fluids in bulk quantities along with sanitary wastes from wastewater-discharge sources. Discharges of drilling mud and drill cuttings from 22 exploration and delineation wells are projected from the development scenario in Section II.A.2; they would occur over an 8-year period. Discharges during exploration would peak in 1998 through 2000 at 2,300 metric tons (2,100 English short tons) of drilling mud per year and 3,000 metric tons (2,700 English short tons) of drill cuttings per year.

Drilling muds used offshore of Alaska are of relatively low toxicity and are limited to this low level of toxicity by NPDES permits granted by the USEPA; in the current permit, they are limited to a 30,000-ppm LC_{50} (USEPA, 1995). The USEPA will prohibit drilling mud and cutting discharges in water depths of <5 m (2.7 fathoms) (Appendix H; USEPA, 1995) in future offshore Arctic exploration. The USEPA has estimated that this restriction should ensure that Federal water quality criteria will be met at the edge of the mixing zone (Appendix H) and should also lessen the likelihood of elevated trace-metal concentrations persisting in shallow marine sediments (see Snyder-Conn et al., 1990). In any case, during exploration, only barium concentrations in discharged muds are expected to be always more than a 100-fold greater than concentrations in shelf sediments (Table IV.B.1-1). Concentrations of cadmium, chromium lead, mercury, and zinc in discharged muds, however, can be more than a 100-fold greater than concentrations in nearshore sediments. Residual, elevated concentrations of USEPA priority metals (arsenic, chromium, lead, and zinc) have been found to persist within Beaufort sediments below mixing zones for at least 2 to 4 years after exploration at shallow (<5-m) water sites in low-energy State waters (Snyder-Conn et al., 1990). However, discharges from exploration drilling are regulated by USEPA and are no longer allowed to occur in <5-m water depth, and the USEPA now estimates that this restriction will eliminate this concern (USEPA, 1995).

Based on the above information and additional analysis provided by Tetra Tech (1994), the USEPA has determined that exploratory discharges are not likely to exceed applicable water-quality criteria outside of a 100-m (328-ft) radius, or 0.03 km^2 (7 acres) around each discharge site. The maximum number of exploratory platforms that may be present during a single year is estimated to be two, and water quality within an area of 0.03 km^2 (7 acres) around each platform, for a total of 0.06 km^2 (15 acres), could be temporarily degraded at any one time and 0.66 km^2 (160 acres) for all of exploration during active discharge of drilling muds and cuttings. Therefore, the effect of exploration discharges on water quality would persist for a few hours within the 100-m-(328-ft)-radius mixing zone around each platform.

e. Deliberate Discharges During Production: The description of deliberate discharges from oil and gas platforms in Jones and Stokes Associates (1990) is incorporated by reference; a summary of this description, as augmented by additional material, as cited, follows. Platforms on the OCS would

Table IV.B.1-1
Expected Trace-Metal Concentrations and Enrichment Factors
(Over Existing Shelf Concentrations in the Beaufort Sea Planning Area)
for Drilling Muds Discharged in the Beaufort Sea

Metal	Maximum Concentrations Measured in Drilling Muds (parts per million)	Enrichment Factor Over: Suspended Sediments	Shelf-Bottom Sediments	Nearshore-Bottom Sediments
Arsenic	11.8	---[1]	0.5-0.7	---
Barium	298,800	---	400-1,600[2]	400-1,600
Cadmium	5.5	---	27	18-140
Chromium	1,820	13-90	21	100-110
Copper	47.7	0.6-10	0.8	1.3-10
Lead	1,270	---	420	64-330
	33.1[3]		10	1.7-8.5
Mercury	19	---	120-630	210-950
	0.36[3]		2.2-10	4-20
Nickel	88	0.9-9	1.9	2.7
Vanadium	235	0.8-120	1.7	2-7
Zinc	3,420	15-430	35	29-180

Source: Table III.A.5.-1 this EIS and Appendix L of the Sale 124 FEIS (USDOI, MMS, 1990) (Jones and Stokes Associates, 1990).

1 --- Denotes no data.
2 Calculated using nearshore-sediment concentrations.
3 The average concentration, which is much lower.

discharge drilling fluids in bulk quantities along with low levels of petroleum hydrocarbons and sanitary wastes from wastewater-discharge sources. However, the quantities of deliberate discharges other than drilling muds, cuttings, and formation waters are too small to have an appreciable effect on water quality.

Total production discharges of drilling muds and drill cuttings are projected from the development scenario in Section II.A.2 of this EIS at 37,000 to 168,000 metric tons (41,000-185,000 English short tons) of drilling muds and 292,000 metric tons (322,000 English short tons) of drill cuttings. Discharges would occur over a 9-year period but would likely peak in 2004 and 2005, when 54 out of the 273-production-well total would be drilled each year.

These quantities projected to be discharged are small compared with the natural sediment load of the Beaufort Sea Planning Area. Inshore waters of the Beaufort Sea are naturally turbid. The Colville River alone annually carries 9 million metric tons (10 million English short tons) of sediment into the Alaskan Beaufort Sea. Ice-related sediment transport mechanisms lift and move huge quantities of sediment in the coastal Beaufort Sea (Kempema, Reimnitz, and Barnes, 1989; Reimnitz et al., 1993). The sediment content of the fast-ice canopy between the Colville River and Sagavanirktok River deltas in the winter of 1978-79 was 16 times the annual suspended load of these rivers (Reimnitz and Kempema, 1987). Strudel scours in the sea bottom resulting from spring river floods overflowing shorefast ice offshore of the Colville, Kuparuk, and Sagavanirktok rivers represent a redistribution of >300 m^3 (ca. 700 metric tons) of sediment per square kilometer (3,000 English short tons per nmi^2) (Forbes and Taylor, 1994). High rates of erosion occur all along the U.S. and Canadian Beaufort coast (Sec. III.A.1 of this EIS; Forbes and Taylor, 1994). For example, coastal erosion adds 300,000 metric tons (ca. 300,000 English short tons) annually to Simpson Lagoon. In addition, high turbidity from runoff following breakup on land extends to the 13-m-(7-fathom)-water-depth contour and limits coastal marine primary production during early summer.

With only two drilling rigs per platform and assuming that maximum discharge rates are limited by USEPA to the same extent during production as during exploration (see Appendix H), instantaneous discharges would be of the same order of magnitude in production as in exploration. The total quantity of drilling muds discharged in production is estimated to be 3- to 13-fold greater than during exploration (Sec. II.A.2) of this EIS. Total discharge of drill cuttings during production drilling would be 18-fold greater than the total discharged during exploration. Therefore, effects on water quality from discharges of muds and cuttings during production drilling should be about an order of magnitude greater than during exploration, but still only local and short term—on the order of square kilometers [km^2 = 0.29 nmi^2] or less—and would persist over a 9-year period of drilling.

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 $^o/_{oo}$. (Seawater has a salinity of 35 $^o/_{oo}$.) Oil and grease concentrations in such waters have been limited by USEPA in the past to a maximum of 72 milligrams per liter (72 ppm), with a maximum monthly average of 48 milligrams per liter (48 ppm). Per USEPA's Best Professional Judgement and revised effluent-limitation guidelines, the current Arctic NPDES General Permit (USEPA, 1995) has reduced these limits to 42 milligrams per liter (42 ppm) daily maximum and 29 milligrams per liter (29 ppm) monthly average for exploration test discharges. Similar limitations (*FR*, 1993) would be applied to production discharges on the basis of Best Available Technology. The USEPA-approved analytical procedures used to measure oil and grease exclude lower molecular-weight hydrocarbons ($<$C14), which pose most of the risk to the biota (NRC, 1985). The NRC has estimated that formation waters average 20 to 50 ppm of lower molecular-weight hydrocarbons and 30 ppm of higher molecular-weight hydrocarbons. In Alaska, discharges from individual oil-treatment facilities for State fields in Cook Inlet average between 18.9 to 52.6 ppm oil and grease and 8.4 to 41 ppm total-aromatic hydrocarbons (Ebasco Environmental, 1990). (Lower molecular-weight and total-aromatic categories overlap but are not identical.)

Over the life of a field, the volume of formation water produced may be equal to 20 to 150 percent of the oil-output volume (Collins et al., 1983). As oil is pumped from a field, the ratio of water to oil being produced increases. For example, some of the older Cook Inlet/Kenai fields in Alaska are now producing up to 5.9 bbl of water for every barrel of oil produced, while the new Point McIntyre Field and middle-aged but declining Prudhoe Bay Field are producing 0.02 and 1.2 bbl of water per barrel of oil, respectively (State of Alaska, Alaska Oil and Gas Conservation Commission [AOGCC], 1995). Toward the very end of the productive life of a field, 10 bbl 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 the field can be estimated at 240 to 1,800 MMbbl, with up to 50 MMbbl of this amount produced in the last year of field production. Over the life of the field, the mass equivalent of 7,000 to 52,000 bbl of oil would be contained in produced water.

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 a USEPA permit and would be regulated so that water-quality criteria, outside an established mixing zone, are not exceeded. To date, for exploration in the Beaufort Sea, USEPA has prohibited discharge of formation waters into waters < 10 m (5.5 fathom) deep. Reinjection and injection projects to maintain field pressure have become almost standard operating procedure. Of the 12 active oil fields in Alaska in 1994, 10 had water-injection projects (State of Alaska, AOGCC, 1995). However, treatment facilities for State Cook Inlet fields still discharge formation waters into Cook Inlet (Ebasco Environmental, 1990). On the other hand, formation water from the Endicott Reservoir, the first offshore-producing field in the Beaufort Sea, is 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 high enough permeability to allow large volumes of water to be injected at low pressure and (2) can contain the water. Also, injection should not be into a formation that might otherwise be a future potable-water supply.

If formation waters were reinjected or injected into a different formation, no discharge of formation waters would occur and no effect would occur. If formation waters were discharged, the effect on water quality would be local but would last over the life of the field.

f. Gravel-Construction Projects: Solid-fill islands may be constructed and used for shallow-water development. A solid-fill island constructed on Federal leases would likely require relatively little fill compared to the above projects as long as causeways to shore were not included. Any of these individual construction projects could be completed within one to two summers, and turbidity effects in the vicinity of the construction activity would be short term and local.

g. Solid-Fill, Artificial Island Removal: Solid-fill, artificial islands used for exploration and/or development would eventually be abandoned. In spite of carefully planned abandonment operations, debris seems to inevitably remain on artificial islands. For example, 2 years after the careful abandonment of Tern Island, there were still fragments of the shoreline-protection system, which is made of large, gravel-filled polypropylene bags and filter fabric. An underwater survey revealed fragments of about 50 large bags. Such bags can become frozen into and/or buried into the subsurface slopes of the islands, becoming at best impractical to remove during abandonment.

The armor debris gradually erodes from the abandoned solid-fill islands, drifts downwind, and accumulates along the mainland coast. For example, near Tern Island in Foggy Island Bay, about 10 bags were found during both 1992 and 1993 shoreline surveys, which indicates an average, yearly accumulation rate of about 0.8 bags per kilometer (1.5 bags per nmi) of coastline. Along the coastlines of the Jones Islands and Simpson Lagoon, which are downwind of Sandpiper and Northstar Islands, debris is accumulating at a faster rate. The approximate numbers of bags retrieved from 1990 to 1994 was about 200 per year, which equaled a couple of thousand square meters (half acre) of polypropylene debris per year. The MMS has required lessees to conduct periodic surveys of adjoining shoreline and to recover the armor debris found. Debris accumulation is anticipated to continue for several more years.

If artificial islands constructed and then abandoned on proposed Sale 144 leases still contained residual armor debris, the MMS would require that the lessee conduct periodic surveys and recover armor debris stranded along the adjoining coastline. Such debris-recovery programs could be necessary for several years.

In addition to armor debris, erosion of abandoned, solid-fill islands can result in local but persistent turbidity plumes as the sediments of the islands are reworked by waves and currents for a few to several years. (Causeways would not similarly erode but would more likely enhance deposition of waterborne materials, decreasing turbidity.)

Summary: Two oil spills of ≥ 1,000 bbl would temporarily and locally increase water-column hydrocarbon concentrations over no more than 200 km^2 (58 nmi^2). The large number of very small spills anticipated over the production life of the field could result in local, chronic contamination within the margins of the oil field. Other effects could result from (1) construction activities that, at most, would increase turbidity over a few square kilometers [km^2 = 0.29 nmi^2] in the immediate vicinity of the construction and only while the activity persisted, (2) abandonment and erosion of artificial solid-fill islands which could similarly increase turbidity over a few square kilometers in the immediate vicinity, but over a few to several years, and (3) discharges of formation waters. Deliberate discharges of muds and cuttings are regulated by USEPA such that any effects on water quality must be extremely local; water-quality criteria must be met at the edge of the mixing zone established by the USEPA-issued NPDES permit. Over the life of the field, discharge of formation waters (with whatever the formation waters contain)—rather than their reinjection into the seafloor—would result in local pollution but also would be regulated by USEPA NPDES permit.

Conclusion: Overall for the base case and over the life of the field, contaminants from oil spills may exceed sublethal but not acute (toxic) levels over up to 200 km^2 for a few weeks; and contaminants from construction, island abandonment, and permitted discharges could exceed sublethal levels over a few square kilometers for several years. Regional water quality would not affected.

2. *Lower Trophic-Level Organisms:* Lower trophic-level organisms (phytoplankton, zooplankton, epontic, and benthic) in the Beaufort Sea are described in Section III.B.2. In the base case, both exploration and production are assumed to occur in the Sale 144 area. Routine activities associated with this alternative that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and construction (discussed below). Accidental activities consist of those associated with an oil spill. The effects of these agents/activities on lower trophic-level organisms have been discussed in previous Alaska OCS Region EIS's—including the FEIS's for the Beaufort Sea Federal/State Oil and Gas Lease Sale (USDOI, BLM, 1979) and Sales 87 (USDOI, MMS, 1984), 100 (USDOI, MMS, 1985), 97 (USDOI, MMS, 1987), and 124 (USDOI, MMS, 1990), as well as Davenport (1982), Howarth (1987), NRC (1985), and USDOI, MMS (1992, OCS Comprehensive Program 1992-1997)—which are summarized below and incorporated herein by reference. The following biological analyses focus on the effects of routine and accidental activities on phytoplankton, zooplankton, epontic, and benthic organisms associated with each alternative. Effects are estimated based on (1) short-term contact with each effects-producing agent (i.e., seismic surveys, drilling discharges, construction, and petroleum) and (2) the estimated amount of time exposed to these agents based on the probability of occurrence and contact. Because the short-term effects of these agents are the same for each alternative, they are discussed in depth only in the base-case analysis. The base-case analysis then considers the extent of contact and the probability of occurrence and contact (2 above), which varies for each alternative, and thus is the sole basis for differences in the estimated effect of each alternative on lower trophic-level organisms.

a. Effects of Seismic Surveys: During seismic exploration, acoustic-energy pulses are used to locate geological structures that might contain oil or gas. The sources of acoustical energy used in seismic surveys have included explosives and airguns, the latter of which use compressed-air releases to generate sounds. Seismic surveys are expected to have little or no effect on plankton because the energy sources now commonly used in Alaska (airguns) do not appear to have any adverse effect on this group of organisms.

In general, even high explosives have had relatively little effect on marine invertebrates, presumably due to lack of air-containing chambers, such as the swim bladder of fish. Gowanloch and McDougall (1946, as cited by Falk and Lawrence, 1973) found no effect of dynamite explosions on shrimp beyond 50 ft and no mortalities at all for oysters. In an experiment by Aplin (1947, as cited by Falk and Lawrence, 1973), lobsters 15 m (50 ft) away from a 90-lb dynamite charge showed no ill effects. Airguns, which are much more innocuous for fish than explosives, also were shown to have no effect on caged oysters placed close to the airgun (Gaidry, unpublished, cited by Falk and Lawrence, 1973).

Seismic surveys typically are performed to identify shallow hazards prior to the drilling of exploration/ delineation wells and the placement of production platforms. Although the exact number and location of seismic surveys for any alternative are unknown at this time, the number can be estimated based on the number of wells and platforms associated with each alternative (see Appendix B, Exploration and Development Schedule [EDS]). For the base case, the EDS estimates that shallow-hazards seismic surveys would be performed for 8 exploration wells, 14 delineation wells, and 8 production platforms. Based on the lack of apparent effect of seismic surveys on lower trophic-level organisms and this relatively low level of estimated seismic activity, seismic activities associated with the base case are expected to have little or no effect on lower trophic-level organisms.

b. Effects of Drilling Discharges: The types of material discharged while drilling include drilling muds and cuttings. The discharge of drilling muds and cuttings and formation waters (contain small amounts of hydrocarbons) creates plumes of material that disperse rapidly in the water column, becoming diluted by a factor of ≥10,000 within 1 to 4 hours of release, depending on conditions at the time (NRC, 1983). (For additional information, see Sec. IV.B.1, Water Quality.) In most continental shelf areas, most drilling muds and cuttings land on the sea bottom within 1,000 m of the discharge point. Environmental factors such as water depth, current speed, tidal exchange, etc., can have large effects on the ultimate fate and dispersion of drilling muds and cuttings. Drilling muds and cuttings theoretically could affect plankton by reducing primary production, either as a result of reduced light levels or the toxic effect of various compounds in drilling muds. However, the effect of drilling muds on lower trophic-level organisms appears to be restricted to benthic organisms living nearest the discharge source. There is no evidence of effects on plankton from drilling muds (Neff, 1991); in some cases, used drilling muds have been found to enhance primary production (Alldredge, Elias, and Gotschalk, 1986).

More than 70 drilling muds have been tested on more than 60 marine species (USDOI, 1985). In general, organisms in larval and early juvenile lifestages are more sensitive than adults. Molting crustaceans proved to be more sensitive than intermolt animals (Conklin, Doughtie, and Rao, 1980). During controlled studies, sublethal effects generally have been observed at hydrocarbon concentrations of 10 to 1,000 ppm. Sublethal responses of larvae and adults have included alterations in behavior, chemosensory abilities, feeding, food assimilation, growth, efficiency, skeletal deposition, respiration and nitrogen excretion, and tissue enzyme activity (NRC, 1983). In general, test results suggest that most water-based drilling muds are relatively nontoxic to lower trophic-level organisms. Additionally, the experimental parameters of these tests for both lethal and sublethal effects could not mimic realistic conditions at sea, most notably the rapid dilution and dispersion of drilling muds and cuttings that typically occur in the field. At sea, the effects of drilling-fluid discharges have been limited to areas near and downcurrent of the discharge point, with most effects detected in the benthos. Hence, the effect of muds and cuttings on lower trophic-level organisms associated with the base case (at sea) is expected to be less than that observed during field and laboratory experiments. Results from laboratory and field experiments also suggest that little bioaccumulation of metals from drilling muds occurs in lower trophic-level organisms (NRC, 1983).

In the exploratory phase of the base case, a maximum of about 13,860 short tons of drilling muds and 18,040 short tons of drill cuttings are expected to be released into the marine environment. These discharges would occur over an 8-year period from 1997 to 2004. During the development and production phase, 273 wells are proposed from eight platforms over a 9-year period, with a maximum total release of about 185,640 short tons of drilling muds and 322,140 short tons of drill cuttings. Based on studies results, plankton are not expected to be adversely affected by these discharges. Benthic organisms within 1,000 m of the platform are expected to experience mostly sublethal effects, with some lethal effects on immature stages. Within this distance, some changes are expected in the species composition of affected benthic areas. However, <1 percent of the lower trophic habitat within the sale area is estimated to be affected in this way (about 1 km^2). Recovery of the affected benthic communities is expected to occur within 1 year after the drilling discharges cease.

c. Effects of Construction: This activity involves (1) the placement of bottom-founded production platforms and (2) pipeline laying. This would affect benthic invertebrates and marine plants (few locations support marine plants) in the immediate vicinity of these activities. Platforms add a three-dimensional structure to the marine environment and thereby provide additional habitat for invertebrates and marine plants that require a hard, secure substrate for settlement. Less-mobile organisms that rely on soft substrates (e.g., bivalves and polychaetes) would be adversely affected when their habitat is altered or eliminated by platforms or pipeline construction. The more mobile adult invertebrates are expected to avoid these areas of disturbance and are not expected to be affected. Construction associated with this alternative is expected to have little or no effect on phytoplankton or zooplankton communities in the Sale 144 area.

Two to four production platforms and one pipeline are proposed for the base case. The placement of the platforms and the pipeline would affect a small area of benthic habitat in the sale area (much less than 1%). Dredging can affect marine organisms by physically altering the benthic environment, increasing sediments suspended in the water column, and killing organisms directly through mechanical actions (Lewbel, 1983). Placement of a platform is expected to kill the immobile benthic organisms under it. Some organisms also will be killed during pipeline laying. Those invertebrates requiring a hard substrate for settlement are expected to colonize the area affected by a platform within 1 or 2 years. Hence, the overall effect of a platform would be to alter species diversity in favor of organisms requiring hard substrates (e.g., marine plants) over those that do not. Much less than 1 percent of the immobile benthic organisms in the sale area would be affected by platform and pipeline construction. The affected benthic communities are expected to recover from these disturbances in <3 years (USDOI, MMS, 1987). Because of the small area affected by platform and pipeline construction and the widespread distribution of benthic marine organisms in the sale area, construction in the base case is expected to have little effect on lower trophic-level communities in the sale area.

d. Effects of Oil: This section addresses the potential effects of an accidental oil spill on lower trophic-level organisms associated with the base case. The following analysis (1) identifies the expected effect of exposing lower trophic-level organisms to petroleum-based hydrocarbons, (2) factors in the probability of occurrence and contact associated with the base case, and (3) estimates the resulting overall effect on lower trophic-level communities. For purposes of analysis it is assumed that recovery from the effects of a former large oil spill has occurred prior to the onset of another large oil spill. The following biological analyses focus on the effects of the base-case on the lower trophic-level organisms of concern, which include phytoplankton, zooplankton, epontic, and benthic organisms.

(1) Planktonic Communities: Phytoplankton are the primary producers of organic material in the ocean and are at the base of the food web. Zooplankton are secondary producers that feed on phytoplankton and are in turn fed upon by higher food-web species. Hence, it can be seen that any effect on these lower trophic-level organisms (natural or unnatural) is expected to have an effect on higher trophic levels as well.

Some hydrocarbons are naturally produced by phytoplankton; and many have been found to be the same as, or similar to, those found in crude oil (Davenport, 1982). Some hydrocarbons are, therefore, considered a normal part of the chemical makeup of phytoplankton. Hence, hydrocarbons occurring in the water column that are similar to those occurring naturally in phytoplankton are expected to have little effect on phytoplankton. Other petroleum-based hydrocarbons (e.g., chlorinated hydrocarbons) are not of natural origin and may have adverse effects on some phytoplankton (USDOI, BLM, 1976), even at low concentrations. Because of the difficulties of conducting field studies at sea, much of the information concerning the effects of petroleum-based hydrocarbons on plankton has been obtained from laboratory studies. Because many phytoplankton species are small and delicate and exhibit rapid morphological or physiological changes, most laboratory experiments have been conducted on larger planktonic species that are slower to change. Such experiments typically use unrealistically high hydrocarbon concentrations (Davenport, 1982) in order to elicit a distinct response. Nevertheless, laboratory experiments have provided much useful information, such as the toxic nature of early dispersant agents.

Effects on phytoplankton vary widely depending on the concentration and type of oil or compounds used in the experiments and on the species being tested (NRC, 1985). Nevertheless, general patterns do exist, and both laboratory and field studies have shown that hydrocarbons typically inhibit phytoplankton growth at higher concentrations, but sometimes enhance growth at lower concentrations. Growth inhibition and/or mortality in phytoplankton have been noted to occur at hydrocarbon concentrations of 1 to 10 ppm. Growth enhancement has been noted at concentrations of ≤0.1 ppm (NRC, 1985).

In terms of data collected during an oil spill or field study, large-scale adverse effects on plankton have not been reported (NRC, 1985). This may be due in part to the difficulties of conducting such studies (e.g., foul weather, sea state, logistics, and plankton patchiness). Observations of phytoplankton biomass and primary productivity following the *Tsesis* spill (in Sweden in 1977) revealed no significant differences between noncontaminated and contaminated areas (Johansson et al., 1980, as cited in NRC, 1985:442). In cases where studies have been conducted following a spill (e.g., as cited above), this lack of substantial adverse effects on plankton populations due to spilled oil is common.

Even if it is assumed that a large number of phytoplankton are contacted by an oil spill in an open-ocean area, the regeneration time of the cells (9-12 hr) and the rapid replacement of cells from adjacent waters are expected to preclude any major effect on phytoplankton communities (NRC, 1985). Further, the vertical distribution of most phytoplankton in the water column is typically below the area where it could be adversely affected by hydrocarbons associated with an oil spill. For these reasons, recovery from the effects of the base-case oil spill is expected to take only 1 to 2 days. In areas where flushing rates are reduced (e.g., in bays and estuaries), the concentration of hydrocarbons in the water is expected to be higher. However, the sensitivity of phytoplankton to hydrocarbons may be related to environmental stability (Fisher, 1977) and the history of environmental pollution (Murphy and Belastock, 1980). Hence, plankton from chronically polluted areas (e.g., boat harbors within bays) may be less affected by an oil spill than plankton from open-water areas in the Beaufort Sea.

The effects of petroleum-based hydrocarbons on zooplankton have been observed in the field at spill sites and also in the laboratory. The primary routes of zooplankton contamination by oil are direct uptake from the water, uptake from food, and direct ingestion of oil particles. It should be noted that some zooplankton have the ability to metabolize and detoxify some types of hydrocarbons and that this ability varies between species. For example, in scyphozoans and ctenophores, hydrocarbons are discharged unchanged. In crustaceans and ichthyoplankton, they are discharged as metabolites (NRC, 1985). The observed vulnerability of zooplankton to hydrocarbons in the water column (dispersed and dissolved) varies widely. Lethal hydrocarbon concentrations for zooplankton range from about 0.05 to 10 ppm, which is similar to that expected for other small floating organisms (e.g., fish eggs and larvae and crustacean larvae). Sublethal crude-oil concentrations for zooplankton range from about 1 ppm to well below 0.05 ppm (NRC, 1985). Sublethal effects include lowered feeding and reproductive activity, altered metabolic rates, and community changes. Lethality and sublethality are dependent on exposure time, hydrocarbon toxicity, species, and lifestage involved (early stages are most sensitive). For example, substantial sublethal effects would be expected if hydrocarbon concentrations of 0.05 to 0.3 ppm persisted for a week or longer, whereas lethal effects would be expected at 0.5 to 1.0 ppm over the same period of time. However, such concentrations rarely persist in the water column for longer than a few days following a spill and only in small areas (NRC, 1985).

Field observations of zooplankton communities at oil spills and in chronically polluted areas have shown that the communities were affected but that these effects appeared to be short-lived (Johansson et al., 1980). Individuals within chronically polluted areas have experienced direct mortality, external contamination by oil, tissue contamination by aromatic constituents, inhibition of feeding, and altered metabolic rates. However, because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity, zooplankton communities exposed to oil spills or chronic discharges in open-water areas appear to recover (NRC, 1985). In areas where flushing rates and water circulation are reduced, the effects of an oil spill are expected to be greater, and recovery of zooplankton biomass and standing stocks are expected to take somewhat longer.

The primary sources of the two assumed large (7,000-bbl) base-case oil spills are either a pipeline or platform spill. In general, the fate of the oil associated with the spills would depend on wind speed and duration, air and water temperature, and the composition of the spilled oil. However, based on the assumptions associated with weathering 7,000 bbl of Prudhoe Bay crude oil (Table IV.A.3-1), within 10 days of each assumed spill (winter), 4 percent of the oil would have evaporated, 60 percent would remain on the surface, and 36 percent would be dispersed into the water column.

As indicated above, contact with dispersed and dissolved oil in the water column is of primary concern to phytoplankton and zooplankton. Surface oil and that fraction that evaporates rarely would contact plankton because plankton typically are beneath the surface. The area most likely to be contacted by a large oil spill would be the sale area (about 39,893 km^2). If it is assumed that the surface slick from the assumed 7,000-bbl oil spill is about .6 mm in thickness, a winter-meltout spill would cover a discontinuous surface area of about 940 km^2 after 10 days (Table IV.A3-1). If it is further assumed that all of the dissolved and dispersed oil from the assumed 7,000-bbl spills is found in the first 5 m of the water column, that the hydrocarbon concentration in this 5-m zone is about 0.1 ppm, and that all of the water under this area is phytoplankton and zooplankton habitat, the spill would contact about 2.4 percent (940/39,893 x 100) of the available plankton habitat in the sale area down to 5 m in depth. Based on the same assumptions, a summer spill (the period when plankton would be most numerous) would cover an estimated discontinuous surface area of 100 km^2 after 10 days, or about .0025 percent of the available plankton habitat down to 5 m in depth.

These estimates assume that all plankton under the affected surface areas (2.4% of the sale area in winter or .0025% in summer) are inhabiting the assumed 5-m zone. However, this is unlikely to occur because plankton are typically distributed much deeper than this in the summer, and in the winter their habitat size is greatly reduced (light limited) by ice cover. More realistically, summer phytoplankton and zooplankton in the area affected by the assumed oil spill would be found to depths from 10 to 30 m (depending on water clarity). Hence, in areas where plankton were found to 10-m depths, only 50 percent of their number under the oiled surface area—or about .0012 percent (.50 x .0024)—of the sale area's summer plankton population would be contacted. In areas where plankton were found to 30-m depths, only 16.7 percent (5/30 x 100) of their number under the oiled surface area—or about 0.0004 percent (.167 x .0025)—of the sale area's summer plankton population would be contacted. This of course assumes that all of the plankton are evenly distributed throughout these depths and that the concentration of hydrocarbons in the first 5 m of the water column is uniform at 0.1 ppm. However, prior oil-spill measurements have shown that the concentration of hydrocarbons in the water column falls off rapidly just under an oil slick, is not uniform throughout the water column (vertical mixing greatly reduces it), and seldom would be much above background levels below 20 m in depth. Further, phytoplankton and zooplankton typically are very patchy in their horizonal distribution; and in many cases, there would be few plankton under portions of an oil slick.

Hence, it can be seen that contact with either .0012 percent of the area's summer plankton for 10-m depths, or 0.0004 percent where they exist down to 30 m, is conservative. More realistically, it is expected that the actual percentage of phytoplankton and zooplankton contacted by the spill (summer or winter) would be even less than these percentages. Regarding the actual concentration of oil in the water column from the assumed 7,000-bbl spill, extensive water sampling following the *Exxon Valdez* oil spill (EVOS) revealed that hydrocarbon levels in the water column were well below (about 10-1,000 times below) the levels known to be toxic, or to cause sublethal effects in plankton, and returned to background levels (0.20 ppb) in less than a month (Neff, 1991). However, because the water samples were taken a week or more after the spill, it is unclear what the actual hydrocarbon concentrations were during and immediately following the EVOS. Thus, for purposes of this assessment, hydrocarbon concentrations during and immediately following the base-case spill are conservatively assumed to be initially harmful to phytoplankton and zooplankton (exceeding 0.1 ppm but for <5 days; Meyer, 1990).

The likelihood of plankton populations being adversely affected by a large oil spill (e.g., 7,000 bbl) would be greatest during the spring period when they are most abundant. Assuming that a large spill occurs during this period, 0.0004 to 0.0012 percent of the plankton in the sale area are estimated to experience sublethal and/or lethal effects, as explained above. Each of the assumed 7,000-bbl oil spills associated with the base case are estimated to affect plankton in this way. Phytoplankton are expected to recover within 1 or 2 days through regeneration and replacement from adjacent waters, whereas zooplankton recovery may require up to 1 week. Small oil spills (an estimated total of 3,343 bbl) may adversely affect individual lower trophic-level organisms in areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

(2) Epontic Communities: Epontic (under-ice) communities are transient in the nearshore areas of the Beaufort Sea. Oil spilled onto the surface of the ice would reduce the light reaching the epontic algae, resulting in lowered productivity. If oil were spilled under the ice and trapped directly beneath it, those epontic organisms that were not highly mobile are expected to be lethally affected. Oil trapped in this way is expected to become encapsulated within the ice with increasing time. If oil on, in, or under the ice is released during breakup, effects of this nature could occur in other nearby epontic communities. However, it is estimated that <5 percent/spill of the epontic community in the sale area would be affected this way.

(3) Benthic Communities: This section considers the effects of petroleum-based hydrocarbons on marine plants (other than phytoplankton) and invertebrates associated with the base case. Benthic communities are higher in the marine food web than plankton, with some forms feeding on plankton and others feeding at higher trophic levels. Many benthic species are fed upon by higher food-web species, such as marine fishes, birds, and mammals. Benthic flora such as that found in the Boulder Patch also provides shelter for small fish and invertebrates and decreases erosion and turbidity. Hence, any effect on benthic-level organisms (natural or unnatural) would be expected to have an effect on higher trophic levels as well.

In the marine environment, hydrocarbons resulting from an oil spill are broken up by wave action into floating surface oil, dispersed and dissolved oil within the water column, and oil that is incorporated into bottom sediments.

Marine plants and animals are affected most by floating surface oil and oil that is being incorporated into bottom sediments through wave action. In marine environments that have distinct intertidal and subtidal floral and faunal communities, the most persistent effects often occur when intertidal and shallow subtidal benthic communities are contacted by oil, particularly in areas where water circulation is restricted (e.g., bays, estuaries, and mud flats).

Marine Plants: What is known about the effect of crude oil on marine plants has come largely from observations following oil spills. Both lethal and sublethal effects have been observed. Effects vary considerably depending on plant species, type and concentration of oil, and the timing and duration of exposure. For example, following the *Amoco Cadiz* spill in 1978, much of the intertidal zone along the north Brittany coast was covered by oil for 2 to 3 weeks; however, recovery occurred readily and growth rates appeared normal (NRC, 1985). In contrast, extensive mortality has been observed for some marsh grasses and macroscopic algae, particularly those found in the mid-to-high intertidal area, following oil spills (Teal and Howarth, 1984). While there is considerable variation in the observed effect, some believe that once locally decimated, marine plant species may not reappear for years (≥5-6 years for *Fucus* spp.) (Teal and Howarth, 1984). However, following the EVOS, the recolonization of heavily oiled intertidal rocky habitat began the first year after the spill (Duncan, Hooten, and Highsmith, 1993; van Tamelen and Stekoll, 1993), and complete recovery was expected in 5 to 6 years. Sublethal effects of oil on marine plants include alterations in chlorophyll-a content, photosynthesis, growth, and reproduction. Experiments with several species of macroscopic brown algae have shown that even at very low con of macroscopic 2 fuel oil (0.2 ppb) can affect fertilization by interfering with the chemical attraction of sperm to eggs (Steele, 1977; Derenbach and Gerek, 1980).

Observations and measurements of *Fucus* species and other closely related genera further illustrate the typical variation that exists in the effect of oil on marine plants. After the *Tsesis* spill (in Sweden in 1977), the predominant littoral plant (*Fucus vesiculosus*) was not measurably affected. In contrast, following the *Arrow* spill, the vertical distribution of *F. vesiculosus* was reduced for 5 years. After the *Amoco Cadiz* spill in 1978, the fucoid *Ascophyllum* sp. was killed and replaced by *Fucus* sp. (Teal and Howarth, 1984). *Fucus distichus*, an Alaskan species, showed little effect when exposed to 7-ppm Prudhoe Bay crude oil for 2 to 4 hours (Shiels, Goering, and Hood, 1973). Large spills of both crude and fuel oil are reported to have had little effect on eelgrass, aside from the loss of some leaves (Thomas, 1973; den Hartog and Jacobs, 1980). Following the EVOS, eelgrass shoot and flower densities were reported to be lower at oiled sites for up to 2 years (Dean, Stekoll, and Jewett, 1993). However, others believe that eelgrass-shoot density was more related to site disturbances due to shoreline treatment than to oil contamination (Lees et al., 1991; Houghton et al., 1993). Observations like these have shown that while marine plants often are adversely affected by oil, they are not always affected in a substantial way. Further, in the areas that were substantially affected by oil, recovery to prespill conditions is likely to occur within 3 years (longer if hot-water washed).

However, in the Beaufort Sea there is no intertidal zone in the traditional sense. This is due to the annual predominance of shorefast ice, which precludes marine plant life and most fauna along the shoreline. Nevertheless, marine plants do exist subtidally at a few locations in the Beaufort Sea, such as the Boulder Patch community in Stefansson Sound. The estimated effect of the assumed oil spills on subtidal marine plants in the Beaufort Sea area is dependent on the type and amount of oil reaching them. However, the only type of oil that can reach marine plants in subtidal zone (most are 5-10 m deep) would be highly dispersed oil having no measurable toxicity, occurring as a result of heavy wave action and vertical mixing. Hence, the amount and toxicity of oil reaching subtidal marine plants is expected to be so low as to have no measurable effect on them.

Marine Invertebrates: Dominant marine invertebrates in the Beaufort Sea area include gastropods, mollusks, annelids, echinoderms, and crustaceans. Crude oil can have lethal effects on marine invertebrates due to either a short-term exposure to high hydrocarbon concentrations or a long-term exposure to lower hydrocarbon concentrations. Lethal effects also can occur from the smothering effect of heavy oils, particularly in the less mobile and exposed benthic forms. In addition to these variables, the effect of hydrocarbons on marine invertebrates also varies in relationship to the species and the lifestages involved (NRC, 1985).

Sublethal effects on crustaceans can include failure to molt or swim, bioaccumulation, reduced growth, and inhibition of feeding and/or reproduction (typically the result of reduced chemoreceptive abilities). Crustaceans are particularly sensitive to oil just before and following molting, and crabs must molt before mating. Molting is related to growth; thus, larvae, which molt more frequently than adults (Caldwell, Calderone, and Mallon, 1977), are more susceptible to the effects of spilled oil. Immature crab and their pelagic larvae are susceptible to surface and dissolved oil and also to oil that becomes entrained in intertidal sediments and is later released back into the water column. Laboratory studies indicate that oil concentrations ranging from 1 to 4 ppm can be lethal to both adult and larval crab and shrimp after 96 hours of exposure (Starr, Kuwada, and Trasky, 1981). Larval shrimp and crab take up hydrocarbons very rapidly with effects also appearing rapidly. Larvae in lethal concentrations of hydrocarbons stop swimming in <20 minutes, which, if it occurred in the natural environment, probably would result in death (Rice, Wolman, and Braham, 1984).

Oil also has been shown to interfere with chemoreception, which is used by many invertebrates to find their prey (Brown, Baissac, and Leon, 1974), as well as to affect larvae and reproduction (Lonning and Hagstrom, 1975; Armstrong et al., 1983). Large oil spills often have resulted in mortality of bivalves (Teal and Howarth, 1984), which are fed on by many species of marine birds, fishes, and mammals. Effects on bivalves can be almost immediate, but declines in numbers may continue for years (6 years [Thomas, 1976]). These delayed declines may be brought about by the delayed release of oil from shoreline bottom sediments and a subsequent uptake and accumulation of hydrocarbons, reduced settlement into contaminated sediments, decrease in gonadal development and fecundity, and increased predation due to alteration of behavior.

Studies following the EVOS in 1989 showed that significant hydrocarbon concentrations in shoreline sediments were found at heavily oiled sites, followed by an apparent migration of the oil into the shallow subtidal zone in 1991 (Wolfe et al., 1993). However, significant concentrations of oil were not found in the subtidal zone. Regarding the toxicity of shoreline areas contaminated by the EVOS, Gilfillan et al. (1993) have shown that the toxicity of oiled intertidal sediments declined rapidly after the spill. Within 18 months, about 75 percent of the oiled shoreline had recovered. In fact, toxicological results indicate that the oiled shoreline was at toxic hydrocarbon levels for only a few months to 1 year. The remaining hydrocarbons were found to be generally nontoxic and are thought to serve as a food source for some biota (e.g., bacteria).

The assumed two base-case oil spills of 7,000 bbl are assumed here to occur in the summer—the most biologically productive period of the year. The OSRA estimates only a 1- to 3-percent combined probability of one or more spills 1,000 bbl occurring and contacting Land Segments (LS's) 27, 29, 32-38, and 40-41 within 10 days (Appendix B, Table B-52). Nevertheless, for purposes of assessment, it also is assumed that some of these land segments would be contacted by both 7,000-bbl oil spills, even though there is only a 1 to 3-percent chance of that happening. Due to the amount of time elapsed in reaching the shore (10 days), the more toxic hydrocarbon fractions already would have evaporated and are not be expected to have toxic effects on marine invertebrates that seasonally inhabit the shoreline. As mentioned earlier, the predominance of shorefast ice along the shoreline of the Beaufort Sea precludes all but seasonal shoreline invertebrate fauna down to about 1 m in water depth. Subtidal organisms deeper than this would not be contacted either because they live below the zone where oil can affect them measurably.

Hence, the only lower trophic-level organisms likely to be contacted by floating or dispersed oil associated with the two assumed 7,000-bbl oil spills would be those closest to the surface. These include zooplankton (e.g. copepods, euphausiids, mysids, and amphipods), as well as the larval stages of marine invertebrates such as annelids, mollusks, and crusteaceans. Because of similarities in habitat use and distribution, the percentage of marine invertebrate larva contacted by floating or dispersed oil is likely to be similar to that expected for plankton (i.e., a maximum of 1%). Due to their wide distribution, large numbers, and rapid rate of regeneration, the recovery of their populations from each of the two large oil spills is expected to take less than a month. Small oil spills (an estimated total of 1,920 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Summary: The base case could affect lower trophic-level communities (phytoplankton, zooplankton, epontic, and benthic) by exposing them to petroleum-based hydrocarbons, seismic surveys, the discharge of drilling muds, and construction activities. Because lower trophic-level organisms are at the lower end of the food web and supply much of the food for higher level organisms, any effect on them (natural or unnatural) is expected to affect higher level organisms as well.

Because of the prevalent use of airguns in Alaskan OCS waters and the apparent lack of effect on plankton and benthic organisms, seismic surveys are expected to have little or no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area and none of its plankton. Affected benthic organisms are expected to experience mostly sublethal effects, but some would be killed. Recovery is expected to occur within 1 year after the discharges cease. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected (mostly sublethal effects). Benthic invertebrates and plants needing a hard substrate for settlement are expected to colonize the platform within 1 or 2 years. Immobile benthic communi- ties affected by pipeline construction are expected to recover in <3 years.

The effect of petroleum-based hydrocarbons on phytoplankton, zooplankton, epontic, and benthic organisms depends on the species and lifestage, the type and concentration of hydrocarbon, and the duration of exposure. The potential effects of such exposure range from sublethal to lethal. Larval forms are more sensitive to toxic agents than adults and would sustain the greatest adverse effect from spring to fall when they are most abundant. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mud- flats), the recovery of the affected communities is expected to take longer. The adverse effects of oil on phytoplankton include inhibition of photosynthetic activity and growth, lowered feeding and reproductive activity, community changes, and death. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Zooplankton can be contaminated by oil by direct uptake from the water, uptake from food, and direct ingestion of oil particles. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil, although individual organisms experienced either direct mortality, external contamination, tissue contamination by aromatic constituents, inhibition of feeding, or altered metabolic rates. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported to date.

Based on the assumptions discussed in the text, the assumed base-case oil spills are estimated to have sublethal and lethal effects on up to .0012 percent of the phytoplankton and zooplankton populations in the Beaufort Sea area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery within the affected embayments is expected to take 1 to 2 weeks.

The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. Sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection). Due to the predominance of shorefast ice along the shoreline of the Beaufort Sea, most of the shoreline is thought to support little or no resident flora or fauna down to about 1 m in depth. Subtidal marine plants and invertebrates are not likely to be contacted by an oil spill, except for floating larval forms, which may be contacted anywhere near the surface in the water column. The organisms likely to be contacted by floating or dispersed oil include zooplankton (e.g., copepods, euphausiids, mysids, and amphipods), as well as the larval stages of annelids, mollusks, and crusteaceans. In general, the percentage of marine invertebrates contacted by floating or dispersed oil is expected to be similar to that expected for plankton (a maximum of 1%). Due to their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate populations from each of the two large oil spills is expected to take less than a month. Small oil spills (an estimated total of 1,920 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Effectiveness of Mitigating Measures: The mitigating measure having the most effect on lower trophic-level organisms includes the Information to Lessees (ITL) on Oil-Spill-Response Preparedness. Potential mitigating measures having the most effect on lower trophic-level organisms include the ITL's on Discharges into the Marine Environment and on Community Monitoring of the Marine Environment. With these mitigating measures in place, there is an increased probability that (1) less oil would reach the shoreline following a large oil spill, (2) discharges due to OCS activities into the marine environment would be minimized, and (3) onsite monitoring of OCS activities would take place by residents in the area. To the degree that they are implemented, these mitigating measures are expected to benefit lower trophic-level organisms; however, their absence is not expected to substantially increase adverse effects.

Conclusion: Each of the two assumed 7,000-bbl oil spills is estimated to have lethal and sublethal effects on <1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. Each of the assumed spills also is estimated to have lethal and sublethal effects on <5 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

3. Fishes: The following assessments are based in general on the descriptive information in Section III.B.2, and particularly on the new information in the proceedings of the Alaska-based symposium on "Fisheries and Oil Development on the Continental Shelf" (Benner and Middleton, 1991). The assessment also incorporates by reference the assessment of effects on fishes for the base case in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). The overall conclusions of both sections were that the effects would be low or very low. The projected level of activity as a result of the lease sale is similar to the previous projections. Under the base-case assumptions, fishes probably would be affected by seismic operations, drilling, oil spills, and, because economic fields might be discovered, by construction of offshore production platforms and pipelines.

a. Seismic Effects: With regard to seismic operations, the methods have changed a little since preparation of the Sale 124 and 126 FEIS's. Modern seismic surveys are sometimes conducted in an unusually intensive manner in order to yield 3-D subterranean images. Even though 3-D surveys would be unusually intensive, they would be conducted with typical strings of vibrators or airguns. Seismic operations would be conducted both for general exploration prior to the lease sale and for postsale shallow-hazards site surveys. For the base-case scenario, the anticipated amount of seismic activity is about 500 km^2 during 1 month of operation (Table IV.A.1-1).

As described in the Sale 124 FEIS, vibrators and airguns would produce high-pressure impulses that could injure nearby marine fishes with air bladders, but the impulses would dissipate to a nonlethal level within a short distance (<100 m [328 ft]). If 3-D seismic exploration were conducted in the lease-sale area during the summer or open-water season, it would affect only a few marine fishes for one generation.

During wintertime or on-ice seismic exploration, the vibrators or airguns would be on top of a very thin (<10 m [<33 ft]) layer of water. Fishes inhabit the relatively thin under-ice layer of water (Newbury, 1983). A special wintertime survey near Prudhoe Bay with echo sounders (Tarbox and Thorne, 1979) showed that fishes with air bladders are about an order of magnitude rarer in this under-ice layer than in most temperate marine coastal waters (only about two fish per million cubic feet of water). So either open-water or on-ice seismic exploration would affect relatively few fishes.

The magnitude of the predicted effects, in terms of the portion of the regional populations that would be affected, would be very small because most arctic marine fishes are widely distributed. The only situation in which a large portion of fish populations might be affected would be for the few arctic marine fishes that usually are concentrated in relatively small, special habitats, such as the kelp snailfish and leatherfin lumpsucker in the Stefansson Sound Boulder Patch.

b. Drilling Effects: Activities associated specifically with drilling-unit installation and operation—including the discharge of drilling fluids—have not changed since preparation of the Sale 124 and 126 FEIS's. For the Sale 144 base-case scenario, <25 wells are projected to be drilled over a 5-year period (Appendix A, Table A-1). Exploration discharges are expected to be <35,000 short tons of drilling muds and cuttings. These amounts are similar to those that were assessed in the Sale 124 FEIS.

As pointed out in the Sale 124 FEIS, large amounts of sediments are contributed by rivers, coastal erosion, runoff from breakup, and mixing of inshore waters; the additional amounts of drilling muds and cuttings that might be released are small relative to the natural suspended-sediment load of the Sale 144 area (see Sec. IV.B.1 on Effects on Water Quality in this EIS). Most fishes should be able to avoid the relatively small areas of active discharge during the open-water season and do not seem to be very sensitive to discharged drilling muds and fluids (Jones and Stokes, 1983). In shallow, ice-covered waters, where water circulation and fish movements are restricted, fishes would be exposed to muds and fluids for relatively long periods of time (Newbury, 1983); however, drilling discharges have been prohibited in such areas during the past decade. The overall effects of drilling discharges on the fish fauna of the Sale 144 area are expected to be low because (1) the affected areas would be relatively small, (2) fish are mobile during the open-water season, (3) fish do not seem to be very sensitive to discharged drilling fluids and cuttings, and (4) discharges in restricted waters have been prohibited during the past decade. So the conclusions about the very low level of drilling effects on fishes in the previous FEIS's remain unchanged: fishes would be displaced a short distance during installation activities and drilling-fluid discharge but would reutilize their habitat upon completion of the activities.

c. ***Oil-Spill Effects:*** The following assessments of the specific effects of oil spills incorporate by reference the base-case assessments on fishes in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). The Sale 124 FEIS contains a very comprehensive review of information on the general effects of oil spills and on aspects of fish habitats, life histories, and trophics that are especially vulnerable to the effects of oil. It also contains an analysis of species-specific effects for anadromous fishes, marine pelagic species, and marine demersal species, concluding that the base-case level of oil-spill effects on fishes would be very low or moderate. All of this information is incorporated by reference.

The base case for Sale 144 assumes that two is the most likely number of spills $\geq$1,000 bbl occurring during the projected production life of the Sale 144 area. Such spills would cover relatively small areas with toxic concentrations of oil (Rice, Karinen, and Korn, 1978; Starr, Kawada, and Trasky, 1981). The latter authors base their conclusions partly on an investigation of the toxic concentrations of oil for arctic cod, citing a 1979 report by the Northwest and Alaska Fisheries Center in Seattle. The effects of a 1,000-bbl spill on arctic cod can be estimated also with recent information on the abundance of fish. The abundance of arctic cod is sometimes very high in coastal surface waters. Thorsteinson (1996) estimated that a peak of 75 million juvenile arctic cod inhabited the surface water of 600-km^2 Camden Bay during one summer. A 1,000-bbl spill probably would create a 50-km^2 surface slick within 30 days. So, such a spill would cover about one-tenth of the bay, probably displacing downward in the water column about 7 million juvenile arctic cod and possibly killing a small portion. Given the small number of spills projected, the relatively small investigated areas with toxic concentrations for arctic fishes, and the broad distributions of these fishes as described in Section III.B.3., the oil-spill effects are expected to be insignificant for marine species in coastal waters.

However, the shallow, nearshore zone is used extensively by anadromous fish. An oil spill contacting the nearshore environment would affect several species of anadromous fishes as they move alongshore to feeding, overwintering, or spawning grounds. Adult fish are likely to avoid an oil spill and therefore not suffer great mortality; but larvae, eggs, and juveniles are more vulnerable because they are more sensitive and less mobile. In particular, species with floating eggs (e.g., arctic cod) could suffer extensive mortality (dependent on the extent and amount of spilled oil, etc.).

The probability that one or more spills $\geq$1,000 bbl would occur and contact land in the open-water season within 30 days during the production life of the Sale 144 area is <5 percent (Appendix B, Table B-30). If an oil spill occurred in the open-water season and affected a segment of the nearshore region, it could adversely affect the ability of fish to reach feeding or overwintering areas or to reach spawning streams. Effects are more likely for fishes that make extensive migrations from natal streams (e.g., arctic cisco), for fishes with high fidelity to natal streams (e.g., arctic char), and for fishes that overwinter in nearshore environments (such as the major river deltas, e.g., rainbow smelt). Anadromous fishes in nearshore areas, especially juvenile fishes, may be susceptible to spilled oil.

The portion of the nearshore habitats of greatest importance to anadromous fishes are the major river deltas in which they overwinter and reproduce, such as the Colville, Sagavanirktok, Canning, and Mackenzie River deltas. The probability of a spill occurring and contacting individual land segments adjoining deltas is less than for the entire coastline (<5%, see Appendix B, Table B-30).

Even though the likelihood of oil-spill contact with major river deltas is low, a relatively large percentage of the population could be affected by lethal concentrations if a delta were impacted. Most anadromous fishes make spawning runs and outmigrations over a period of time, so it is very unlikely that an entire population would be affected, but a small portion of the population is likely to be affected. For example, about 200,000 broad whitefish are estimated to inhabit Prudhoe Bay (see Fig. III.B.3-3), so a spill probably would affect a few hundred thousand of these fishes; and the lifespan of arctic cisco is 7 years, so a fish kill would reduce the population for a maximum of 7 years. Further, it is unlikely that the bays or major river deltas would be entirely contacted, given the broad expanses of the bays and deltas and the small estimated size of a ≥1,000-bbl spill. For example, a 1,000-bbl spill probably would cover about 50 km^2 after 30 days. This combination of factors suggests that, in the unlikely event an oil spill contacts nearshore waters, it would be lethal to a small portion (e.g., a few hundred thousand) of several anadromous fish populations. The lifespan of arctic cisco is 7 years, so such a fish kill would reduce the population for that many years.

Overall, the most serious effects of the projected ≥1,000-bbl oil spills would be death of a few marine and/or anadromous fishes because of the small probability of a spill and the likelihood that only a small portion of the populations would be affected.

d. Effects from Construction Activities: The following assessments of the effects of construction of platforms and pipelines incorporate by reference the base-case assessments of construction effects on fishes in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). Those previous EIS sections concluded that the projected base-case construction activities would have a low or very low effect on fishes.

During development and production, oil is expected to be transported between local facilities (offshore and onshore) via buried pipelines. An estimated 300 km (162 mi) of pipeline would be laid offshore in conjunction with the activities of Sale 144. A certain amount of trenching would be involved in laying the pipeline, which would displace bottomfish. However, effects of offshore pipeline installation on fishes are expected to be very localized and of temporary duration. Because fish and the epibenthic invertebrates on which they feed annually recolonize shallow environments that are seasonally disturbed, disruption of the bottom substrates should not significantly affect their abundance.

Several short jetty-like structures would be needed in conjunction with the shore approach of the pipelines (Appendix A, Table A-6). According to the base-case scenario, these landfalls and associated jetties might be needed near Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point in the central part of the Alaskan Beaufort Sea. The landfalls might occur at existing structures, such as West Dock. The effects of long docks and causeways (e.g., West Dock and the Endicott causeway) have been a topic of much controversy; their effects are summarized later in the context of nearshore State developments in the section on Cumulative Effects on Fishes (Sec. IV.G.3.d). The effects of short causeways or jetties, like East Dock at Prudhoe Bay, have not been as controversial (Colonell and Gallaway, 1990). East Dock apparently has had no effect on the diversity or local distribution of anadromous species, summarized in Section III.B.2.b, nor on their population levels and fishery yields, as graphed in Section III.B.2.b. A similar low level of effects on fishes is anticipated from the recently proposed short dock for the Badami Development Project near Bullen Point in Mikkelsen Bay (Wilson and Colonell, 1995).

However, the actual siting of a proposed jetty or causeway and its design would greatly affect its potential for having effects on fishes. Site-specific modeling would enable better prediction of potential effects on fishes. Without such site-specific information and appropriate modeling, projecting the possible effects on fishes of such construction activities is quite difficult. Site-specific effects of short jetties or causeways that might be proposed as part of the Sale 144 activities would be more appropriately addressed in a development and production EIS. At this stage, the assumptions are that there might be pipeline landfalls at Oliktok Point, using the Kuparuk Field infrastructure; at Point McIntyre/West Dock, using the Prudhoe Bay infrastructure; and at an eastern point, as stated in Section IV.A.1.b(4)(a).

In general, the projected short length of the jetties in the Sale 144 scenario means that the magnitude of hydrographic changes should be much less than for long causeways sited at the same locations. The effects on fish movements and migrations are likely to be only localized and short term.

Summary: The most likely effects on fishes as a result of the base case activities would be from oil spills and short jetties. The two probable oil spills probably would be lethal to a very small portion of nearshore fish populations, affecting at most a generation of fish in overwintering habitats. Short jetties likely would affect only fish movements.

Effectiveness of Mitigating Measures: No mitigating measures address directly the probable effects on fishes, but two do so indirectly: the stipulation on Protection of Biological Resources and the ITL on Information on Sensitive Areas To Be Considered in the Oil-Spill Contingency Plan. The stipulation is expected to provide additional protection from construction projects and drilling discharges to special benthic habitats such as the Stefansson Sound Boulder Patch, where leatherfin lumpsuckers and other snailfish are found. The ITL is expected to provide additional oil-spill protection to listed habitat such as the Colville River Delta, where many anadromous fish overwinter. The ITL informs lessees that these areas should receive special protection in the event of an oil spill. If these two mitigating measures are not part of the proposal, the effects on fishes are expected to be slightly worse than for the base case.

Conclusion: Overall, the two oil spills and other activities assumed for the base case would at worst be lethal to a very small portion of some nearshore anadromous fish populations, which would decrease population levels for one generation (<7 years).

4. Marine and Coastal Birds:

Several million migratory birds of about 150 species occur on marine habitats within and/or on coastal and tundra habitats adjacent to the proposed Sale 144 area. Oldsquaw, red phalarope, glaucous gull, and common eider are among the most abundant species present. Important coastal habitats are shown in Figure III.B.3. The primary adverse effects on marine and coastal birds from base-case OCS exploration and development activities in the proposed sale area could come from oil pollution of the marine environment, noise and disturbance of bird populations, and alteration of habitats.

To aid in the interpretation of the following effects discussion, an explanation of the term "population in the region" follows. A population of marine and coastal birds is the number of a particular species of seabird, waterfowl, or shorebird that breeds either within or number that occurs seasonally within the Beaufort Sea Planning Area or within the North Slope region. A portion of a population in the region would, for example, be the number of common eiders that nest on the barrier islands or the number of Pacific brant that nest on the Colville River Delta.

a. Effects of Oil Spills:

(1) General Effects:

The effects of oil spills on birds are well documented. (For a detailed discussion of the nature of these effects, see Alaska OCS Region Technical Paper No. 3 [Hansen, 1981] which is summarized here and incorporated by reference, along with more recent information on this topic.) Direct oil contact alone usually is fatal and often results in substantial mortality of many birds. Oiling of birds causes death from hypothermia, shock, or drowning. Oil ingestion through preening of oiled feathers significantly reduces reproduction in some birds and causes various pathological conditions such as endocrine dysfunction, liver function impairment, and significant weight loss and reduced growth in young birds (Holmes and Cavanaugh, 1990; Holmes, 1985; Harvey, Phillips, and Sharp, 1982; Peakall et al., 1980; Koth and Vank-Hentzelt, 1988; Hughes, Kassera, and Thomas, 1990; Burger and Fry, 1993). Oil contamination of eggs by oil-fouled feathers of parent birds also significantly reduces egg hatching through toxic effects on the chick embryo or by abandonment of the eggs, chicks, and nest by parent birds (Harfenist, Gilman, and Maus, 1990; Stickel and Dieter, 1979; and Butler et al., 1988).

Indirect effects of oil pollution include reduction, contamination, and displacement of food sources, as well as contamination of shoreline habitats. A sudden oil-spill-related, local 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 also can lead to chronic toxicity in birds through the accumulation of hydrocarbon residues that may adversely affect their physiology, growth, reproduction, and behavior.

The effects on birds of an oil spill in the Sale 144 area would vary with the season; volume, nature, and duration of the spill; species and numbers of birds occurring in the areas affected; and many other variables. Spills that occurred during the winter would have no immediate effects on birds because of their absence from the sale area during this season. If any oil remained in the ice after winter-cleanup efforts, however, it could directly affect birds during the following spring-breakup period or indirectly affect them through changes or reductions in food-source availability.

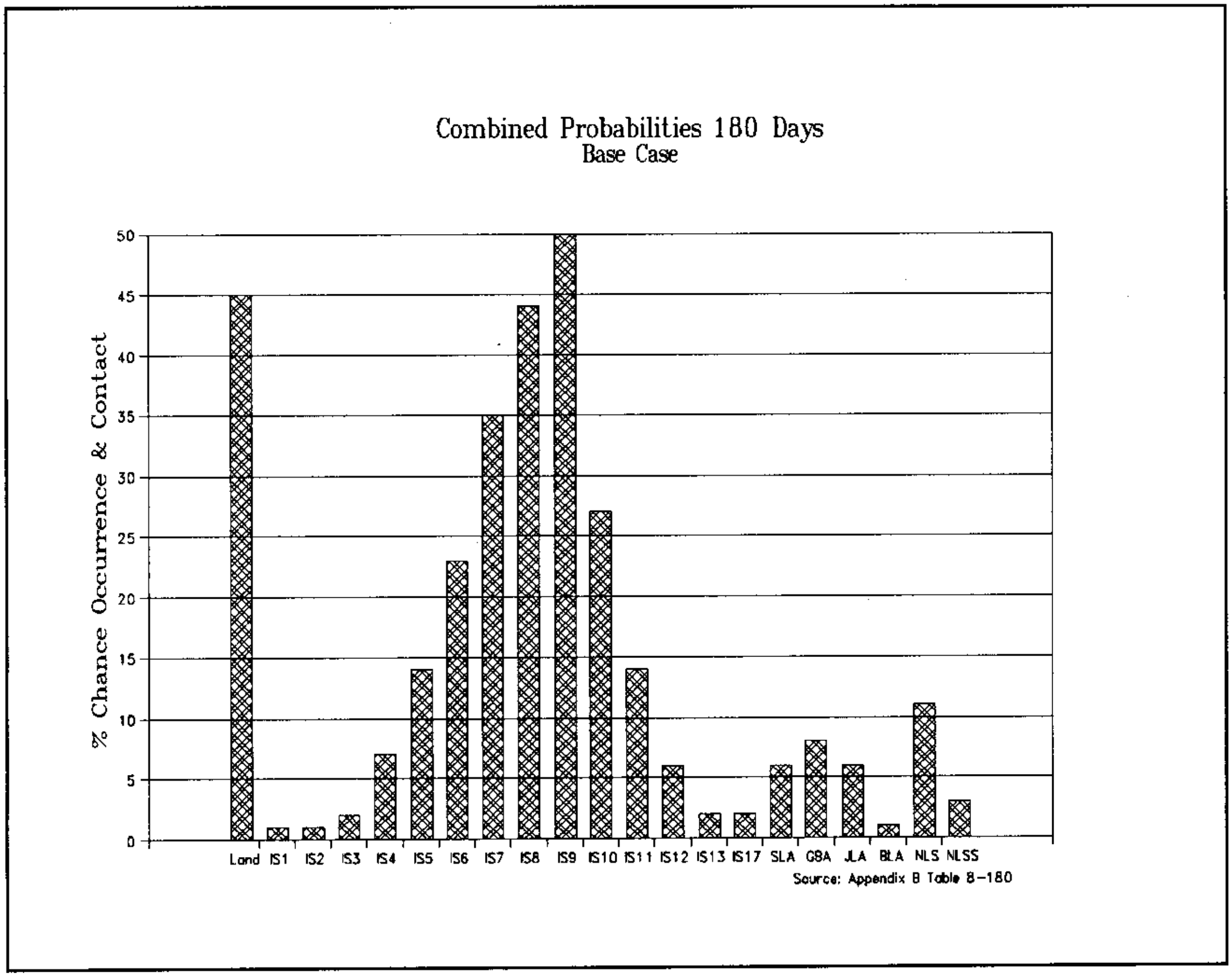
(2) ***Site-Specific Effects:*** Unless otherwise specified, oil-spill contact and probabilities referred to in this section assume the occurrence of exploration and development as estimated in the base-case scenario (Table IV.A.1-1) and associated spill rates (Sec. IV.A.1). Most attention is devoted to spills ≥1,000 bbl, which have a trajectory period of up to 30 days during the open-water period. It is assumed that two oil spills of 7,000 bbl (88% chance of one or more spills occurring) would occur under the base case.

For this analysis, the combined probabilities of oil spills occurring throughout the year and contacting specific bird-habitat areas during the summer (open-water) season are compared in Figure IV.B.4-1. For the base case, these marine- and coastal-bird habitats have a range of from less than a 0.5-percent chance up to a 50-percent chance of being contacted during the year within 180 days. Marine bird habitats offshore of Camden Bay (represented by Ice/Sea Segment IS9) have the highest (50%) chance of spill occurrence and contact of all habitat areas for spill contact within 180 days. The important offshore seasonal feeding area near Point Barrow referred to as the Seabird-Feeding Area (Bering Sea Intrusion Area, see Sec. III.B.3) has an 11-percent chance of oil-spill occurrence and contact within 180 days (Fig. IV.B.4-1). The Gwydyr Bay coastal-concentration area is at greater risk (8% vs. 0 to 6%) than other lagoon habitats. Spill-occurrence and contact risks to any one coastal wetland area are ≤7 percent under the base case (Fig. IV.B.7-1). However, the chance of oil-spill occurrence and contact to any land or shoreline is 45 percent (Fig. IV.B.4-1).

Over the life of the proposed field, there is an 88-percent chance of one or more oil spills ≥1,000 bbl. For this analysis, two such spills are assumed to occur during the winter and melt out during the open-water season or occur during the summer and contact one of the bird-habitat areas compared above (Fig. IV.B.4-1). If the spill occurred during the winter season, it is assumed that at least part of the spill would not be effectively cleaned up prior to ice breakup and could contact one or more of the above habitat areas (Fig. IV.C.4-1) after ice breakup. An oil spill contacting (several km of habitat) nearshore (<20-m water depth) or coastal habitats during the open-water period could expose the following average number of birds per square kilometer (birds/km^2) to contamination: Elson Lagoon-Plover Islands, 100; Pitt Point-Cape Halkett, 145; Harrison Bay, 30; Simpson Lagoon, 70; Gwydyr Bay-Flaxman Island, 80; Camden Bay, Jago Lagoon-Hulahula River, and Beaufort Lagoon, approximately 25 (densities taken from Divoky, 1983).

Because the assumed spill is expected to spread or sweep over several hundred kilometers of habitat, several hundred or more birds are likely to be affected by a spill in nearshore waters west of Cape Halkett, while probably fewer birds would be contaminated by a nearshore spill east of Flaxman Island. If a spill contaminated lagoon waters where large aggregations of several thousand oldsquaw or other bird species were rafting, several thousand birds might be killed. If an oil spill contaminated the seabird-feeding area offshore of Point Barrow during the open-water season, an average of 38 birds/km^2 (of the common species) could be affected. The contamination or loss of a small portion of the seasonally abundant crustaceans in the Point Barrow feeding area (the Bering Sea intrusion) due to an oil spill could temporarily (30 days) reduce available food sources of some of the migratory shorebirds very near the spill. Bird mortality during fall migration for a portion of the North Slope shorebird populations could increase for that year as could mortality for some Ross' gulls. This could represent the loss of several thousand birds.

The direct loss of birds due to one or more oil spills might range from a few to several thousand. Local reduction or contamination of available food sources due to an oil spill also could temporarily reduce survival and reproductive rates of a few to several thousand additional migratory birds for that season. Most migratory species use various Beaufort Sea coastal habitats, depending on food availability. However, the contamination of some local habitat areas is not likely to affect a large portion of a species' regional population frequenting the Beaufort Sea coast. This is because an oil spill contacting the Point Barrow seabird-feeding area is likely to affect only a portion of this habitat and bird-food source because much of the spill would disperse and evaporate rapidly in open water. The death of several thousand oldsquaw, other sea ducks, or other abundant species would not have a long-term (>1-generation) effect on the regional population of those species, because natural recruitment within abundant species' populations such as oldsquaw probably would replace such losses within less than one generation. Species (such as black guillemot) with low reproductive rates or species with low population levels (such as loons) are not likely to suffer high mortality as a result of an oil spill occurring in the Beaufort Sea. Because black guillemots are not abundant in the sale area and do not occur in large feeding flocks, the number of birds of this species expected to encounter and be killed by the spill is likely to be low; and because loon populations are not concentrated, they feed in both freshwater lakes (not contaminated by the assumed spill[s]) and in marine environments in the arctic, and do not



IV.B.4-1. Base-Case Combined Probabilities (expressed as a percent chance) of One or More Oil Spills ≥1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas; Ice/Sea Segments (IS3 through IS13); Lagoons: Simpson Lagoon (SLA), Gwydyr Bay (GBA), Jago Lagoon (JLA), Beaufort Lagoon (BLA); and Ice Leads: the Northern Lead System (NLS), Northern Lead System During Spring (May through June) (NLSS), Within 180 Days Over the Assumed Production Life of Sale 144 congregate in flocks offshore, the number of loons expected to encounter the spill or be killed by the spill is expected to be low. Other species of marine and coastal birds with low numbers in the Arctic are not expected to suffer high losses from the assumed spills for the same reasons Therefore, the effects of oil spills on marine and coastal birds in the Sale 144 area are expected to include the loss of several thousand to perhaps 10,000 sea ducks (primarily oldsquaw) and some seabirds, with recovery of populations within one generation (about 2-3 years).

Additional small spills assumed to occur under the base case are as follows:

- A total of 2 small oil spills ≥1 bbl and <1,000 bbl during exploration and 281 small oil spills <50 bbl and 12 spills ≥50 bbl but <1,000 bbl during production are assumed to occur offshore (Table IV.A.2-4). These minor spills are expected to have additive effects on marine and coastal bird losses, perhaps increasing losses by a few thousand birds and increasing habitat contamination by about 1 percent.

- A total of about 1,500 small spills <50 bbl and 9 spills ≥50 bbl but <1,000 bbl of either crude oil or petroleum products are assumed to occur onshore in association with pipeline facilities, including the TAPS (Table IV.A.2-4). These minor spills are expected to have additive effects on marine and coastal bird losses, perhaps increasing losses by a few hundred birds and increasing contamination of terrestrial habitats along pipeline and road corridors by 1 percent.

b. Effects of Disturbance:

(1) General Effects: Human activities associated with OCS exploration and development, especially air traffic and humans on foot near nesting waterfowl, shorebirds, and seabirds, could reduce the productivity of groups of some individuals of some species and may cause temporary abandonment of important nesting, feeding, and staging areas. Effects studies in the Arctic indicate that arctic tern, black brant, and common eider all show lower nesting success in disturbed areas (Gollup, Goldsberry, and Davis, 1974). Spindler (1984) reported that snow geese were particularly sensitive to aircraft disturbance during premigratory staging. The estimated threshold for response-disturbance of Pacific brant to aircraft (especially helicopter) noise appears to be considerably lower than for other waterfowl (Ward et al., 1988; Murphy et al., 1989). Flocks of molting Pacific brant in the Teshekpuk Lake area were disturbed by helicopter takeoffs and landings at distances up to 2.8 km away, and these molting brant appeared to remain disturbed for a longer period of time—6 minutes versus 1 to 2 minutes—than brant staging at Izembek Lagoon (located on the north side of the Alaskan Peninsula) that were exposed to aircraft overflights (Derksen et al., 1988). Some species, such as tundra swans, are particularly sensitive to humans on foot and may leave their nests when humans approach within 500 to 2,000 m of the nests (Murphy et al., 1989; Monda, Ratti, and McCabe, 1994).

The responses of birds to human disturbances are highly variable. These responses depend on the species; the physiological or reproductive state of the birds; distance from the disturbance; type, intensity, and duration of the disturbance; and many other factors. Adjacent to the proposed sale area, potential disturbance of eiders nesting on barrier islands is a primary concern.

Waterfowl (such as Pacific brant) nesting on the Colville River Delta also may be disturbed by aircraft and boat traffic, and some disturbance of molting and staging oldsquaw and/or other waterfowl and shorebirds on Jago, Elson, and Simpson Lagoons is likely to occur. However, effects studies by Ward and Sharp (1973) and Gollup, Goldsberry, and Davis (1974) indicate that long-term displacement or abandonment of important molting and feeding areas by oldsquaw due to occasional aircraft disturbance is unlikely. Disturbance of nesting birds in the sale area is expected to occur locally but probably would not involve disturbance of very large groups or very large colonies of nesting birds, such as could be the case in other lease-sale areas. The nesting activities of most species of marine and coastal birds are widely dispersed over the coastal tundra, and disturbance of local nesting birds probably would have little effect on North Slope bird populations as a whole.

Birds nesting on the barrier islands, river deltas, and coastal marshlands also may be indirectly affected by increases in predation pressure from gulls and arctic foxes, whose populations have increased in association with human development and availability of garbage. Arctic fox as predators on eggs and young of Pacific brant can limit the abundance and distribution of nesting brant and slow or prevent the recovery of this species' population (Raveling, 1989).

Frequent boat-traffic disturbance of nesting ducks has resulted in a 200- to 300-percent increase in the gull predation rate on duck eggs and young ducklings in nesting areas that occur within 200 m of gull colonies versus predation rates at undisturbed duck nesting areas (Ahlund and Gotmark, 1989).

(2) Site-Specific Noise and Disturbance Effects: Primary sources of noise and disturbance of marine and coastal birds would come from the air and marine traffic and offshore platform construction (on gravel islands) or installation that are assumed to occur with exploration and development. Air support is assumed to be centered out of Deadhorse, Prudhoe Bay, or Kuparuk with 1 helicopter round trip per day per exploration well and a total of about 280 helicopter trips per year during exploration, between 64 and 344 helicopter flights/month during development to the eight drill platforms and back to Deadhorse or other onshore base, and 48 boat trips per year for exploration. In the summer, drillships could be used during exploration. If there are drilling operations during the open-water season, MMS requires the operator to maintain an emergency standby vessel within the immediate vicinity of the drilling unit. Depending on ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units.

The greatest disturbance is likely to come from aircraft traffic flying near barrier-island bird colonies and to a lesser degree from aircraft and boats passing near lagoon concentrations of feeding and molting waterfowl and shorebirds. Aircraft flying between the exploration platforms and support facilities at Deadhorse-Prudhoe Bay or Barter Island that take a route along the coast of the sale area during the nesting season are more likely to temporarily disturb thousands of birds than aircraft that fly directly from the Deadhorse or Barter Island airport to the offshore platforms. Occasionally, these direct offshore flights may briefly disturb foraging flocks of seabirds with little or no lasting effects; however, aircraft disturbance of local feeding or molting concentrations of waterfowl and shorebirds in the lagoon areas during the fall may reduce the ability of migratory birds to acquire the energy (fat-lipid reserves) necessary for successful migration. The buildup of lipid reserves in migratory birds is critical because these birds greatly increase their utilization of fats-lipids during long periods of fasting that occur during migration (Cherel, Robin, and Le Maho, 1988). If such disturbance occurred frequently, migration mortality might increase and winter survival of other affected birds might be reduced, but the amount of air traffic (one or two flights/day per platform during drilling of the exploration wells) is not likely to disturb more than a few local feeding and molting flocks of birds near a portion of the coast or near the drill platforms on occasion. The noise and disturbance effects on birds from aircraft traffic are not likely to be more than short-term displacement.

The noise associated with drilling operations and the movement of barges and supply vessels (about 16 supply-boat trips/year) could disturb foraging seabirds near drilling sites. However, the low-frequency sounds emitted from drilling operations have not been shown to continually displace foraging seabirds from active oil-development areas along the California coast or in Cook Inlet. Expected Sale 144 vessel traffic of about two boat trips per year to and from Prudhoe Bay during exploration and development could temporarily disturb local assemblages of marine and coastal birds. As the vessels pass near the birds, short-term diving or flight responses may result. Unless industry uses small boats or hovercraft capable of moving through very shallow water and boat operators deliberately pass through the coastal lagoons and river deltas, local disturbance of birds by vessel traffic is likely to be very brief (a few minutes to <1 hour). It is very unlikely that industry opera- tions under the proposed marine-support and -transportation scenarios would have any reason for moving boats through the shallow lagoons adjacent to the sale area. However, if industry boat traffic were to pass through the lagoons, disturbance effects on birds would be similar to those of low-flying aircraft. The overall effect of noise and disturbance from aircraft, boat traffic, and drilling activities on marine and coastal birds is likely to be short-term displacement (a few minutes to <1 hour).

(3) Noise and Disturbance Effects from Exploration Construction Activities: For Sale 144 exploratory drilling, one to two drilling units are expected to be used each year. Construction activities associated with platform installation could temporarily displace (one season) several birds near the platform-installation sites. Some brief displacement of birds could occur because of noise and aircraft and boat-traffic movement. This local disturbance of birds within about 1 mi of construction activities would be short term (≤ 1 season).

(4) *Effects of Disturbance from Oil-Spill Cleanup:* In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of nesting birds, the presence of several thousand humans, hundreds of boats, and several aircraft operating in the area involved in cleanup activities is expected to cause displacement of nesting, molting, and feeding birds in the oiled areas and contribute to reduced reproductive success of the birds. This effect is expected to persist during cleanup operations (perhaps 1 or 2 seasons) and affect birds within about ≤1 mi of the activity.

c. Effects of Habitat Alteration—Pipeline Development: For the proposed action, the base-case development would include onshore pipelines of 168 km (104 mi) and offshore pipelines of 128 km (80 mi), with landfalls occurring at three locations: Point McIntyre-West Dock area, Oliktok Point, and a point about 32 km (20 mi) east of Bullen Point along the Beaufort Sea coast. The trenching and/or burial of 128 km (80 mi) of offshore pipelines with a few km^2 of benthic habitat altered along the pipeline route would have temporary effects on the availability of food sources of some birds very near or within 1.6 to 3.2 km (1 or 2 mi) of the pipelaying operation for about one season or year due to turbidity and removal of prey organisms along the pipelines. The construction of onshore elevated pipelines and adjacent access roads could have more persistent effects on the local distribution of nesting birds and waterfowl brooding activities because the onshore pipelines are assumed to be accompanied by roads and associated vehicle traffic and adjacent habitat changes (creation of water impoundments and dust shadow along the roads). Pipelines from Point McIntyre, Oliktok Point, and Point Thomson to TAPS would tie into existing onshore pipeline systems such as the Kuparuk and Endicott pipelines.

The formation of water impoundments along the pipeline roads would benefit some waterfowl species but adversely affect (displace) the nesting of shorebirds in localized areas near the pipeline-road complex. The creation of a dust shadow due to the traffic along the pipeline roads also would benefit some waterfowl-feeding activities during the spring due to early snow melt and early plant growth within the dust shadow but would adversely affect the availability of shorebird-prey-food items very near the road. Although such habitat effects would be persistent over the life of the base case, the effect would be very local (within 1.6 km or 1 mi, generally within 100 m of the road-pipeline corridor) and would not affect marine and coastal bird populations. During road and pipeline construction (about 2 years for main pipeline routes), high levels of motor vehicle traffic (>100 vehicles/day) and humans on foot would be disturbance sources for nesting and feeding waterfowl and shorebirds along the pipeline-road corridors. Some waterfowl and shorebirds would be displaced along the pipeline corridors during construction that occurred in the summer months. Nonetheless, waterfowl and shorebird populations are expected to recover from this habitat loss and displacement within one generation (about 2-3 years).

Construction activities associated with the base case that could affect birds include installation of four production platforms, onshore-gravel mining for road construction for 168 km of onshore pipeline, and road development. Onshore-construction activities would destroy or alter tundra-nesting and -feeding habitat of marine and coastal birds within about 109 to 218 m (100-200 yd) along the onshore pipelines and associated roads. The permanent loss of about 109 to 218 m (100-200 yd) of local onshore habitats along the pipeline-road corridors and also gravel mining during the development phase would represent a small portion of the available tundra habitat and is not expected to affect bird populations in the sale area.

Overall Summary: For the base case, adverse effects on marine and coastal birds primarily would come from (1) one or more oil spills, (2) exploration activities, (3) development and production activities, and (4) alteration of marine (a few square km) and terrestrial habitats (a few square km) associated with exploration and development and production. Over the life of the base case, two oil spills (7,000 bbl) are assumed to occur and could contaminate one or more coastal-habitat areas or an important pelagic habitat, resulting in perhaps the death of several hundred to several thousand birds, particularly abundant oldsquaw and other sea ducks. If a summer-concentration area is widely contaminated, several thousand birds may be directly killed in a severe event. Some local habitats are likely to be contaminated, which could temporarily reduce available food sources of some part of various regional species populations; however, an oil spill is not likely to affect food availability on a regional basis. High bird mortality (loss of several thousand birds) in the Sale 144 area due to an oil spill would not likely result in a long-term population decline, because natural recruitment probably would replace losses of abundant species within 1 to 3 years (1-2 generations). Bird species with low regional populations or species with low reproductive rates (such as black guillemots) are not likely to suffer high mortality (because of their sparse distribution in the marine environment) due to the assumed oil spills in the Beaufort Sea. Effects of oil spills on abundant marine and coastal birds such as eiders and Pacific brant are expected to include the loss of several thousand sea ducks and smaller loses of seabirds and shorebirds, with population recovery occurring within one generation (about 2-3 years).

Noise and disturbance of marine and coastal birds would come from low-flying aircraft, boats, and human presence. Sensitivity of birds to these disturbance sources is highly variable. Industrial activities associated with exploration and development (64-334 helicopter round trips/month and 16 supply-boat trips/year) are likely to disturb some local assemblages of nesting, feeding, and molting birds on barrier islands, lagoons, and tundra habitats. However, nesting activities of most species of marine and coastal birds are widely dispersed over the coastal tundra; and disturbance of local nesting birds probably would have little effect on North Slope bird populations as a whole. Effects of disturbance are expected to be short-term (a few minutes to < 1 hour), with recovery taking place within less than one generation (probably 1 year).

Displacement of waterfowl and shorebirds by onshore-construction activities, especially motor-vehicle traffic and humans on foot, is expected to have a short-term (< 1-generation) effect on the distribution of nesting and feeding waterfowl and shorebirds along the pipeline-access roads during construction. Offshore construction that includes platform installation and pipeline-trenching and -laying activities, with a few square kilometers of benthic habitat altered, represents a short-term (< 1-generation) effect and temporarily would displace some birds within about 1 mi of the activity sites.

Effectiveness of Mitigating Measures: The Orientation Program stipulation and the ITL on Information on Bird and Marine Mammal Protection are expected to reduce potential noise and disturbance effects of air and vessel traffic on marine and coastal birds. The Orientation Program is expected to inform oil-company workers and company contractors of the sensitivity of nesting and molting birds to noise and disturbance from air and vessel traffic and to make the workers (and aircraft pilots) aware of the ITL and the recommended measures to be taken to avoid disturbing bird-concentration areas.

This analysis assumes that the oil industry and its contractors would comply with the ITL on Bird and Marine Mammal Protection and avoid flying within 1.6 km (1 mi) of barrier island nesting colonies and other known bird-concentration areas when weather conditions permitted them to avoid these areas. This compliance is expected to prevent excessive or frequent disturbance of marine and coastal birds. However, some disturbance of individual nesting birds and feeding concentrations is expected to occur when (1) weather conditions prevent aircraft from flying at or above the recommended 545-m (1,500-ft) altitude or within ≥ 1.6 km (1 mi) from concentrations, (2) aircraft may fly low over concentrations of birds during takeoffs and landings, and (3) boats may disturb some near river deltas and lagoons. These effects are expected to be short-term and local and would not be expected to affect bird populations.

The ITL on Information on Sensitive Areas To Be Considered in the Oil-Spill Contingency Plans (OSCP) may provide some protection for marine and coastal bird sensitive habitats that are listed in the ITL (such as the lead system off Point Barrow, Colville River Delta, and Simpson Lagoon). The lessees are informed that these areas should be protected in the event of an oil spill. However, it is unlikely that oil-spill-protection and -cleanup measures would prevent a large spill from contacting these marine and coastal bird habitats if wind and ocean currents were driving the spill into these areas.

The stipulation on Protection of Biological Resources primarily concerns protection of benthic habitats that may be buried or covered by drill-platform installation. The amount of benthic habitats (probability $< 1\ km^2$ or $.62\ mi^2$) is not expected to be of consequence to marine and coastal bird populations; thus, this stipulation is not expected to provide much protection to marine and coastal birds. Other stipulations that are part of the proposal and other proposed mitigating measures are not expected to provide any additional protection for marine and coastal birds or to reduce potential adverse effects.

While these mitigating measures are expected to provide possible benefits, if they are not part of the proposal, the effects on marine and coastal birds are expected to be about the same as with the measures. This is because the measures that provide protection for marine and coastal birds, primarily the ITL on Bird and Marine Mammal Protection and the ITL on Sensitive Areas To Be Considered in Oil-Spill-Contingency Plans, still are likely to be complied with by the lessees in order to meet requirements and regulations of the Fish and Wildlife Service (FWS) under the Migratory Bird Treaties in their review of oil and gas exploration and development plans.

Conclusion: The overall effect of potential oil spills, noise and disturbance, and habitat alteration on marine and coastal birds (waterfowl, seabirds, and shorebirds) is expected to include the loss of several thousand birds due to oil contamination. The overall effect from noise and disturbance and habitat alteration would be the short-term (a few minutes to < 1 hour) displacement of nesting, feeding, and molting birds. Bird-population recovery is expected within one generation (about 2-3 years).

5. Pinnipeds, Polar Bears, and Belukha Whales: Six species of nonendangered marine mammals—numbering over 100,000 ringed, spotted, and bearded seals; 3,000 to 5,000 polar bears; 200,000 to 250,000 walruses; and about 12,000 belukha whales—commonly occur year-round or seasonally in a portion of or throughout the Beaufort Sea Planning Area and are very likely to be exposed to OCS exploration and development and production activities under the base case. Oil pollution, noise and disturbance, and alteration of habitats could adversely affect marine-mammal populations found in the proposed Sale 144 area. To aid in the interpretation of the following effects discussion, an explanation of the term "population of the region" (see Table S-2) follows: A population of nonendangered marine mammals in the region is the number of ringed, bearded, or spotted seals or the number of polar bears, walruses, or belukha whales that occur seasonally within the Beaufort Sea Planning Area. A portion of a population in the region would be, for example, the number of polar bears that den on the Arctic National Wildlife Refuge (ANWR) coast during the winter.

a. Effects of Oil Spills:

(1) General Effects of Oil Pollution: This section briefly discusses the nature of effects of oil on marine mammals that commonly occur in the sale area; see OCS Report, MMS 85-0031 (Hansen, 1985; 1992) for a detailed discussion of the various possible direct and indirect effects of oil and other chemical pollutants on marine mammals. A summary of this report, which is incorporated by reference in this EIS, is as follows:

(2) Direct Effects of Oil: Direct contact with spilled oil may kill some marine mammals and have no apparent effect on others depending on factors such as the species involved and the animals' age and physiological status. Some polar bears and newly born seal pups occurring in the sale area are likely to suffer direct mortality from oiling through loss of thermoinsulation, which could result in hypothermia. Adult ringed, spotted, and bearded seals and walruses are likely to suffer some temporary adverse effects such as eye and skin irritation with possible infection. Such effects may increase physiological stress and perhaps contribute to the death of some individuals (Geraci and Smith, 1976; Geraci and St. Aubin, 1980; St Aubin 1990). Deaths attributable to oil contamination are more likely to occur during periods of natural stress such as during molting or times of food scarcity and disease infestations.

Although species-specific effects of oil contact on belukha whales have not been conducted, studies of hydrocarbon effects on dolphins and porpoises as representative odontocetes by Geraci and St. Aubin (1982; 1990) provide sufficient insight on potential effects of oil-spill contact on belukhas. The findings of these experiments suggest that smooth-skinned cetaceans such as belukha 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; 1992). 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. Consumption of apparently large quantities of oil over a relatively short period of time (as in the Oritsland et al. experiment with polar bears) can result in high concentrations of hydrocarbons in the bloodstream. If these concentrations exceed the filtering ability of the kidneys (and liver) to remove toxins and the ability of the liver to detoxify hydrocarbons (Engelhardt, 1983), kidney failure may occur, with severe toxic reactions and an imbalance of body chemistry leading to the death of the animal (Oritsland et al., 1981). Chronic oil ingestion may cause degeneration of liver and kidney tissue in marine mammals that have thick fur (to which oil will adhere) and that exhibit intensive grooming behavior, such as sea otters and polar bears. Although pinnipeds are known to scratch themselves with their flippers, they do not seem to mouth or lick themselves as a form of grooming (McLaren, 1990).

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 (1976) demonstrated that seals are able to excrete as well as absorb oil. Both seals and cetaceans potentially can metabolize oil 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). This finding suggests that seals and cetaceans might not suffer any serious physiological effects if they consume small quantities of oil, but some portion of the metabolized hydrocarbons would be stored in lipid-rich tissues, especially the blubber, where some residues have been reported. However, there is no evidence of associated pathological or metabolic effects, nor evidence that such compounds would accumulate with repeated exposure (St Aubin, 1990).

(3) Oil-Spill Avoidance: Seals, walruses, polar bears, and belukha whales are not likely to avoid oil spills intentionally, 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; 1992). 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. Polar bears may be attracted to an oil- spill site due to their curiosity (Adams, 1986, pers. comm.) and due to the presence of dead birds or other animals killed by the spill.

(4) Indirect Effects of Oil: Indirect effects of oil pollution on seals, walruses, polar bears, and belukha 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, belukha and bowhead whales, and marine birds feeding primarily on a few species of abundant invertebrates and arctic cod. During heavy ice years, primary productivity is comparatively low, and food could be a limiting factor for large areas of the Beaufort Sea (Frost and Lowry, 1981).

If a major spill occurred during such a heavy ice year, the short-term loss of plankton and benthic invertebrates could locally reduce marine-mammal-food sources during a critical period and result in local decreased productivity of breeding ringed seals due to possible nutritional deficiencies from a local reduction in prey abundance or availability for that season. The local reduction in ringed seal numbers as a result of direct or indirect effects of oil could in turn affect polar bear distribution for that year.

However, ringed, spotted, and bearded seals; walruses; and belukha whales opportunistically prey on a variety of available food organisms and are quite 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 would persist for no more than one season due to the rapid recruitment of the food organisms and would represent a short-term (< 1-year) effect.

(5) Effects of Disturbance From Oil-Spill Cleanup: In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of ringed seals, other seals, walruses, and polar bears, the presence of several thousand humans, hundreds of boats, and several aircraft operating in the area involved in cleanup activities is expected to cause displacement of seals, bears, and other marine mammals in the oiled areas and to contribute to increased stress and reduced pup survival of ringed seals, if operations occur during the spring. This effect is expected to persist during cleanup operations (perhaps 1 or 2 seasons) and to affect seals, bears, and other marine mammals within ≥ 1.6 km (1 mi) of the activity.

(6) Site-Specific Effects of Oil Spills: Unless otherwise specified, oil-spill contact and probabilities referred to in this section assume the occurrence of base-case development to the extent estimated in Section II.B.2.a and the associated spill rates (Sec. IV.A.1). Most attention is devoted to spills equal to or greater than 1,000 bbl that have a trajectory period of up to 30 days during the open-water period. There is an 88-percent chance of one (7,000-bbl average) or more spills of 1,000 bbl or greater occurring under the base case, and two spills of 7,000 bbl are assumed to occur under the base case.

The combined probabilities of oil spills that occur at any time of the year and contact pinniped, polar bear, and belukha whale marine-mammal offshore-habitat areas (represented by Ice/Sea Segments IS1 through IS13, IS17, and the Northern Lead System [NLS] off Point Barrow) within 180 days are shown in Figure. IV.B.4-1. The chances of spills ≥ 1,000 bbl occurring and contacting these habitat areas within 180 days are described as follows: The portion of the NLS off Point Barrow has an 11-percent chance of spill contact within 180 days because of the net westward movement of oil-spill trajectories. This probability increases substantially beyond 30 days because of the net movement of the oil spills to the west—particularly if one of the two assumed 7000-bbl spills occurred east of Point Barrow during the winter and melted out of the ice during the open-water season (see Appendix B, Table B-40, 180-day trajectories for the Northern SLS) from Hypothetical Spill Locations L1 through L7 and L9 compared with 30-day trajectories on Table B-18 from the same spill locations). The ice-flaw zone represented by the Ice/Sea Segments numbered 1 through 13 in Figure IV.B.4-1 is an important habitat area for marine mammals. This zone is extensively used during the winter by subadult and nonbreeding ringed seals, bearded seals, and polar bears. The highest risk of spill occurrence and contact (50%) to seals and polar bears within the ice-flaw-zone habitat is the area north and offshore of Camden Bay (Fig. IV.B.4-1, Ice/Sea Segment IS9). This spill risk reflects the assumed location of oil resources and the westward movement of spill trajectories from the east. Marine mammals using the flaw zone and pack-ice edge offshore of Barter Island (IS10) west to the Cape Halkett area (IS6) are at greater risk (>20% chance of spill occurrence and contact) of potential oil-spill contamination within 180 days from the two base-case spills than marine mammals distributed in other offshore habitats of the Beaufort Sea (Fig. IV.B.4-1, Ice/Sea Segments IS6 through IS10).

Winter spills that occur nearshore within the 20-m (54-ft) isobath fast-ice zone are likely to affect some pupping and breeding ringed seals. Spills that occur in October are not likely to be cleaned up effectively under freezeup conditions and may contaminate fast-ice habitats of ringed seals. However, once freezeup occurs in the fast-ice zone, little spill movement or oil spreading would occur under fast ice. The number of ringed seal pups and adult seals contaminated is likely to be small (2-3 seals/mi^2 in fast ice or perhaps >100 seals total loss). Assuming one of the 7,000-bbl oil spills occurred during the open-water period or occurred during winter in the offshore flaw zone, larger numbers of ringed and bearded seals might be contaminated. Aggregations of hundreds of seals do occur in open water. Such an event could result in the contamination and loss of perhaps 200 to 300 seals.

The net westward movement of spills and the chance of spill contact for the Northern Lead System [during] Spring (NLSS) during the spring, May through June (Fig. IV.B.4-1, NLSS) indicate that extensive walrus-feeding habitat northwest and west of Point Barrow could be at some risk (3%) of oil-spill contact within 180 days. Herds of several thousand walruses seasonally occupy marine habitats from Icy Cape to Point Barrow and along the pack-ice edge northwest of Point Barrow during the open-water season. Oil contamination of walruses probably would not result in direct mortality of healthy individuals. However, contamination could seriously stress diseased or injured animals and stress young calves, causing some deaths. Perhaps a few hundred calves and some adults could die from oil contamination, but such a loss is likely to be replaced within one generation by natural recruitment in the population. Little or no significant contamination of benthic food organisms and bottom-feeding habitats of walruses and bearded seals is expected, because the fraction of the spill (such as 16%) is expected to be widely dispersed in the water column and to be weathered and degraded by bacteria prior to sinking to the bottom as scattered tarballs (see Sec. IV.A.3, Spilled Oil Fate and Behavior in Marine Waters). Because the walrus population presently is believed to be near the carrying capacity of its habitat, the seasonal temporary loss or contamination of benthic-food sources could have noticeable effects on walrus productivity and survivorship for the following winter and spring seasons. However, the amount of benthic prey killed or contaminated by scattered tarballs from the spill is likely to be a very small or insignificant proportion of the prey and benthic habitat available in the eastern Chukchi Sea.

Polar bears would be most vulnerable to oil-spill contamination along the ice-flaw zone north of Camden Bay to Cape Halkett and offshore of Point Barrow in the NLS (Fig. IV.B.4-1, Ice/Sea Segments IS6-IS9 and NLS, respectively). However, the number of bears likely to be contaminated or indirectly affected by local reduction in seals as a result of an oil spill probably would be small considering the approximate density of one bear per 78 to 130 km^2 (48-81 mi) (Amstrup, 1983a). In a severe situation, where a concentration of perhaps 20 or 30 bears were contaminated by an oil spill and all the bears died, this one-time loss is not likely to affect populations of polar bears; annual recruitment probably would replace lost bears within less than one generation (<5 years).

Belukha whales would be most vulnerable to oil contact during spring migration off Point Barrow (Fig. IV.B.4-1, NLSS). Oil-slick contamination of the ice-lead system during spring migration (April to June) could directly expose several thousand whales or a large portion of the western Beaufort Sea stock to some oil-spill contact. However, oil-spill-effects studies conducted with similar smooth-skinned cetaceans suggest that such brief or intermittent contact with oil spills (as is likely to occur during migration) probably would not result in any deaths of healthy whales or have long-lasting sublethal effects after short exposure (see discussion above under General Effects of Oil Pollution). An oil spill may contact the lead system (NLSS, Fig. IV.B.4-1) during the spring, May through June, period. However, the likely physical reaction between oil, ice, water temperature, and wind off Point Barrow would appreciably reduce the chance of an oil slick persisting in the lead system (Sackinger, Weller, and Zimmerman, 1983). Therefore, belukhas of the western Beaufort population may have some contact with an oil spill (hydrocarbons in the water column or on the surface) that would temporarily contaminate the lead system off Point Barrow; however, few, if any, belukha whales are likely to be seriously affected, even in a severe situation, with no significant effect on their distribution or abundance.

A total of 2 small oil spills ≥1 bbl and <1,000 bbl during exploration and 281 small oil spills <50 bbl and 12 spills ≥50 bbl but <1,000 bbl during production also are assumed to occur offshore under the base case (Table IV.A.2-4). These minor spills are expected to have an additive effect on seal, walrus, and polar bear losses, perhaps increasing losses by a few polar bears, seals, and walrus pups and increasing habitat contamination by perhaps about 1 to 2 percent.

b. Effects of Noise and Disturbance: Airborne or underwater noise associated with OCS activities is the main source of disturbance of seals, walruses, polar bears, and belukha whales. For a discussion of the nature of airborne and underwater noise effects on pinnipeds, polar bears, and belukha whales, see the Sale 124 FEIS (USDOI, MMS, 1990). A discussion of site-specific noise and disturbance effects follows:

The primary sources of noise and disturbance of ringed, bearded, and spotted seals; walruses; polar bears; and belukha whales would come from the air and marine traffic associated with the base case and more specifically from the supply boats, icebreakers, and helicopters associated with the assumed one to two exploration-drilling rigs and eight production platforms. Geophysical on-ice equipment, geophysical seismic boats, the onshore pipeline, and additional support facilities assumed for the base case also would be primary noise sources (see Sec. II.B.2.a). Secondary disturbance sources would be low-frequency noises from drilling operations on the exploration-drilling rigs and production platforms. Aircraft traffic (about 280 helicopter round trips/year during exploration and 64 to 334 round-trip flights/month during development) centered out of Deadhorse-Prudhoe Bay or Barter Island, traveling to and from the two exploration platforms and the eight production platforms, is assumed to be a source of primary disturbance to spotted seals hauled out on the beaches along the Colville River Delta and other haulout areas and to walruses and bearded and ringed seals hauled out on the ice. Some belukha whales might be diverted by helicopter noise and presence if they occur on the ice up to 100 m away (Richardson et al., 1995). Such brief occasional disturbances are not likely to have any serious consequences for cetaceans (Richardson et al., 1991; 1995).

Exploration drilling would take place from bottom-founded mobile and floating drilling units; depending on ice conditions, the floating units would be supported by one or more vessels with icebreaking capabilities. Exploratory drilling during the winter season—when natural leads are often frozen over—would result in the formation of leads and cracks in the ice on the leeward sides of the drill rigs, and such local changes in the ice habitat would attract seals and in turn attract polar bears (Stirling, 1988). Some polar bears could be unavoidably killed to protect oil workers when the bears were attracted to the rigs due to food odors and curiosity. Under the Marine Mammal Protection Act, the oil companies would be required to have a permit to take or harass polar bears. Consultation between the companies and the FWS on this matter is expected to result in the use of nonlethal means in most cases to protect the rig workers from polar bear encounters. The number of bears lost as a result of such encounters is expected to be very low (such as <10 bears "taken").

Exploration drilling from drillships in the deeper water tracts may coincide with the belukha whale fall migration through the offshore areas along the pack-ice front. Icebreaker traffic has been demonstrated to disturb belukha whales within 35 to 50 km (22-31 mi) of the vessel (Finley and Davis, 1986). However, expected reaction distances of belukha whales to an icebreaker operating off Point Barrow during the spring migration was 5 to 7 km, with some whales expected to tolerate icebreaker noise within 5 to 7 km under some circumstances (Richardson et al., 1995). Thus, different populations of belukhas might respond to icebreaker noise at varying distances from the source or from a different icebreaker or icebreakers under different circumstances. Other than flight responses, the meaning or importance of behavioral changes correlated with the sound and presence of boats is uncertain. Boat traffic (about 16 supply boat trips/year) or icebreakers could briefly (a few days) disturb some marine-mammal concentrations within a lead system; and it may temporarily interrupt the movements of belukha whales, seals, and walruses or temporarily displace some animals 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 leasing proposal. Such traffic is not likely to have more than a short-term (a few hours to a few days) effect on marine-mammal migrations or distributions, but the displacement of pinnipeds, polar bears, and belukha whales could affect the availability of these animals to subsistence hunters for that season. Icebreaker activity also may physically alter some ice habitats and destroy some ringed seal lairs in pack-ice areas, perhaps crushing or displacing some ringed seal pups and perhaps displacing some denning polar bears.

Some of the air traffic to and from the two exploration-drilling units (about 280 helicopter trips/year) and to and from the eight production platforms (64-334 flights/month) could disturb hauled-out seals and walruses, causing them to charge in panic into the water. Because of frequent low visibility due to fog, aircraft may not always be able to avoid disturbing walruses and seals hauled out on the ice. Walrus nursery herds that haul out on the ice in the far western part of the planning area are not expected to be exposed to aircraft traffic, because the westernmost lease blocks of the proposal are to the east of the icefront where walrus nursery herds occur during the summer-fall (July through September) season. However, aircraft disturbance of hauled out seals in the sale area could result in injury or death to young seal pups. Although air-traffic disturbance would be very brief, the effect on individual seal pups could be severe. The number of seals affected would depend on the number of disturbance incidents (one or two aircraft flights/day to four platforms). Aircraft disturbance of small groups of spotted and ringed seals hauled out along the coast or disturbance of bearded and ringed seals hauled out offshore near the two drill platforms is not likely to result in the death or injury of large numbers of seals, although increases in physiological stress caused by the disturbance might reduce the longevity of some seals if disturbances were frequent. During the belukha whale migration, some of the aircraft traffic over open-water ice-leads temporarily may divert the migration movements of some belukha whales as the aircraft pass overhead or nearby, but these reactions are not expected to be biologically significant (Richardson et al., 1995).

c. Effects of Geophysical Seismic Activities: It is assumed that geophysical surveys (23 km^2 [14 mi^2]/well) over a total of 507 km^2 (314 mi^2) during exploration and 736 km^2 (456 mi^2) during development would be shot over 7-day periods, primarily during the open-water season, using about two vessels. Geophysical site-clearance surveys covering a minimum area of about 147 km^2 (92 mi^2) for a block survey would occur during development in association with production-platform installation; and 483 km (302 mi) of high-resolution seismic-survey lines are assumed to be run in association with the laying of 128 km (80 mi) of offshore pipeline (see Sec. II.B).

Ringed seals pupping in shorefast-ice habitats within about 150 m (490 ft) of the on-ice shot lines are likely to be disturbed by on-ice seismic exploration (Burns et al., 1983). However, the number of ringed seal pups that could possibly be lost as a result of this level of disturbance is likely to be less than a few hundred, considering the low density of breeding seals in the Beaufort Sea, and would represent no more than a short-term (<2 year) effect on the population. During development, an estimated 736 km^2 (456 mi^2) of open-water shallow-hazards survey lines at four survey sites (based on past seismic activity), using perhaps two seismic boats for 56 days, could disturb pinnipeds, polar bears, and belukhas during the 4 weeks of survey activity. Similar to other boat traffic, open-water, active seismic activities are likely to result in startle responses by ringed, bearded, and spotted seals; walruses; polar bears; and belukha whales near the sound source. As with other vessel traffic, this disturbance response is likely to be brief; and the affected animals are likely to return to normal behavior patterns within a short period of time after a seismic vessel has left the area. Noise and disturbance from seismic boats and other vessels could be a problem if boat traffic moved near marine-mammal-haulout areas or interfered with spotted seal and walrus movements. However, this effect is unlikely, given the expected amount of vessel traffic associated with the base case. If the presence of noise from industrial activity occurred very near coastal subsistence areas and reduced or delayed the use of these habitats by marine mammals, the availability of these subsistence resources to villagers could be adversely affected (see Sec. IV.B.10, Effects on Subsistence). Overall, noise and disturbance from air and marine traffic associated with the base case is expected to have a short-term (a few minutes to a few hours), local effect on marine-mammal populations.

d. ***Effects of Offshore Construction:*** Under the assumed development scenario, one to two exploration-drilling units per year and eight oil-production platforms are assumed to be used in the sale area. Platform-site preparation and pipeline trenching along the assumed 128 km (80 mi) of offshore pipeline could affect marine mammals through noise and disturbances, through habitat alterations (a few km^2) of benthic habitat representing less than 1 percent of the benthic habitat in the sale area affected by pipeline trenching), and through temporary changes in availability of food sources within this area. Some pinnipeds, polar bears, and belukha whales could be temporarily displaced by noise and disturbance from platform-installation and pipelaying activities and also from other support activities. Temporary displacement could occur within 2 to 3 km of the following platform and pipeline-trenching locations: northeast and northwest of Barter Island, offshore of Point Thomson, Oliktok Point in Harrison Bay, and west of Harrison Bay. Prey species could be temporarily disrupted or buried near the pipeline-trenching and platform-preparation sites (see Sec. IV.C.2). During construction, some marine mammals near platform-installation sites and along the total of 128 km (80 mi) of offshore pipelines could be temporarily displaced for approximately one season. In theory, marine mammals could continue to be disturbed, and habitat use could continue to be diverted a few kilometers away from the platforms over the life of the field. The installation of exploration and production platforms (and drill rigs) in ice habitats of seals and their breathing-hole ice habitat is a concern (Akootchook, 1986, pers. comm). However, the amount of displacement and change in habitat use (within 2-3 km of the platforms) is likely to be very small in comparison with the natural variability in seasonal habitat use and natural variations in marine-mammal distributions. Noise-disturbance and adverse-habitat effects associated with platform and offshore-pipeline installation are expected to be very local (within a few kilometers or less of the platforms) and not affect marine-mammal populations.

e. ***Effects of Onshore Construction:*** Onshore landfall development for pipelines to the TAPS is assumed to take place at Oliktok Point, Point McIntyre-West Dock, and a point about 32 km (20 mi) east of Bullen Point with the construction of 168 km of elevated onshore pipelines to the TAPS. During construction, this development could disturb and perhaps displace a small number of seals and polar bears within a few kilometers of these three landfall sites.

Ringed seals that seasonally inhabit shorefast ice along the coast and a few polar bears could be displaced near the site. However, the number of animals disturbed and/or displaced would be few, and the amount of coastal habitat altered would be localized near the pipeline-landfall sites. Under the base case, onshore-development effects on regional marine-mammal populations are likely to be short term (1 year or season) and local (1-3 km [0.62-1.9 mi] from activity), with any disturbance of seals and polar bears declining after construction activities are complete.

Summary: For the base case, oil spills; noise and disturbance; and habitat alterations from drill-platform installation, pipeline laying, and other construction could have some adverse effects on pinnipeds, polar bears, and belukha whales found in the lease-sale area. There is an 88-percent chance of one (7000-bbl average) or more oil spills of 1,000 bbl or greater occurring during base-case exploration and development. The assumed two 7,000-bbl oil spills pose the greatest risk of contact to all marine mammals in the Camden Bay offshore area (Ice/Sea Segment 9) and in other ice-flaw-zone habitats located from Barter Island west to Cape Halkett (Ice/Sea Segment 6) (Fig. IV.B.4-1).

Some aggregations of about 10 to perhaps a few hundred ringed, spotted, and bearded seals and walruses occurring in these habitats could be contaminated and suffer lethal or sublethal effects. A small number of breeding ringed seals and their pups are likely to be contaminated by a winter oil spill, resulting perhaps in the death of some pups—probably no more than 200 because of the sparse distribution of pupping lairs. Polar bears also would be most vulnerable to oil spills in the ice-flaw zone; however, a small number of bears (probably fewer than 50-100) are likely to be affected because of their sparse distribution, with recovery taking place within 1 year or less than one generation.

Walrus herds of several thousand and their seasonal feeding habitat west and north of Point Barrow could be at some risk of oil-spill contact. Direct effects of oil are likely to include the loss of a few hundred walrus calves and highly stressed adults. Healthy adult walruses are not likely to die from oil-spill contact, but a few hundred or more young calves could be killed if oiling occurred. The oil contamination of part of the walrus herd could result in the loss of several hundred calves and some adult walruses, but such a loss is likely to be replaced by natural recruitment within one generation. Little or no significant contamination of benthic-food sources of walruses and bearded seals is expected, because very little oil is likely to sink to the bottom except for scattered tarballs. This contamination is not expected to reduce the availability of benthic organisms.

Belukha whales are most vulnerable to oil-spill contact during spring migration off Point Barrow. The western Beaufort Sea population of belukhas is likely to have some contact with hydrocarbons in the water column or on the surface if an oil spill contaminated the lead system off Point Barrow during spring migration. However, few belukha whales are likely to be seriously affected by probable brief exposure to the spill (< 10 whales), with population recovery taking place within 1 year.

Ringed seal pups and polar bears are the species most likely to suffer direct mortality from oil spills in the sale area. A small number of ringed seals—perhaps 75 to 100 pups and highly stressed adults—and a small number of polar bears (no more than perhaps 20-30 in a severe case) could die if a spill occurred. This would represent no more than a short-term (< 1-generation) effect on the Beaufort Sea populations, with losses within the populations replaced within one generation.

Present knowledge of the behavior of nonendangered marine mammals and the nature of noise associated with offshore oil and gas activities suggests that intense noise causes brief startle, annoyance, and/or flight responses of pinnipeds, polar bears, and belukha whales. Helicopter trips (about 280/year) and supply-boat traffic (about 16 trips/year) to and from the two base-case exploration-drilling units and 64 to 334 helicopter round trips/month) to the eight production platforms could disturb some hauled out ringed, bearded, and spotted seals and walruses, causing them to panic and charge into the water, resulting perhaps in the injury or death of some seal pups and walrus calves. Because the walrus nursery herds and nursing seals and pups are widely distributed along the ice front, aircraft moving to and from drill platforms are likely to temporarily disturb only a small portion of the walrus and seal populations. Thus, aircraft disturbance of seals, walruses, and polar bears is likely to cause short-term displacement (a few minutes to less than a few days) of small numbers of these animals (less than a few hundred) within about 1 km of the air traffic. Vessel traffic (16 trips/year) associated with the two exploration-drilling units and eight production units and seismic vessels operating during the open-water season temporarily could displace or interfere with marine-mammal migration and change local distribution for a few hours to a few days. Such short-duration and local displacement (within 1-3 km [0.62-1.9 mi] of the traffic) is expected to have a short-term (< a few days') effect on the distribution of pinnipeds, polar bears, and belukha whales.

The installation of eight production platforms and the laying of 128 km^2 (80 mi^2) of offshore pipelines with a few square kilometers of benthic habitat altered are likely to have a short-term and local effect on these marine mammals. The combined effect of oil spills, noise and disturbance, and habitat alterations is likely to be short-term, with populations recovering within one generation or less (2 to 5 years).

***Effectiveness of Mitigating Measures*:** The stipulation on the Orientation Program and the ITL on Information on Bird and Marine Mammal Protection are expected to reduce potential noise and disturbance effects of air and vessel traffic on pinnipeds, polar bears, and belukha whales. The Orientation Program is expected to inform oil-company workers and company contractors of the sensitivity of seals and walruses to noise and disturbance from air and vessel traffic and to make the workers (and aircraft pilots) aware of the ITL and the recommended measures to be taken to avoid disturbing seal and walrus-haulout areas.

This analysis assumes that the oil industry and its contractors would comply with the ITL on Bird and Marine Mammal Protection and avoid flying within 1.6 km (1 mi) of seal and walrus haulout sites and other known marine mammal-concentration areas when weather conditions permitted them to avoid these areas. This compliance is expected to prevent excessive or frequent disturbance of seals and walruses. However, some disturbance of hauled out and feeding seals, walruses, and a few polar bears is expected to occur when (1) weather conditions prevent aircraft from flying at or above the recommended 545-m (1,500-ft) altitude or within ≥ 1.6 km (1 mi) from concentrations; (2) aircraft may fly low over concentrations of seals, walruses, or polar bears during takeoffs and landings; and (3) boats may disturb some seals, walruses, or cetaceans near ice floes on in leads. These effects are expected to be short term and local and not to affect pinniped, polar bear, or belukha whale populations.

The ITL on Information on Sensitive Areas To Be Considered in the Oil-Spill Contingency Plans (OSCP) may provide some protection, at least in theory, for nonendangered marine mammal sensitive habitats that are listed in the ITL (such as the lead system off Point Barrow). The lessees are informed that these areas should be protected in the event of an oil spill. However, it is unlikely that oil-spill-protection and -cleanup measures would prevent a large spill from contacting these marine mammal habitats if wind and ocean currents were driving the spill into these areas.

The stipulation on Protection of Biological Resources primarily concerns protection of benthic habitats that may be buried or covered by drill-platform installation. The amount of benthic habitats (probability < 1 km^2 [0.62 mi^2]) is not expected to be of consequence to marine mammal populations; thus, this stipulation is not expected to provide much protection to pinnipeds, polar bears, and belukha whales. Other stipulations that are part of the proposal and other proposed mitigating measures are not expected to provide any additional protection for nonendangered marine mammals or to reduce potential adverse effects.

If these mitigating measures are not part of the proposal, the effects on pinnipeds, polar bears, and belukha whales are expected to be about the same as with the measures enforced. This is because the measures that provide protection for marine mammals, primarily the ITL on Bird and Marine Mammal Protection, are still likely to be complied with by the lessees because of the Marine Mammal Protection Act, which requires lessees to have a permit to conduct activities that may harass or take marine mammals in order to limit and avoid excessive harassment or taking of nonendangered marine mammals.

Conclusion: The effects from activities associated with the base case are expected to include the loss of small numbers of seals (200-300 seals), walruses (no more than perhaps several hundred), polar bears (perhaps 20-30 bears), and belukha whales (<10), with populations recovering (recovery meaning the replacement of individuals killed as a consequence of the proposal) within one generation or less (such as about 2-5 years).

6. Endangered and Threatened Species: The endangered bowhead whale, the threatened spectacled eider, the proposed Steller's eider, and the recently delisted arctic peregrine falcon (considered here as a candidate species) may occur year-round or seasonally in the Beaufort Sea Planning Area and may be exposed to OCS exploration and development/production activities under the base case of the proposal. The OCS activities under the base case may result in noise and disturbance, altered habitat, and spilled oil or other contaminants, such as drilling muds and cuttings, and could adversely affect the behavior, distribution, and abundance of individuals or populations occurring in or adjacent to the Sale 144 area. It is assumed that crude oil would not be released during exploration.

The base-case scenario assumes that one or two drilling units would drill 1 or 2 exploration wells each year between 1997 and 2001 and 1 or 2 delineation wells each year between 1997 and 2004 for a total of 22 wells. Support for operations on ice islands or nearshore gravel islands is expected to be by ice roads. Drilling operations farther offshore would be supported during the open-water season by at least one supply-boat trip/drilling unit/week and one helicopter flight/drilling unit/day. Depending on ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units. The time required to drill and test a well is about 90 days. It is also assumed that eight production platforms (with a total of 273 wells) would be in operation for 24 years. More detailed information on logistics and transportation scenarios may be found in Section II.A.2.

Activities that would occur during development and production are similar to those that would occur during exploration, with the addition of activity associated with oil transport. A spill of crude oil during development or production could affect individual species, as discussed below. In addition, cleanup activities associated with any oil spill may result in disturbance.

The OSRA estimated two spills ≥1,000 bbl, with an estimated 88-percent chance of one or more such spills occurring over the production life of the proposed action. Combined probabilities of spill occurrence and contact factor in the volume of oil assumed to be produced and the estimated spill rates for platforms, pipelines, and tankers expressed as a percent chance of one or more spills ≥1,000 bbl occurring and contacting a specific Environmental Resource Area (ERA) within a specific timeframe during a specific season. Probabilities in the following discussion, unless otherwise noted, are combined probabilities estimated by the OSRA model (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting an ERA important to endangered or threatened species within 30 days (Fig. IV.A.2-3) over the production life of the proposed action. The threshold combined probability (expressed as a percent chance) at which it is assumed that contact and/or damaging effects on the resource would begin to occur—requiring more than a brief interval for recovery of the population to its original status—is 5 percent in the following analyses.

Conditional probabilities are much higher than combined probabilities because conditional probabilities assume that an oil spill has occurred within a particular lease-block location or along specific hypothetical pipeline or tanker routes. The conditional probabilities cited below assume that a spill has occurred at a particular location and indicate the estimated probability, expressed as a percent chance, that the spilled oil will contact a specific ERA within 30 days during the summer (Appendix B, Table B-25) or winter season (Appendix B, Table B-18).

The following analysis of potential effects was extracted from pertinent sections of the Biological Evaluation for Threatened and Endangered Species with Respect to the Proposed Beaufort Sea Oil and Gas Lease Sale 144 (included as Appendix F of this EIS).

Pursuant to requirements under the Endangered Species Act of 1973 (ESA), as amended, the MMS Alaska OCS Region has consulted with the FWS and National Marine Fisheries Service (NMFS) on a previous proposed lease sale in this region (Beaufort Sea Planning Area Oil and Gas Lease Sale 124). In the Sale 124 Biological Opinion, the FWS concluded that leasing and exploration activities would not be likely to jeopardize the continued existence of the arctic peregrine falcon. The NMFS considered Sale 124 as a reoffering of previous Beaufort and Chukchi Sea sales that were previously addressed in the Arctic Regional Biological Opinion. The NMFS concluded that leasing and exploration activities were not likely to jeopardize the continued existence of endangered whales.

In accordance with the ESA, Section 7, regulations governing interagency cooperation, MMS notified FWS and NMFS by letter dated January 23, 1995, of the endangered, threatened, and proposed species that would be included in a Biological Evaluation for Section 7 consultation. The NMFS responded on February 7, 1995, confirming the bowhead whale as the species to be included in the evaluation. The FWS responded on March 13, 1995, confirming spectacled eiders, Steller's eiders, and Arctic peregrine falcons as the appropriate species to be discussed in the evaluation and referenced additional species that could be affected along transportation routes south of the proposed sale area.

The biological evaluation was completed and, in accordance with Section 7(a) of the ESA, formal consultations on the proposed Beaufort Sea Sale 144 were initiated with the FWS and NMFS on July 31, 1995. The NMFS responded with a letter dated November 16, 1995, determining that the Arctic Region Biological Opinion satisfies the requirements of Section 7 of the ESA for the Sale 144 planning process. The Arctic Region Biological Opinion, dated November 23, 1988, concluded that the proposed lease sale and exploration activities in the Beaufort Sea are not likely to jeopardize the continued existence of any endangered or threatened cetaceans. A Final Biological Opinion was received from the Fish and Wildlife Service (FWS) on April , 1995. The Final Biological Opinion found that the proposed sale and associated exploration in the Beaufort Sea would not jeopardize any listed species for which FWS is responsible.

Analysis of oil-spill risk on species along transportation routes south of the proposed sale area, particularly the southern sea otter and the marbled murrelet, can be found in the Cook Inlet Planning Area Oil and Gas Lease Sale 149 DEIS (USDOI, MMS, Alaska OCS Region, 1995), which is incorporated here by reference. The DEIS discusses potential effects of an oil spill on these species as a result of tankers transporting oil from the Cook Inlet sale area to California ports. Potential effects include oil contamination of their insulative capabilities resulting in hypothermia, inflammation/lesion of sensitive tissues following oil contact, tissue or organ damage from ingested oil, and emphysema from inhaled vapors. Potential indirect effects from an oil spill include a reduction in available food resources due to mortality or unpalatableness of prey organisms. Mortality of southern sea otters resulting from any spill of oil (estimated probability of occurrence is 6% in the potentially affected area) tankered from the Sale 149 area to southern California is expected to be moderate (an estimated 23 individuals) with an estimated 1-year-recovery time (<1 generation), although conditions prevailing at the time of a spill could cause much greater mortality to occur. Mortality of marbled murrelets resulting from any spill of oil (estimated probability of occurrence is 6% in the potentially affected area) tankered from the Sale 149 area to northern California is expected to be high (estimated 30-144 individuals, 2-9% of the California population), with an estimated 3- to 15-year (2-8 generations) recovery time.

a.   Effects on the Bowhead Whale: Bowhead whales may be present in the Sale 144 area generally from early April to mid-June during their spring migration from the Bering Sea to the Canadian Beaufort Sea and from August through October during their fall migration back to the Bering Sea. The following discussion describes how bowhead whales may be affected by oil and gas exploration activities.

(1)   Potential Effects of Noise and Disturbance: Noise-producing exploration activities, including aircraft traffic, icebreaking or other vessel traffic, geophysical-seismic surveys, and drilling are the activities most likely to affect bowhead whales.

Sound is transmitted efficiently through water. Hydrophones often detect underwater sounds created by ships and other human activities many kilometers away, far beyond the distances where human activities are detectable by senses other than hearing. Marine mammals use calls to communicate and probably listen to natural sounds to obtain information important for detection of open water, navigation, and predator avoidance. Concern has arisen that manmade noise may affect bowheads by raising background noise levels—which could interfere with detection of sounds from other bowheads or from important natural sources—or by causing disturbance reactions. There has also been speculation that extremely strong noise might cause temporary or permanent hearing impairment under some conditions.

Sound transmission from noise-producing sources is affected by a variety of things, including water depth, salinity, temperature, frequency composition of the sound, ice cover, bottom type, and bottom contour. In general terms, sound travels farther in deep water than it does in shallow water. Sound transmission in shallow water is highly variable since it is strongly influenced by the acoustic properties of the bottom material, bottom roughness, and surface conditions. Similarly, sound propagation is enhanced if there is smooth annual ice cover on the surface, and the roughness of the under-ice surface becomes more significant than bottom properties in influencing sound-transmission loss (Richardson and Malme, 1993).

Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines. Data on reactions of bowheads to helicopters are limited. Observations indicate that most bowheads are unlikely to react significantly to occasional single passes by low-flying helicopters ferrying personnel and equipment to offshore operations. Observations of bowhead whales exposed to helicopter overflights indicate that most bowheads exhibited no obvious response to helicopter overflights at altitudes above 150 m (164 yd). If bowheads were overflown at altitudes <150 m (164 yd), some would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). However, this noise generally is audible for only a brief time (tens of seconds) if the aircraft remains on a direct course, and the whales should resume their normal activities within minutes. Fixed-wing aircraft overflights at low altitude (≤300 m [328 yd]) often cause hasty dives. Reactions to a circling aircraft are sometimes conspicuous if it is below a 300-m (328-yd) altitude, uncommon at 460 m (503 yd), and generally undetectable at 600 m (656 yd) (Richardson and Malme, 1993). The effects from such an encounter would be brief, and the whales should resume their normal activities within minutes.

Bowheads react to the approach of vessels, even from greater distances, more than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. Avoidance usually begins when a rapidly approaching vessel is 1 to 4 km (0.62-2.5 mi) away. A few whales may react at distances from 5 to 7 km (3-8 mi) and a few whales may not react until the vessel is <1 km (<0.62 mi) away. Received noise levels as low as 84 decibels relative to 1 microPascal (dB re 1 μPa) or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi). In the Canadian Beaufort Sea, bowheads observed in vessel-disturbance experiments began to orient away from an oncoming vessel at a range of 2 to 4 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (Richardson and Malme, 1993). Vessel disturbance under experimental conditions caused a temporary disruption of activities and sometimes disrupted social groups when groups of whales scattered as a vessel approached. Reactions to slow-moving vessels, especially if they do not approach directly, are much less dramatic. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. In some instances, bowheads have returned to their original locations.

Bowhead whales probably would encounter a few vessels associated with Sale 144 activities during their fall migration or while feeding in the eastern Alaskan Beaufort Sea. Vessel traffic would be generally limited to routes between the exploratory-drilling units and the shore base. Each floating drilling unit probably would have one vessel remaining nearby for emergency use. Depending upon ice conditions, floating drilling units may have two or more icebreaking vessels standing by to perform ice-management tasks. It is likely that vessels actively involved in ice management or moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. In either case, bowheads probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending a drilling unit and probably would move away from vessels that approached within a few kilometers. Vessel activities associated with the sale are not expected to disrupt the bowhead migration, and small deflections in individual bowhead-swimming paths and a reduction in use of one to several small areas of bowhead-feeding habitat near exploration units should not result in significant adverse effects on the species. During their spring migration (April through June), bowheads are expected to encounter few, if any, vessels along their migration route because ice at this time of year typically would be too thick for drillships and supply vessels to operate in.

Sound from seismic exploration is another potential source of noise disturbance to bowhead whales. Marine seismic exploration uses underwater sounds with source levels exceeding those of other activities discussed here. Seismic surveys are of two types: low-resolution, deep-seismic and high-resolution, shallow-seismic surveys. Deep-seismic surveys emit loud sounds, which are pulsed rather than continuous, and can propagate long distances from their source. Bowheads likely will temporarily change their individual swimming paths as they approach or are closely approached by seismic vessels. These short-term responses are not likely to preclude a successful migration or to significantly disrupt feeding activities. Seismic surveys are not expected to be conducted in or near the spring lead system through which bowheads migrate because (1) degraded ice conditions would not allow on-ice surveys and (2) insufficient open water is present for open-water seismic surveys. Scientific studies have shown that when an operating seismic vessel approaches within a few kilometers, most bowheads exhibit strong avoidance response and specific changes in surfacing, respiration, and dive patterns. Strong pulses of seismic noise often are detectable 25 to 50 km (15.5-31 mi) from seismic vessels, but most bowheads exposed to seismic sounds from vessels more than about 7.5 km (4.7 mi) away rarely show avoidance. Strong avoidance occurs when received levels of seismic noise are 150 to 180 decibels per 1 microPascal (dB re 1 μPa) (Richardson and Malme, 1993). Besides avoidance, whales may exhibit significant tendencies for reduced surfacing and dive durations, fewer blows per surfacing, and longer intervals between successive blows. Bowheads' surface-respiration-dive characteristics appeared to recover to preexposure levels within 30 to 60 minutes following the cessation of the seismic activity. The next few paragraphs provide a brief discussion of a number of studies on the effects of noise from seismic operations on bowhead whales.

Ljungblad et al. (1985) conducted a set of four experiments where bowhead whales were approached by an operating seismic vessel. In the first experiment, an active seismic vessel approached to within 1.3 km (0.81 mi) with received sound level of 152 dB. At 3.5 km (2.18 mi), milling and social behavior ceased. Surfacing, respiration, and dive characteristics changed significantly and avoidance behavior began as the vessel approached to within 1.3 km (0.81 mi). Experiment 2 involved a sudden seismic startup at a range of 7.2 km (4.47 mi) with a received sound level of 164 dB. The whales responded to the sudden startup by changing their surfacing behavior and, as the vessel approached 3.5 km (2.18 mi), the surfacing, respiration, and dive characteristics changed significantly. Surfacing, respiration, and dive characteristics also changed significantly in experiment 3, as the seismic vessel approached from 12 to 5 km (7.5 to 3.1 mi) with received sound levels ranging between 154.9 and 171.2 dB, respectively. Two whales remained until the vessel approached to within 3.5 km (2.18 mi). In the last experiment, seismic sounds were initiated at a distance of 11.8 km (7.3 mi) with received levels of 154 dB. Surfacing, respiration, and dive characteristics began to change at a range of 7 km (4.35 mi) with a received sound level of 158.1 dB, partial avoidance behavior began at 3.5 km (2.18 mi) with a received sound level of 163.1 dB, and complete avoidance reactions were exhibited at 1.8 km (1.12 mi) when the estimated received sound level was 169 dB. This study concluded that whales responded to seismic sounds at ranges <10 km (6.2 mi), with the strongest responses occurring when whales were within 5 km (3.1 mi) of the sound source, and that a period of 30 to 60 minutes is required before whales recover from the effects of close seismic disturbance. No discernable behavioral changes occurred during exposure to seismic sound at ranges >10 km (6.2 mi). It also was concluded that the findings in this study were consistent with the findings of several earlier studies. A subcommittee of the International Whaling Commission reviewed this data and some members were critical of the methodology and analysis of the results. "Comments included reference to: the small sample size; inconsistencies between the data and the conclusions; lack of documentation of calibration of sound monitoring possible interference from other active seismic vessels in the vicinity. The sub-committee acknowledged the difficulty of performing experiments of this kind, particularly in the absence of a 'control' environment free of industrial noise. It recommended that additional research taking into account the concerns expressed above be undertaken, and that the 1984 experimental results be subjected to rigorous reanalysis, before it can draw any conclusions on the effects of seismic activity on this species" (IWC, 1987).

In Fraker et al. (1985), an active seismic vessel traveled toward a group of bowheads from a distance of 19 km (11.8 mi) to a distance of 13 km (8.18 mi). The whales did not appear to alter their general activities. Most whales surfaced and dove repeatedly and appeared to be feeding in the water column. During their repeated surfacing and dives, they moved slowly to the southeast (in the same direction as seismic-vessel travel) and then to the northwest (in the opposite direction of seismic-vessel travel). The study first stated that a weak avoidance reaction may have occurred but then stated there is no proof that the whales were avoiding the vessel. The net movement was about 3 km (1.86 mi). The study found no evidence of differences in behavior in the presence and absence of seismic noise but noted that observations were limited. In another study (Richardson, Wells, and Wursig, 1985) involving a full-scale seismic vessel with a 47-liter airgun array (source level 248 dB re 1 μPa), bowheads began to orient away from the approaching ship when its airguns began to fire 7.5 km (4.7 mi) away. The received level was estimated at 134-138 dB at 7 km (4.35 mi). Some near-bottom feeding (evidenced by mud being brought to the surface) continued until the vessel was 3 km (1.86 mi) away. The closest point of approach to any whale was approximately 1.5 km (.93 mi), with the received level probably well over 160 dB. No conspicuous changes in behavior were noted and the whales began feeding again about 40 minutes after the seismic noise ceased. These results were consistent with earlier studies.

While conducting a monitoring program around a drilling operation, Koski and Johnson (1987) noted that the call rate of a single observed bowhead whale increased after a seismic operation had ceased. During the 6.8 hours of observation, the whale was within 23 to 27 km (14.3-16.8 mi) from the drillship. A seismic vessel was reported to be from 120 to 135 km (74.58-83.9 mi) from the sonobuoy, and the two loudest calls received were determined to be approximately 7 km (4.35 mi) and 9 km (5.6 mi) from the sonobuoy, with received levels of 119 dB and 118 dB, respectively. Approximate S:N ratios were 24 dB and 22 dB, respectively. No information is provided regarding the exact distance the whale was from the operating seismic vessel. The increase in call rate was noted within 25 minutes after seismic noise ceased. It also needs to be noted that there were few, if any, calls heard during the 2 hours prior to the start of seismic operations, so it is unclear whether the increase in call rate relates to cessation of seismic noise, the presence of the operating drillship, the combination of both activities, or some other factor that occurred in the late afternoon. During this same study a subgroup of 4 to 7 whales within a larger group was noted moving away from an approaching seismic vessel at a distance of 22 to 24 km (13.7-14.9 mi). The received level was 137 dB at 19 km (11.8 mi). The surfacings and dives were unusually brief, and there were unusually few blows per surfacing. No information was available regarding the time required for these whales to return to normal behavior. Richardson and Malme (1993) noted that this apparent response is the longest-distance avoidance of a seismic vessel noticed thus far.

Richardson and Malme (1993), while synthesizing data on the effects of noise on bowheads, concluded that collectively the studies show that when an operating seismic vessel approaches within a few kilometers, most bowheads exhibit strong avoidance and specific changes in surfacing, respiration, and dive patterns. Bowheads exposed to pulses from vessels more than ~7.5 km (4.7 mi) away rarely show avoidance reactions, but their surfacing, respiration, and dive cycles may be altered in the same manner as those of whales closer to the vessels. Tom Albert, NSB, testifying at the Barrow public hearing on the Beaufort Sea Sale 144 Draft EIS, said the whaling captains "don't believe the 7.5-kilometer thing," referring to the conclusions of several studies and the synthesis of studies by Richardson and Malme, (1993) regarding the distance at which most bowheads are likely to show avoidance response to seismic operations. "[T]he hunters that go out, feel that the reaction is on the order of a 10 miles or more?" (1995).

High-resolution seismic surveys, which are much lower energy, generally are conducted on leases following the lease sale to evaluate potential shallow hazards to drilling. Shallow-hazard seismic surveys for exploration-delineation-well sites most likely would be conducted during the ice-free season. Because high-resolution seismic surveys are lower energy and tend to be relatively quiet, these activities are not likely to have significant effects on endangered whales. In the study by Richardson, Wells, and Wursig (1985) four controlled tests were conducted by firing a single 40-in^3 (0.66-liter) airgun at a distance of 2 to 5 km from the whales. Bowheads sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3 to 5 km away (received noise levels at least 118-133 dB re 1 μPa). Some bowheads oriented away during an experiment at a range of 2 to 4.5 km and another experiment at a range of 0.2 to 1.2 km (received noise levels at least 124-131 and 124-134 dB, respectively).

Frequencies of turns, predive flexes, and fluke-out dives were similar with and without airgun noise, and surfacing and respiration variables and call rates did not change dramatically during the experiments.

Inupiat subsistence whalers feel that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and is thereby interfering with the subsistence hunt at Barrow (Ahmaogak, 1989). Aerial surveys conducted from 1982 to 1987 (Ljungblad et al., 1988) provided no evidence of such a trend. An analysis of distance of random bowhead sightings from shore was conducted but no significant differences were detected in the bowhead migratory route between years. The axis of the bowhead migratory route near Barrow was found to fall between 18 and 30 km from shore. Also, median water depths at locations of bowhead whale sightings across the Beaufort Sea for the years 1982 to 1994 ranged from 18 to 66 m, with the exception of 1983 when the median water depth was 347 m (Treacy, 1995). The cumulative median water depth is 37 m. Although there is variation between the years, there appears to be no indication that the annual whale migration has been progressively displaced to deeper water during the 1982 to 1994 timeframe. Ljungblad et al. (1987) concluded that although the 1983 migration could be said to be displaced compared to other years, it is not likely that this was the result of industrial activities because such activities were curtailed that year due to ice conditions.

Mr. Burton Rexford, Chairman of the Alaska Eskimo Whaling Commission, testified that loud noises drive the animals away and spook them. Mr. Rexford, who has more than 53 years experience in subsistence whaling, was testifying at a public meeting in Barrow, Alaska, on the Letter of Authorization at the Kuvlum Prospect in the Beaufort Sea (1993): "We know where whales can be found; when the oil industry comes into the area, the whales aren't there. It is *not* the ice; it is the noise." Mr. Rexford is concerned that the whales will abandon the usual hunting areas, that subsistence whalers will be displaced, and that placing a physical barrier (such as a drillship or seismic vessel) between whalers and whales will drive whales away from their normal migration route. Mr. Thomas Napageak, also at the public meeting, testified that the migration *has* been affected (1993). Frank Long Jr., a whaling captain from Nuiqsut testifying at the public meeting on the Kuvlum Prospect in Barrow, testified, "The G&G work from July through October is very critical. The seismic work will affect the whale. As long as activity is going on in Camden Bay, the whale migration will change; it's changing already. The migratory route is changing each season" (1993).

Another source of noise would be from the exploration drilling units. Stationary sources of offshore noise (such as drilling units) appear less disruptive to bowhead whales than moving sound sources (such as vessels). Bowhead whales exhibiting normal behavior while on their summer-feeding grounds have been observed on several occasions within a few miles of operating drillships, well within the zone where drillship noise is clearly detectable. In playback experiments, some bowheads showed a weak tendency to move away from the sound source at a level of drillship noise comparable to that which would be present several kilometers from an actual drillship. Reactions to drilling sound from artificial islands and caisson-retained islands have yet to be observed, but underwater-sound levels at various distances from a caisson-retained island (with support vessels nearby) in the Canadian Beaufort Sea were similar to those produced by a drillship. In general, it appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. The following paragraph provides a brief discussion of a number of studies on the effects of noise from drilling operations on bowhead whales.

The distance at which bowheads may react to drillships is difficult to gauge, because some bowheads would be expected to respond to noise from drilling units by slightly changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23 to 27 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 km (5.9 mi) of the drillship and few were observed within 15 km (9.3 mi). In other studies, Richardson, Wells, and Wursig (1985) observed three bowheads 4 km (2.48 mi) from operating drillships, well within the zones ensonified by drillship noise. The whales were not heading away from the drillship but were socializing even though exposed to strong drillship noise. Eleven additional whales on three other occasions were observed at distances of 10 to 20 km (6.2-12.4 mi) from operating drillships. On two of the occasions, drillship noise was not detectable at distances from 10 to 12 km (6.2-7.4 mi) and 18 to 19 km (11.2-11.8 mi), respectively. In none of the occasions were whales heading away from the drillship. Ward and Pessah (1988) reported observations of bowheads within 0.2 to 5 km (0.12-3 mi) from drillships. While conducting aerial surveys over the Kuvlum drilling location, Brewer et al. (1993) showed that bowhead whales were observed within about 30 km (18.6 mi) north of the drilling location. The closest observed position for a bowhead whale detected during the aerial surveys was approximately 23 km (14.3 km) from the project icebreakers. The drilling rig was not operating on that day, but all three icebreakers had been managing ice during the day. Bowhead whale call rates peaked when whales were about 32 km (19.9 mi) from the industrial activity. It should be noted, however, that while this study showed whales about 30 km (18.6 mi) north of the drilling location in 1992, Treacy (1993) concluded that the estimated median and mean water depths at the location of bowhead whales sighted by BWASP in 1992 are consistent with a previously noted trend for whales to be located in deeper water during years of moderately heavy ice cover. There was moderate to heavy ice conditions throughout the monitoring area, with heavy, grounded ice flows to the west, north, and east of the drilling site. Brewer et al. (1993) was unable to determine if either ice or industrial activity by themselves caused the whales to migrate to the north of the drilling location, but concluded that ice alone probably did not determine the observed distribution of whales. Miles, Malme, and Richardson (1987) predicted that roughly half of bowheads are expected to respond at a distance of 1 to 4 km (0.62-2.5 mi) from a drillship drilling when the signal-to-noise ratio (S:N) is 30 dB. A smaller proportion would react when the S:N is about 20 dB (at a greater distance from the source), and a few may react at an S:N even lower or at a greater distance from the source.

Sounds recorded 130 m (426 ft) from the actual *Karluk* drillrig were used as the stimulus during disturbance test playbacks (Richardson et al., 1991). For the overall 20 to 1,000 Hz band, the average source level was 166 dB re 1 μPa in 1990 and 165 dB re 1 μPa in 1989. The largest quantity of data was collected on May 13, 1990, when a stream of bowheads migrated along a long, narrow lead through otherwise heavy pack ice. Bowheads continued to pass the projector while normal *Karluk* drilling sounds were projected. During the playback tests, the source level of sound was 166 dB re 1 μPa. One whale came within 110 m (360 ft) of the projector. Many whales came within 160 to 195 m (525-640 ft), where the received broadband (20-1000 Hz) sound levels were about 135 dB re 1 μPa. That level was about 46 dB above the background ambient level in the 20 to 1000 Hz band on May 13. Bowhead movement patterns were strongly affected when they approached the operating projector. When bowheads were still several hundred meters away, most began to move to the far side of the lead from the projector, which did not happen during control periods while the projector was silent. Bowhead whales also were observed on one occasion while distorted *Karluk* sounds were being projected. Too few data are available to allow a statistical analysis of distribution or movements during the distorted playback versus other occasions. However, the closest point of approach distribution of bowheads observed by ice-based and aerial observers during the distorted playback appeared similar to that during projection of normal *Karluk* sounds later on the same day.

The authors stated that one of the main limitations of this study is the inability of a practical sound projector to reproduce the low-frequency components of recorded industrial sounds. The *Karluk* rig emitted strong sounds down to ~10 Hz, and quite likely at even lower frequencies. It is not known whether the under representation of components below 80 Hz and especially below 63 Hz during playbacks had significant effects on the responses by bowheads. Bowheads presumably can hear sounds extending well below 80 Hz, but it is not known whether their hearing extends into the infrasonic range below 20 Hz. The projector adequately reproduced the overall 20-1000 Hz level at distances beyond 100 m even though components below 80 Hz were under represented. If bowheads are no more responsive to sound components at 20-80 Hz than to those above 80 Hz, then the playbacks provided a reasonable test of the responsiveness to components of *Karluk* sound above 20 Hz.

In a subsequent phase of this continuing study, Richardson et al. (1995) concluded that "migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 km (0.54 nmi). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector." Some migrating bowheads diverted their course enough to remain a few hundred meters to the side of the projector. Surfacing and respiration behavior, and the occurrence of turns during surfacings, were strongly affected out to 1 km (0.62 mi). Turns were unusually frequent out to 2 km (1.25 mi), and there was evidence of subtle behavioral effects at distances up to 2 to 4 km (1.25-2.5 mi). The study concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior were not biologically significant.

Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by bowheads than do moving sources, particularly ships. Most observations of bowheads tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Since other cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with a harmful event, this suggests that bowheads will habituate to certain noises that they learn are nonthreatening. However, in Canada, bowhead utilization of the main area of oil-industry operations within the bowhead range was low after the first few years of intensive offshore oil exploration began in 1976, suggesting perhaps cumulative effects from repeated disturbance may have caused the whales to leave the area. In the absence of systematic data on bowhead summer distribution until several years after intensive industry operations began, it is arguable whether the changes in distribution in the early 1980's were greater than natural annual variations in distribution, such as responding to changes in the location of food sources. Ward and Pessah (1988) concluded that the available information from 1976 to 1985 and the historical whaling information do not support the suggestion of a trend for decreasing utilization of the industrial zone by bowheads as a result of oil and gas exploration activities.

Fall-migrating bowheads could be exposed to drilling operations on 1 to 4 exploration or delineation wells per year with a maximum of two drilling units operating concurrently as a result of Sale 144. An estimated 22 exploration and delineation wells would be drilled within the Sale 144 area during the 8 years following the sale. An estimated 273 production/service wells would be drilled from eight platforms and would be in operation for 24 years. Spring-migrating bowheads are not expected to be exposed to drilling noise. Bowhead whales whose behavior appeared normal often have been observed within 10 to 20 km (6.2-12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2 to 5 km (0.12-3 mi) from drillships (Richardson and Malme, 1993). Some bowheads in the vicinity would be expected to respond to noise from drilling units by slightly changing their migration speed and swimming direction so as to avoid closely approaching these noise sources. Under open-water, mean ambient-noise conditions, it has been estimated that bowheads might respond to drilling noise at 1 to 8 km (0.62-5 mi) from a drillship but only 0.2 to 1.8 km (0.12-1.12 mi) from an artificial-island drilling site (Miles, Malme, and Richardson, 1987). If the drillships were attended by icebreakers, as is typically the case during the fall in the U.S. Beaufort Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to icebreakers breaking ice. Response distances would vary depending upon icebreaker activities and sound-propagation conditions. Based on models, bowhead whales would then likely respond to the sound of the attending icebreakers at distances of 2 to 20 km (1.24-12.4 mi) from the icebreakers (Miles, Malme, and Richardson, 1987). Zones of responsiveness for intermittent sounds such as an icebreaker pushing ice have not been studied. This study predicts that roughly half of the bowhead whales show avoidance response to an icebreaker underway in open water at a range of 2 to 12 km (1.25-7.46 mi) when the S:N is 30 dB. The study predicts roughly half of the bowhead whales show avoidance response to an icebreaker pushing ice at a range of 4.6-20 km (2.86-12.4 mi) when the S:N is 30 dB. The authors emphasize that the estimates for intermittent sources are only theoretical and should not be used to predict whale avoidance at specific locations, as the methods may or may not be valid. It should also be noted that the calculated range of 20 km (12.4 mi) exceeds the maximum range at which the propagation model was believed to be reliable. That is also the case with many of the sound-propagation estimates presented in Appendix D of the study. The North Slope Borough in their November 17,1995, comments on the DEIS referenced page 317 of Appendix D of this report. Comment number 9 in their letter said "The estimated radius of the zone of responsiveness (even assuming median ambient noise levels) at a 20 dB signal to noise ratio (using 250 Hz and East/West distance values) is 25 miles. The zone in which some whales will respond to an icebreaker (pushing ice) is therefore 50 mi in diameter. When using a signal to noise ratio of 30dB (using 250 Hz and East/West distance values, medium ambient noise) the size of the zone of responsiveness is still very large (page 317 of Reference 14). Under these conditions it is estimated that 50 percent of the whales will "move away" in response to the noise of the icebreaker. In this case the radius of the zone would be about 11 mi so therefore the zone of responsiveness would be 22 mi in diameter." (Page 317, Appendix D of the study shows the estimated range at which noise from an icebreaker pushing ice would be received at a 20 dB S:N ratio (using 250 Hertz [Hz] and East/West distance values) is 42 km (26 mi). It should be noted this exceeds the maximum range at which the propagation model is believed to be reasonably reliable, which is 30 km (18.6 mi). The value of the 42 km (26 mi) figure isn't clear considering that it falls outside the reliability range of the model. The estimated range at which noise from an icebreaker pushing ice would be received at a 30 dB S:N ratio (using 250 Hz and East/West distance values) is 18 km (11.2 mi), which is within the maximum range at which the propagation model is believed to be reasonably reliable. This distance, 18 km (11.2 mi), falls within the 4.6 to 20 km (2.86-12.4 mi) distance in the revised text. It is important to remember the authors emphasize that the estimates for intermittent sources are only theoretical and should not be used to predict whale avoidance at specific locations, as the methods may or may not be valid. Also, the zone of responsiveness is generally given as a range rather than as a diameter since sound generally doesn't travel equivalent distances in all directions. As stated earlier in the text, sound transmission is affected by a wide variety of things, including water depth, salinity, temperature, frequency composition of the sound, ice cover, bottom type, and bottom contour.) Some whales would likely react at greater ranges when the S:N is 20 dB. For example, this study estimated the zone of responsiveness for bowhead whales for intermittent icebreaker noise at a frequency of 250 Hz at the Erik location at a range of 19 km (11.8 mi) and 4.6 km (2.86 mi) (adjusted for duty cycle) in the east/west direction when the S:N is 20 dB and 30 dB, respectively.

Richardson et al. (1995) found that bowheads migrating in the nearshore lead often tolerated exposure to projected icebreaker sounds at received levels up to 20 dB or more above the natural ambient noise levels at corresponding frequencies. The source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in this study (median difference 34 dB over the frequency range 40-6300 Hz). Over the two-season period (1991 and 1994), when icebreaker playbacks were attempted, an estimated 93 bowheads (80 groups) were seen near the ice camp when the projectors were transmitting icebreaker sounds into the water, and approximately 158 bowheads (116 groups) were seen near there during quiet periods. Some bowheads diverted from their course when exposed to levels of projected icebreaker sound more than 20 dB above the natural ambient noise level in the 1/3-octave band of the strongest icebreaker noise. However, not all bowheads diverted at that S:N, and a minority of whales apparently diverted at a lower S:N. The study concluded that exposure to a single playback of variable icebreaker sounds can cause statistically but probably not biologically significant effects on movements and behavior of migrating whales in the lead system during the spring migration east of Pt Barrow. The study indicated the predicted response distances for bowheads around an actual icebreaker would be highly variable, but for typical traveling bowheads, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to 50+ km (31.1 mi). Effects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant. It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. (The predicted "typical" radius of responsiveness around an icebreaker like *Robert Lemeur* is quite variable because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least 10 dB around the "typical" threshold, with commensurate variability in predicted reaction radius).

The authors stated that one of the main limitations of the study (during all 4 years) was the inability of a practical sound projector to reproduce the low-frequency components of recorded industrial sounds. Both the *Karluk* rig and the icebreaker *Robert Lemeur* emitted strong sounds down to ~10-20 Hz, and quite likely at even lower frequencies. It is not known whether the under representation of low-frequency (<45 Hz) components during icebreaker playbacks had significant effects on the responses by bowheads. Bowheads presumably can hear sounds extending well below 45 Hz. It is suspected but not confirmed that their hearing extends into the infrasonic range below 20 Hz.

While conducting aerial surveys over the Kuvlum drilling location, Brewer et al. (1993) noted that the closest observed position for a bowhead whale detected during the aerial surveys was approximately 23 km (14.3 mi) from the project icebreakers. The drilling rig was not operating on that day but all three icebreakers had been actively managing ice periodically during the day. The study did not indicate what the whale's behavior was, but it did not appear to be avoiding the icebreaker. Three whales were sighted that day and all three appeared to be moving to the northwest along the normal migration route at speeds of 2.4 to 3.4 kn.

There has also been speculation that extremely strong noise might cause temporary or permanent hearing impairment under some conditions. According to Richardson and Malme (1993), there is no evidence that noise from routine human activities (aside from explosions) would permanently cause negative effects to a marine mammal's ability to hear calls and other natural sounds. Given their mobility and avoidance reactions, it is unlikely that whales would remain close to a noise source for long. Also, baleen whales themselves often emit calls with source levels near 170 to 180 dB re 1 μPa, comparable to those from many industrial operations. It is unknown whether noise pulses from nonexplosive seismic sources, which can be much higher than 170 to 180 dB, are physically injurious at any distance. The avoidance reactions of bowheads to approaching seismic vessels normally would prevent exposure to potentially injurious noise pulses.

Concerns also have been raised regarding the effects of noise from OCS exploration and production operations in the spring-lead system and the potential for this noise to delay or block the bowhead spring migration. As stated previously, spring-migrating bowheads are not likely to be exposed to drilling noise. Unlike previous Beaufort Sea sales, Sale 144 does not extend west and southwest of Barrow. Only the portion of the spring-lead system east of Barrow is included in the sale. To date, there have been no drilling or production operations in the vicinity of the spring-lead system during the bowhead migration, and none are anticipated for Sale 144. Consequently, the following discussion is theoretical only.

If drilling operations were to occur in the spring-lead system, drilling activities from bottom-founded drilling units would be the principal sources of OCS-related noise. The MMS funded a study on the effects of production activities on whales in the arctic, and a portion of that study included observations of bowhead whale behavior in the presence of recorded noise from production operations played back as whales migrated through the spring-lead system. Additional information on this study is presented earlier in this section in the discussion about the effects of drilling noise on bowhead whales. Much of the data from the study was collected as bowheads migrated along a long, narrow lead through otherwise heavy pack ice. Richardson et al. (1995) concluded that "migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 km (0.54 nmi). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector." Some migrating bowheads diverted their course enough to remain a few hundred meters to the side of the projector. The closest sighting was of a bowhead that swam to within 35 m (115 ft) of the operating projector. Surfacing and respiration behavior, and the occurrence of turns during surfacings, were strongly affected out to 1 km (0.62 mi). Turns were unusually frequent out to 2 km (1.25 mi), and there was evidence of subtle behavioral effects at distances up to 2 to 4 km (1.25-2.5 mi). The study concluded that the demonstrated effects were localized and temporary, and that playback effects of drilling noise on distribution, movements, and behavior were not biologically significant. One factor to consider in assessing the possible effects of exploration and production noise in the lead system is that exploration units and production platforms are stationary, whereas the lead system is not. Consequently, a platform present within or near a lead one day may be well outside the lead the next day, possibly an obstacle to the whale migration on one day and not the next. High ambient-noise levels have been measured at the boundary between open water and pack ice; consequently, ambient noise could be high in the area of the spring lead. If this is the case, ambient noise would tend to mask distant industry noise, making it less audible and probably less disturbing to the bowheads. Gray whales, which appear to react to noise disturbance at levels fairly similar to bowheads, show little avoidance of production- or drilling-platform noise. Experimental evidence using playback noise indicated that the point at which 50 percent of migrating gray whales would avoid platform noise was 56 m (61 yd) for production platforms and 40 m (44 yd) for drilling platforms. Sightings of migrating gray whales immediately adjacent to production platforms off the California coast seem to support this experimental evidence. Consequently, if bowheads react to platforms as do gray whales, there should be little avoidance of platforms or drilling units located in or near the spring-lead system, and adverse effects on the migration should be minimal.

There also could be a number of minor alterations in bowhead habitat as a result of Sale 144 exploration. Discharge of drilling muds and cuttings during exploration or development and production activities are not expected to cause significant effects either directly through contact or indirectly by affecting prey species. Any effects would be very localized around the drill rig due to rapid dilution/deposition of these materials. Bottom-founded drilling units and/or gravel islands may cover small areas of benthic habitat, and drilling muds and cuttings may cover portions of the seafloor that support epibenthic invertebrates used for food by bowhead whales. However, the effects are expected to be negligible because bowheads feed primarily on pelagic zooplankton, and the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat. Pipeline-construction activities also could result in noise and disturbance to bowhead whales. Offshore pipelines between production platforms and onshore facilities would be installed during the open-water season and could take 1 or 2 seasons to complete. Pipeline-construction activities would be relatively close to shore but could cause whales to avoid the area of activity.

(2) Potential Effects from an Oil Spill: The effects of an oil spill on bowhead whales are unknown. According to Geraci and St. Aubin (1982) and St. Aubin, Stinson, and Geraci (1984), short-term exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Assuming an oil spill occurred in bowhead whale habitat while bowheads were present, some whales could experience one or more of the following: skin contact, baleen fouling, respiratory distress caused by inhalation of hydrocarbon vapors (from a fresh spill), localized reduction in food resources, consumption of some contaminated prey items, and perhaps a temporary displacement from some feeding areas. The number of whales contacted would depend on the size, timing, 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.

Bowhead whales have not been observed in the presence of an oil spill, so it is uncertain if they can detect an oil spill or would avoid surfacing in the oil. Several investigators have observed a variety of cetaceans in the presence of spilled oil. It was noted that cetaceans, including fin whales, humpback whales, gray whales, dolphins, and pilot whales, did not avoid slicks but swam through them, apparently showing no reaction to the oil. During one study, humpback whales, fin whales, and a whale tentatively identified as a right whale were observed surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). None of the observations provide a definitive picture of whether cetaceans are capable of detecting oil and avoiding it. Some researchers have concluded that the surface vision of baleen whales is so effective that they rely upon visual clues for a variety of activities. Bowhead whales have been observed "playing" with floating logs and sheens of floating dye on the sea surface, suggesting that bowheads may be able to recognize oil floating on the sea surface (Bratton et al., 1993).

If a bowhead came in contact with spilled oil, the skin would be the first organ to be exposed to the oil. Oil is unlikely to adhere to smooth areas of bowhead skin but might adhere to rough areas on the skin surface. Haldiman et al. (1981) described the skin and lesions on the skin of bowheads. The structure of the skin of bowheads is described in more detail in Haldiman et al. (1985). The maximum thickness of the epidermal layer was found to be as much as seven to eight times thicker than found on most whales. This study also included some very simple preliminary trials to determine possible interactions between bowhead skin and crude oil. Using preserved bowhead skin dipped into crude oil, the study found that little or no crude oil adhered to the skin with up to three immersions as long as a water film was maintained on the skin surface. Once the oil made sufficient contact with the skin to adhere, it would adhere in small patches to the epidermal surface and to the vibrissae. Although it isn't known whether spilled oil will adhere to the skin of a free-ranging cetacean, Albert (1981) suggests that oil would adhere to the rough surfaces of the skin (eroded areas on the skin surface, tactile hairs, and the depressions around the tactile hairs). Albert theorizes that information provided to the animal by the tactile hairs could be affected and the skin could be irritated, especially the eroded areas on the skin surface. Because the function of the hairs is unknown, it is difficult to assess the impact of their possible loss of function to the bowhead. Albert expresses concern that if the eroded skin is damaged more, it may provide a point of entry for pathogenic bacteria to enter into the bloodstream. Shotts et al. (1990) found a large number of species of bacteria and yeast both from the normal skin and from lesions on bowheads. Enzymatic assays from isolates from normal and lesional skin demonstrated production of enzymes capable of causing necrosis. Many of these species were determined to be potential pathogens of mammalian hosts. Hansen (1985) suggests that crude oil may kill the bacteria in the lesions and that much of the oil is likely to be washed off as the whale moves through the water. Haldiman et al. (1981) suggested that the significance of the epidermal erosion in the lesions may be misinterpreted because epidermal thickening also occurred at the rim of some lesions, resulting in no actual decrease in the distance between the epidermal surface within the lesion and the tips of the dermal papillae. If bowheads vacated oiled areas, it is probable that most of the oil would wash off the skin and body surface within a short period of time. However, if bowheads remained in oiled areas, oil might adhere to the skin and other surface features (such as sensory hairs) for longer periods of time.

Histological data and ultrastructural studies from the work of Geraci and St. Aubin showed that long exposures to petroleum hydrocarbons produced only transient damage to cells of the epidermis, with cells showing signs of recovery within 3 to 7 days after exposure. Bratton et al. (1993), in a synthesis of studies on the potential effects of contaminants on bowhead whales, stated that there is no published data to prove oil-fouling of the skin of any free-living whales and concluded that bowhead whale encounters with fresh or weathered petroleum most likely present little toxicologic hazard to the integument. The report concluded that cetacean skin presents a formidable barrier to the toxic effects of petroleum.

Bowheads would be most likely to contact spilled oil as they surfaced to breathe. It is unlikely that they would inhale oil into the blowhole while breathing, although bowheads surfacing in a spill of lightly weathered oil could inhale some hydrocarbon vapors that might result in pulmonary distress. Perhaps the most serious situation would occur if oil were spilled into a lead from which bowheads could not escape, although the probability of such an occurrence is extremely low. In this situation, the inhalation of oil vapor might cause intoxication (Bratton et al., 1993). Presumably, a whale may react in fear or panic and breathe more rapidly, which could result in a higher risk of death associated with exposure. If this scenario were to occur, Bratton et al. (1993) theorized that whales could experience irritation of the mucous membranes or respiratory tract and possibly absorb volatile hydrocarbons into the bloodstream as a result of inhalation of toxic vapors. The volatile hydrocarbons would likely be rapidly excreted. Vapor concentrations that could be harmful to whales would be expected to dissipate within several hours after termination of a spill. Whales exposed to toxic vapors within a few hours after the spill could suffer pulmonary distress and possible mortality. Generally, only a few whales would be likely to occupy the affected lead at any given time.

While feeding, bowheads sometimes skim the water surface, filtering large volumes of water for extended periods, and consequently might ingest some spilled oil if any were present. Albert (1981) suggested that tarballs or large "blobs" of oil could be inadvertently engulfed along with prey items or that baleen "hairs" which have been swallowed and become matted together into small "balls" due to the oil and potentially cause a mechanical blockage in the stomach at the connecting channel. The connecting channel is a very narrow tubular structure connecting the fundic and pyloric chambers of the stomach (Tarpley et al., 1987). Hansen suggests that cetaceans can metabolize ingested oil due to the presence of cytochrome p-450 in their livers (1992) and that any oil adhering to baleen filaments causing clumping may be broken down by the digestive process (1985). There is no evidence from observational studies or stranding records to suggest that cetaceans would feed around a fresh oil spill long enough to accumulate a critical dose of oil.

If feeding bowheads contacted spilled oil, the baleen hairs might be fouled, resulting in a reduced filtration efficiency. Studies conducted by Geraci and St. Aubin found that 70 percent of the oil adhering to baleen plates was removed within 30 minutes after fouling, and 95 percent of the oil was removed within 24 hours after exposure. Their data suggest that the residual level of fouling of the baleen causes no compromise in the function of the baleen 24 hours after exposure to petroleum (Bratton et al., 1993). Bowheads most likely would occupy oiled waters for only a short period of time, and zooplankton-filtration efficiency would return to normal in a matter of hours as oil is flushed from the baleen. However, repeated baleen fouling over an extended period of time might result in reduced food intake and blubber deposition, which might, in turn, adversely affect the health and survival of bowheads.

The population of zooplankton, the major food source of bowhead whales, likely would not be permanently affected by an oil spill. Richardson et al., 1987, as cited in Bratton et al, 1993, stated that it was unlikely that accidental oil spills would permanently affect zooplankton or their availability to bowheads in the area studied. They postulated that if effects on zooplankton or their availability did occur, they would be most likely to occur in nearshore feeding areas. The amount of zooplankton lost in even a large oil spill would be negligible in comparison with the plankton resources available on the whales' summer-feeding grounds (Bratton et al., 1993). Bowheads might ingest some oil-contaminated prey items, but it is likely these organisms would comprise only a small portion of the bowheads' food intake. Some zooplankton consumed by bowheads actively consume oil particles but apparently can excrete hydrocarbons from their system relatively rapidly. Tissue studies analyzing the level of naphthalene in the liver and blubber of whales indicated low levels of naphthalene in baleen whales, suggesting that prey species have low concentrations in their tissues or that baleen whales may be capable of metabolizing and excreting petroleum hydrocarbons (Geraci and St. Aubin, 1990).

Information regarding the adverse effects on the bowhead whale from materials such as petroleum products, heavy metals, and other contaminants is generally lacking, and information about cetacean metabolism also is inadequate. Based on the limited data available, Bratton et al. (1993) conclude that potential contaminants such as petroleum products appear to pose no harm to bowheads or to humans who eat them, although much more work is required to understand the significance of residue levels to both whales and humans.

In the event of an oil spill, it is likely that large numbers of personnel, vessels, and aircraft will be present and conducting cleanup operations in the Beaufort Sea. If spilled oil is present during the bowhead whale migration, it could result in disturbance and possible displacement of whales from their normal migration route. Potential effects of noise disturbance to bowhead whales is discussed in more detail earlier in this section. Disturbance effects on the bowhead whale are expected to persist for the duration of cleanup operations if the operations are conducted during the whale migration period.

Concern has been raised about the effects of oil spilled into the spring lead system during the bowhead whale migration. Mr. John George, at a public hearing in Barrow in 1990 on Oil and Gas Lease Sale 124, testified that if oil got into the spring lead system, the situation could potentially affect the entire herd. He referenced the 1988 census, when about 95 percent of the population migrated through the area in roughly a 2- to 3-week period. A discussion of such effects is contained on pages IV-B-78 through IV-B-82 of the Chukchi Sea Oil & Gas Lease Sale 109 FEIS (USDOI, MMS, Alaska OCS Region, 1987) and is hereby summarized and incorporated by reference. The presence of ice could restrict the spread of the oil. Agitation of ice particles in combination with oil could initially increase oil dispersion into the water column; however, it also would result in a more rapid formation of a water-in-oil emulsification. Grease ice (newly formed ice) and spilled oil would be blown downwind and would accumulate in a band along the downwind edge of open leads or ice floes. When the lead closed or ice floes were blown together, the accumulated grease ice and oil would be pushed onto the adjacent ice. It is unlikely that oil would completely cover the surface of the water except in cracks and small pools sheltered from the wind. Toxic vapors would be carried away from any leads by the wind, and volatile compounds would be lost within 24 to 48 hours of weathering at the surface. Harmful concentrations of toxic vapors from spilled oil should not persist for more than a few hours after the oil has weathered at the surface. Oil spilled under winter ice would pool and freeze to the underside of the ice. First-year arctic ice—the most prevalent type in the area—can store up to 150,000 to 300,000 bbl of oil per square kilometer in under-ice relief. Consequently, oil spilled in heavy ice cover would be unlikely to spread appreciably under the ice before being frozen into the ice. The spilled oil would then move as part of the pack ice. The oil either would melt out at the southern ice edge as the pack retreated or migrate through brine channels and pool on top of the ice as melting conditions began to occur.

Effects of oil contacting bowheads under winter or broken-ice conditions generally would be similar to those previously described. Such effects include baleen fouling, inhalation of toxic vapors, ingestion of oil or oil-contaminated prey, and irritation of skin or sensitive tissues. Bowheads may migrate through an oil-spill area without actually contacting oil because, as mentioned earlier, the oil would accumulate along the downwind edge of any open-water areas. On occasion, bowheads have been observed continually returning to the same small area of open water, presumably because there was no other readily available open water where they could surface. 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 is expected to be a very rare case that would affect only a low number of whales.

Should a large oil spill occur and cover a substantial stretch of a major spring lead used by migrating bowheads, a number of bowheads may contact oil and/or a portion of the spring bowhead migration might be delayed or temporarily blocked. Bowheads probably would not migrate through the pack-ice zone to avoid an oil spill blocking a lead unless the pack-ice zone had an adequate number of cracks or small ponds for bowhead respiration. Bowheads may migrate under the ice and avoid the oil contamination. Such a spill could affect a substantial portion of the bowhead population; but unless the spill were prolonged, its effects likely would be short-lived. Within several hours to several days after cessation of the spill, the oil should have accumulated along the downwind or downcurrent edge of the lead and should no longer pose an impediment to the migration. Such a short-term delay in the migration should not result in significant effects on the population, because there is considerable natural variability in the timing of the migration due to ice conditions. A substantial number of bowheads could contact oil if individuals, driven by the migratory urge, attempted to swim through the oil-covered lead. Some of these individuals might succumb to toxic vapors if the spill were very fresh. It has been shown, however, that bowheads are quite adept at migrating beneath at least thin ice (George et al., 1989); and bowheads may migrate under the ice around the area of oil contamination.

The OSRA model estimated a 6- to 45-percent probability (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting bowhead whale habitat such as Environmental Resource Areas (ERA's) 5-11 (Ice/Sea Segments 5-11), areas where bowheads may be present during the fall migration, within 30 days over the production life of the proposed action. There is an estimated 45-percent probability of contact in ERA 9, which is the area of highest probability of contact. The OSRA model estimated a 5-percent probability (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting bowhead whale habitat such as ERA SLSN (Northern Spring Lead System), an area where bowheads may be present during the spring and fall migration, within 30 days over the production life of the proposed action. For conditional probabilities, the OSRA model estimated a 72-percent and a 94-percent probability (expressed as a percent chance) of a spill ≥1,000 bbl contacting ERA SLSN within 30 days during the winter, assuming that a spill occurred at Launch Area L3 and Pipeline Segment P1, respectively. The OSRA model estimated an 8-percent and a 7-percent probability (expressed as a percent chance) of a spill ≥1,000 bbl contacting ERA FFA (Fall Feeding Area) within 30 days during the winter, assuming that a spill occurred at Launch Area L2 and Pipeline Segment P1, respectively. The OSRA model estimated a 75-percent and a 91-percent probability (expressed as a percent chance) of a spill ≥1,000 bbl contacting ERA SLSN within 30 days during the summer, assuming that a spill occurred at Launch Area L1 and Pipeline Segment P1, respectively. The OSRA model estimated a 26-percent and a 21-percent probability (expressed as a percent chance) of a spill ≥1,000 bbl contacting ERA FFA (Fall Feeding Area) within 30 days during the summer, assuming that a spill occurred at Launch Area L2 and Pipeline Segment P1, respectively.

If commercial quantities of oil are discovered and development and production proceed, pipeline-construction activities would occur. Dredging or trenching may be used in construction of the gathering pipeline from the production platform to shore. Bowhead reactions to dredge noise have been observed to be similar to their reactions to drilling noise, including avoidance of the near vicinity of the activity. In one instance, as many as 12 bowheads were observed within 5 km (3 mi) from active dredging operations on their summer-feeding grounds. However, some bowheads were detected within 800 m (875 yd) of the site (Richardson and Malme, 1993). Dredge sounds were well above ambient levels up to several kilometers away (22 dB above average ambient level at 1.2 km (0.75 mi) from the dredge). In other instances, bowheads were observed at distances where they were well within the ensonified area of dredging operations. However, in playback experiments, some whales responded to the onset of similar levels of dredge noise by exhibiting weak avoidance. Bowheads seen in the vicinity of actual dredging operations may have habituated to the activity, or there may be variation among bowheads in the degree of sensitivity toward noise disturbance, so that bowheads seen in the vicinity of dredging operations may have been the more tolerant individuals.

Summary: Bowheads may exhibit avoidance behavior if approached by vessels at a distance of 1-4 km (0.62-2.5 mi). They are not affected much by any aircraft overflights at altitudes above 300 m (328 yd). Most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a distance of a few kilometers but rarely show avoidance behavior at distances >7.5 km (4.7 mi). Bowheads have been sighted within 0.2 to 5 km (0.12-3 mi) from drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to noise-producing activities. A few bowheads may avoid drilling noise at 20 km (12.4 mi) or more. If drillships were attended by icebreakers, as is typically the case during the fall in the U.S. Beaufort Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to icebreakers breaking ice, but it has been predicted that roughly half of bowheads would respond at a distance of 4.6 to 20 km (2.86-12.4 mi) when the S:N is 30 dB. Noise from dredging (trenching) for pipeline construction and the production operations from the eight platforms may cause whales to avoid the immediate vicinity of the activities; however, it is likely that the area of avoidance would be relatively small because whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident; and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30 to 60 minutes (in the case of seismic activity). It also should be noted that individuals that are engaged in feeding, socializing, breeding, etc., may react to a stimulus at a higher threshold than resting or milling animals.

Inupiat subsistence whalers feel that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and is thereby interfering with the subsistence hunt at Barrow (Ahmaogak, 1989). Mr. Burton Rexford, Chairman of the Alaska Eskimo Whaling Commission, testified that loud noises drive the animals away and spook them. Mr. Rexford, who has more than 53 years experience in subsistence whaling, was testifying at a public meeting in Barrow, Alaska on the Letter of Authorization at the Kuvlum Prospect in the Beaufort Sea (1993). "We know where whales can be found; when the oil industry comes into the area, the whales aren't there. It is not the ice; it is the noise". Mr. Rexford is concerned that the whales will abandon the usual hunting areas, that subsistence whalers will be displaced, and that placing a physical barrier (such as a drillship or seismic vessel) between whalers and whales will drive whales away from their normal migration route. Mr. Thomas Napageak, also at the public meeting, testified that the migration has been affected (1993). Aerial surveys conducted from 1982 to 1987 (Ljungblad et al., 1988) provided no evidence of a trend that the migration is being displaced. He found no significant differences in the migratory route between years. Treacy, (1995), looking at median water depths at the location of bowhead sightings, said there appears to be no indication that the annual whale migration has been progressively displaced to deeper water during the 1982 to 1994 timeframe.

Occasional brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migrating between the central Bering and eastern Beaufort Seas. However, these disturbance or avoidance factors might become significant if industrial activity were sufficiently intense to cause repeated displacement of specific individuals (which we do not believe to be the case at the level of activity projected under the base case). Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant seismic exploration, drilling, and dredging. Behavioral studies have suggested that bowheads habituate to noise from distant ongoing drilling, dredging, or seismic operations (Richardson, Wells, and Wursig, 1985: Richardson et al., 1985), but there still is some apparent localized avoidance (Davis, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely impact bowhead use of that area (Richardson et al., 1985), but there has been no documented evidence that noise from OCS operations would serve as a barrier to migration. Exposure of bowhead whales to noise-producing activities is not expected to result in lethal effects; but some individuals could experience temporary, nonlethal effects.

The OSRA model estimated a 6- to 45-percent probability (expressed as a percent chance) of one or more spills $\geq$1,000 bbl occurring and contacting ERA's 5-11, areas where bowheads may be present during the fall migration, within 30 days over the production life of the proposed action. The probability of oil actually contacting whales would be considerably less than the probability of contact with bowhead habitat. If an uncontrolled, uncontained spill were to occur, a few bowheads could experience one or more of the following: skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the consumption of oil-contaminated prey items, and perhaps temporary displacement from some feeding areas. Some individuals may be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small. Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering within 1 to 3 years. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects.

Effectiveness of Mitigating Measures: The stipulation on Industry Site-Specific Bowhead Whale-Monitoring Program will determine when bowhead whales are present in the vicinity of leases during exploratory-drilling operations and study the effects of these activities on the behavior of the bowheads. If the information obtained from this or other monitoring programs indicates that there is a threat of serious, irreparable, or immediate harm to the species, the lessee will be required to suspend operations causing such threat, which should help to minimize the likelihood of disrupting whale feeding, migration, or socialization. Some endangered whales may interact with the activities associated with exploratory drilling and some inadvertent conflicts or incidental "taking" situations may occur. These inadvertent conflicts with or incidental "taking" situations of some individual whales as a result of exploration-drilling activities would not constitute a threat of harm to the species. This stipulation, in conjunction with the ITL on Information on Endangered Whales and MMS Monitoring Program, addresses the NMFS's Conservation Recommendation No. 4 in the Arctic Region Biological Opinion and will help protect endangered bowhead whales during their migration from significant adverse effects due to exploratory activities, such as a blockage or delay of the migration.

Three other ITL's apply for protection of the bowhead whale: Bird and Marine Mammal Protection, which advises lessees of requirements under the ESA and Marine Mammal Protection Act and provides guidelines regarding disturbance of marine mammals; Sensitive Areas To Be Considered in Oil-Spill-Contingency Plans, which identifies areas needing protection in the event of an oil spill; and Consultation with NMFS to Protect Bowhead Whales in the Spring-Lead System, which advises that NMFS will be consulted before exploration and development and production activities will be allowed in the spring-lead system. While benefits are gained, the overall effects on bowhead whales with these mitigating measures in place is likely to be the same as if the measures were not in place.

Overall the mitigating measures may provide additional protection to whales but will not eliminate all potential effects. The Industry Site-Specific Bowhead Whale-Monitoring Program should be effective in preventing a delay or blockage of the migration. Fewer whales may be affected by activities due to these measures or affected to a lesser extent. However, even with the mitigating measures in place, whales are still expected to experience temporary, nonlethal effects as a result of exposure to oil and gas activities, with potential for some mortality if whales are exposed to freshly spilled oil over a prolonged period.

Concern has been expressed that long-term environmental monitoring (5-15 years) should be required for major industrial actions (Ahmaogak, 1985) and, if significant impacts are detected, there must be a regulatory mechanism in place to require that appropriate mitigation measures be taken. The above-referenced stipulations and ITL's are for the life of the lease, which is 10 years. All activities conducted on a particular lease over the life of the lease would be subject to the stipulations that pertain to that lease.

Conclusion: Overall, bowhead whales exposed to noise-producing activities and oil spills most likely would experience temporary, nonlethal effects. Bowheads may exhibit temporary avoidance behavior in response to vessels and to activities related to seismic surveys, drilling, and construction during exploration and development and production. Avoidance behavior usually begins at a distance of 1 to 4 km (0.62 to 2.5 mi) from a vessel, 0.2 to 5 km (0.12 to 3.1 mi) from a drillship, and 7.5 km (4.7 mi) or less from seismic operations. A few whales may avoid drilling noise at 20 km (12.4 mi) or more. Behavioral changes may last up to 60 minutes after the disturbance has left the area or the whales have passed. Although there is no indication from studies that the bowhead whale migration has been displaced (Ljungblad et al., 1988; Treacy, 1995), Inupiat subsistence whalers feel that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and is thereby interfering with the subsistence hunt at Barrow (Ahmaogak, 1989). Some bowhead whales could be exposed to spilled oil, resulting primarily in temporary, nonlethal effects. Some mortality might result if exposure to freshly spilled oil were prolonged; however, the population is expected to recover within 1 to 3 years.

b. Effects on the Arctic Peregrine Falcon: If oil were released and contacted coastal areas near peregrine-nest sites or feeding areas, peregrine falcons may be affected through direct contact by adults (when hunting or via prey caught in the vicinity of the spills) or indirectly through disruption or a reduction in prey organisms (seabirds and shorebirds). The probability of such an event would be related to the probability of spilled oil being present in the vicinity of peregrine-nesting and/or -feeding areas. There is a very low probability that arctic peregrine falcons would contact spilled oil. Peregrines may occur in coastal areas such as the Colville or Canning River Deltas in the fall. The combined probability (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting potential foraging areas within 30 days (LS's 20-45) ranges from <0.5 to 4 percent (Appendix B, Table B-30). If a spill occurred, the conditional probability of contact in these areas (expressed as a percent chance) from Launch Areas and Pipeline Segments, with few exceptions, is ≤5 percent (Appendix B, Tables B-12, B-13); nearly all are <3 percent. Because the actual risk (probability) of spill contact for peregrines in these areas probably is even less than suggested by the OSRA values, due to this species' transient occurrence in the areas likely to be contacted and the fact that they typically do not contact the water surface, it is very unlikely that peregrines would be significantly affected by oil spills. If oil spills affected prey populations, short-term, localized reductions in food availability for peregrines could occur.

Nesting peregrines could, on rare occasions, be disturbed by aircraft overflights related to the proposed sale that may occur inland from the coast. Nesting sites such as those near Ocean Point on the Colville River, about 40 km (25 mi) inland, may be vulnerable to such occasional disturbance. The extent of such disturbance would depend on future locations of support facilities. Aircraft based in Deadhorse or Barrow typically would not fly over this area. Thus, significant disturbance of peregrine falcons associated with the exploration phase is unlikely. Significant population-level-disturbance effects associated with the development and production phase would be unlikely as well. It appears that the onshore gathering pipelines projected for the production phase will be routed coastward of all peregrine falcon-nesting sites and thus should not adversely affect the species. Gravel mining for any artificial islands associated with Sale 144 also is unlikely to affect the peregrine, because extraction is expected to occur near the Beaufort Sea coast where peregrines are not known to nest.

Summary: Peregrine falcons foraging in coastal areas could be affected by an oil spill through contact with oiled prey or shoreline, or by a reduction in available prey (aquatic birds). The low probability (≤5%) of shoreline contact by a spill, the transient occurrence of peregrines in coastal areas, and their general avoidance of water contact supports the expectation that they would not be affected significantly by an oil spill. Because support aircraft are not likely to fly routes as far inland as peregrines nest, this activity is not expected to be a source of significant disturbance. Pipeline development is likely to take place coastward of nesting areas and thus is not expected to affect peregrines. Gravel mining associated with Sale 144 is not expected to occur near peregrine nesting areas.

Effectiveness of Mitigating Measures: Awareness of potential disturbance effects through the stipulated Orientation Program is expected to result in fewer disturbances of arctic peregrine falcons by personnel associated with this proposed project. The Information on Bird and Marine Mammal Protection ITL is expected to result in fewer disturbance incidents involving aircraft as a result of awareness of recommended approach distance and altitude from animal concentrations. Because few adverse effects are expected to result from disturbance factors associated with this proposal, these mitigating measures are not expected to significantly reduce overall effects on the arctic peregrine falcon.

Conclusion: The arctic peregrine falcon is a highly transient species within the proposed sale area and, therefore, there is a very low probability that a large oil spill would contact them while in their foraging areas. Because of this, the overall effect on arctic peregrine falcons from oil spills and disturbance is expected to be minimal, with <5 percent of the population exposed to potentially adverse factors; no mortality is expected to result from the proposed action.

c. Effects on the Spectacled Eider: Spectacled eiders staging or migrating in nearshore areas along the Beaufort Sea coast are not expected to experience substantial adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparent low probability that routes traveled and area covered by scattered coastal flocks during two relatively brief staging/migration intervals would be intersected by the flight paths of support aircraft (1-2 round-trip flights/day) between rigs and onshore facilities at Kuparuk Field or Deadhorse. It is likely that only a limited degradation of available foraging habitat would occur within about 1 to 2 km (0.62-1.2 mi) of the established flight paths from rigs west of Oliktok Point during the limited time males in late June and females with juveniles in late August are traversing the area. However, if helicopters servicing rigs in the western sale area first return to and then follow the coastline to onshore facilities during these periods, disruption of foraging activity potentially could be more widespread. Likewise, because nest sites are scattered over much of the arctic slope, relatively few are expected to be overflown by helicopters from offshore units, and significant disturbance of nesting or brood-rearing eiders is not expected to occur. Little significant disturbance resulting from cleanup activities following an oil spill is expected to occur because staging/migrating flocks are likely to be isolated from such activity. However, disturbance of some individuals over the life of the project is expected to be unavoidable, and any disturbance could be considered a "take" under the Endangered Species Act.

Exposure of spectacled eiders to oil is expected to result in the general effects noted in Section IV.B.4 (i.e., not expected to survive moderate to heavy contact). A highly variable proportion of the eider population could be vulnerable to an oil spill contacting the Beaufort coastline west of Oliktok Point because although the staging/migrating individuals generally are scattered in relatively few flocks along the coast during two brief intervals, such flocks typically contain substantial numbers of individuals. Because most spring-migrant spectacled eiders arrive at the nesting areas via overland routes, few are expected to occupy leads offshore where they would be vulnerable to any oil entering such habitat. Eiders are not present in the area from October to May. The combined probability (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting areas occupied during staging/migration periods within 30 days (Elson Lagoon-C2; LS's 20-32) ranges from <0.5 to 1 percent (Appendix B, Tables B-32, B-33). If a spill occurred, the conditional probability of contact in these areas within 30 days (expressed as a percent chance) from Launch Areas L1-L8 and Pipeline Segments P1-P4 and P13 is ≤6 percent (Appendix B, Tables B-6, B-7, B-12, and B-13); most are <3 percent. Thus, relatively low spectacled eider mortality is expected from oil spills associated with the proposed action (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur if the population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Summary: Spectacled eiders staging or migrating along the Beaufort Sea coast, or nesting at inland sites, are not expected to experience significant adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparent low probability that scattered nest sites or the routes traveled and area covered by scattered coastal flocks during two relatively brief staging/migration intervals would be overflown by support aircraft flights between offshore units and onshore facilities. Disturbance of some individuals over the life of the project is expected to be unavoidable, and any disturbance could be considered a "take" under the Endangered Species Act. Relatively low spectacled eider mortality is expected from an oil spill (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur if population status is declining as at present.

Effectiveness of Mitigating Measures: Awareness of potential disturbance effects through the stipulated Orientation Program is expected to result in fewer disturbances of spectacled eiders by personnel associated with this proposed project. The Information on Bird and Marine Mammal Protection ITL is expected to result in fewer disturbance incidents involving aircraft as a result of industry awareness of recommended approach distance (1 mi) and altitude (1,500 ft) from animal concentrations, and the Information on Spectacled Eider and Steller's Eider ITL emphasizes the protected status of these species under the Endangered Species Act. Because few adverse effects are expected to result from disturbance factors associated with this proposal, these mitigating measures, with the exception of the buffer recommendations of the Bird and Marine Mammal Protection ITL, are not expected to significantly reduce overall effects on the spectacled eider.

Conclusion: Overall routine effects on the spectacled eider are expected to be minimal, affecting <2 percent of the population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur if population status is declining as at present.

d. Effects on the Steller's Eider: Steller's eiders staging or migrating in nearshore areas along the western Beaufort Sea coast are not expected to experience substantial adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparently low probability that the routes traveled and area covered by scattered coastal flocks of this small Alaskan population during two relatively brief staging/migration intervals would be intersected by the flight paths of support aircraft (1-2 round-trip flights/day) between rigs and onshore facilities at Kuparuk Field or Deadhorse. It is likely that only a limited reduction of available foraging habitat would occur, within about 1 to 2 km (0.62-1.2 mi) of the established flight paths from rigs in the western sale area during the limited time males in late June and females with juveniles in late August are traversing the area. However, if helicopters servicing rigs in the western sale area first return to and then follow the coastline to onshore facilities during these periods, disruption of foraging activity potentially could be more widespread. Also, it is unlikely that the primary Alaskan nesting area, located south and southeast of Barrow, would be overflown by helicopters from offshore units, so significant disturbance of nesting or brood-rearing eiders is not expected to occur. Little significant disturbance resulting from cleanup activities following any oil spill is expected to occur because staging/migrating flocks are likely to be isolated from such activity. Any disturbance that does occur could be considered a "take" under the Endangered Species Act.

Exposure of Steller's eiders to oil is expected to result in the general effects noted in Section IV.B.4 (i.e., not expected to survive moderate to heavy contact). A highly variable proportion of the eider population could be vulnerable to any oil spill contacting the Beaufort coastline adjacent to the extreme western portion of the proposed sale area because the staging/migrating individuals generally are scattered in relatively few flocks along the coast during two brief intervals. Because most spring migrant spectacled eiders arrive at the nesting areas via overland routes, few are expected to occupy leads offshore where they would be vulnerable to any oil entering such habitat. Eiders are not present in the area from October to May. The combined probability (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting areas occupied during migration periods within 30 days (Elson Lagoon-C2; LS's 20-32) ranges from <0.5 to 1 percent (Appendix B, Tables B-50, B-52). If a spill occurred, the conditional probability of contact in these areas within 30 days (expressed as a percent chance) from Launch Areas L1-L8 and Pipeline Segments P1-P4 and P13 is ≤ 6 percent (Appendix B, Tables B-6, B-7, B-12, and B-13); most values are <3 percent. Thus, relatively low Steller's eider mortality is expected from an oil spill (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery of the Alaska population from spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Summary: Because potentially disturbing routine activities (primarily helicopter flights) associated with this sale generally would be far removed from most of the Steller's eiders staging or migrating along the western Beaufort Sea coast or breeding in the primary nesting area south of Barrow, the population is not expected to experience any significant effects from such activities. Any disturbance of individuals could be considered a "take" under the Endangered Species Act. Relatively low Steller's eider mortality would be expected from an oil spill (<100 individuals); however, unless mortality is quite low, recovery of the Alaska population from spill-related losses is not expected to occur if population status is declining as at present.

Effectiveness of Mitigating Measures: Awareness of potential disturbance effects through the stipulated Orientation Program is expected to result in fewer disturbances of Steller's eiders by personnel associated with this proposed project. The Information on Bird and Marine Mammal Protection ITL is expected to result in fewer disturbance incidents involving aircraft as a result of industry awareness of recommended approach distance (1 mi) and altitude (1,500 ft) from animal concentrations, and the Information on Spectacled Eider and Steller's Eider ITL emphasizes the protected status of these species under the Endangered Species Act. Because few adverse effects are expected to result from disturbance factors associated with this proposal, these mitigating measures are not expected to significantly reduce overall effects on the Steller's eider.

Conclusion: Overall routine effects on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur if population status is declining as at present.

7. Caribou: Among the terrestrial-mammal populations that could be affected by Sale 144 are the more than 634,000 caribou of the Western Arctic, Central Arctic, Teshekpuk, and Porcupine caribou herds (referenced in this discussion as the WAH, CAH, TLH, and PCH, respectively) occurring along the coast adjacent to the Beaufort Sea Planning Area. Under the base case, the primary potential effects of OCS exploration and development activities on caribou would come from motor-vehicle traffic (disturbance) along pipeline-road corridors and near other onshore-support facilities (aircraft traffic is likely to have less of an effect, see Sec. IV.E.7). Secondary effects could come from potential oil spills contacting coastal areas used by caribou for insect relief and small areas of habitat alteration associated with onshore pipeline-road construction including gravel mining for roads, for onshore facilities, and for possible artificial-island construction.

a. Effects of Disturbance:

(1) 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 early summer months immediately after calving, 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, 1980; Valkenburg and Davis, 1985; and Johnson and Todd, 1977). The variability and unpredictability of the arctic environment (snow conditions, late spring or early winter, etc.) dictate that caribou have the ability to adapt their behavior (such as change the time and route of migration) 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 led to some degree of tolerance by most caribou of the CAH. 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, most 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 CAH from a small portion of the calving range near the Prudhoe Bay and Milne Point facilities has occurred (Cameron, Whitten, and Smith, 1981, 1983; Cameron et al., 1992). This displacement of some caribou cows and calves has occurred within about 1 to 2 km (0.62-1.2 mi) of some oil facilities (Dau and Cameron, 1986). The use of specific calving sites within the broad calving area varies from year to year; and the amount of displacement may be of secondary importance due to the low density of caribou on the calving range and the abundance of the CAH's calving habitat. However, recent information on the productivity of CAH caribou calving in the oil fields (west of the Sag River) compared to CAH cows calving east of the oil fields (east of the Sag River) suggests that displacement-disturbance of cow caribou on the oil fields may be affecting caribou productivity

(Cameron, 1994). The avoidance of the Prudhoe Bay oil-field complex of roads and pipelines by cow caribou represents a functional loss of summer range habitat (Cameron et al., 1995).

(2) Sale-Specific Disturbance Effects Associated With Oil and Gas Exploration: Disturbance of caribou associated with exploration activities would come primarily from helicopter traffic (2-6 flights/day) to and from Deadhorse-Prudhoe Bay or to and from Barter Island or other onshore facilities and the two offshore-exploration platforms. Caribou have been shown to exhibit panic or violent flight reactions to aircraft flying at elevations of 60 m (162 ft) or less and exhibit strong escape responses (animals trotting or running from aircraft) to aircraft flying at 150 to 300 m (500-1,000 ft) (Calef, DeBock, and Lortie, 1976). These documented reactions of caribou were from aircraft that circled and repeatedly flew over caribou groups. Aircraft traffic associated with exploration is likely to pass overhead of caribou once during any flight to or from the platforms; and the disturbance reactions of caribou are expected to be brief, lasting for a few minutes to no more than 1 hour.

(3) Effects of Exploration Habitat Alteration: No significant habitat alteration is expected to occur during exploration because it is assumed that existing onshore-support facilities at Prudhoe Bay, Camp Lonely, Barter Island, or other facilities will be used. The only habitat alteration that might occur would be gravel extraction from onshore-mining sites used in construction of an artificial gravel-island drilling platform. Such gravel is likely to come from existing quarries and would represent a very small (a few acres or hectares) loss of tundra habitat.

b. Effects of Oil Spills:

(1) 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 the loss of thermoinsulation through fur contamination, although toxic hydrocarbons could be absorbed through the skin and also could be inhaled.

Oiled caribou hair would be shed during the summer before the 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. However, caribou that become oiled by contact with a spill in coastal waters could die from toxic-hydrocarbon inhalation and absorption through the skin.

(2) Site-Specific Effects of Oil Spills: Unless otherwise specified, oil-spill-contact probabilities referred to in this section assume the occurrence of exploration and development activities to the extent estimated for the base case in Section II.B.2.a and associated spill rates (Sec. IV.A.1). Attention is devoted to the assumed two spills of an average of 7,000 bbl each and to spill contacts that occur within 30 days. Coastlines that may be frequented by caribou in the Point Thomson-Bullen Point area (LS's 36-37) and Prudhoe Bay-Point McIntyre area (LS's 34 and 35) have the highest (4-7%) chance of oil-spill occurrence and contact (Fig. IV.B.7-1). The spill-occurrence and contact risks to land segments in Figure IV.B.7-1, >4 percent, reflect the locations of assumed offshore pipeline routes and pipeline landfalls assumed to occur at Bullen Point (LS 37), Point McIntyre (LS 34), and Oliktok Point (LS 33); see Figure III.B.7 and Figure IV.B.7-1.

The chance of a spill occurring and contacting any coastlines within 180 days is 28 percent, and shoreline habitats from Draw Point (LS 26), west of Cape Halkett to Griffin Point (LS 43), east of Barter Island, have some chance (≥1%) of spill occurrence and contact within 180 days (Figs. IV.B.4-1 and IV.B.7-1, respectively). Thus, some caribou may come in contact with contaminated coastlines and oiled vegetation if a spill occurred. However, probably only a very narrow band of coastline would be oiled.

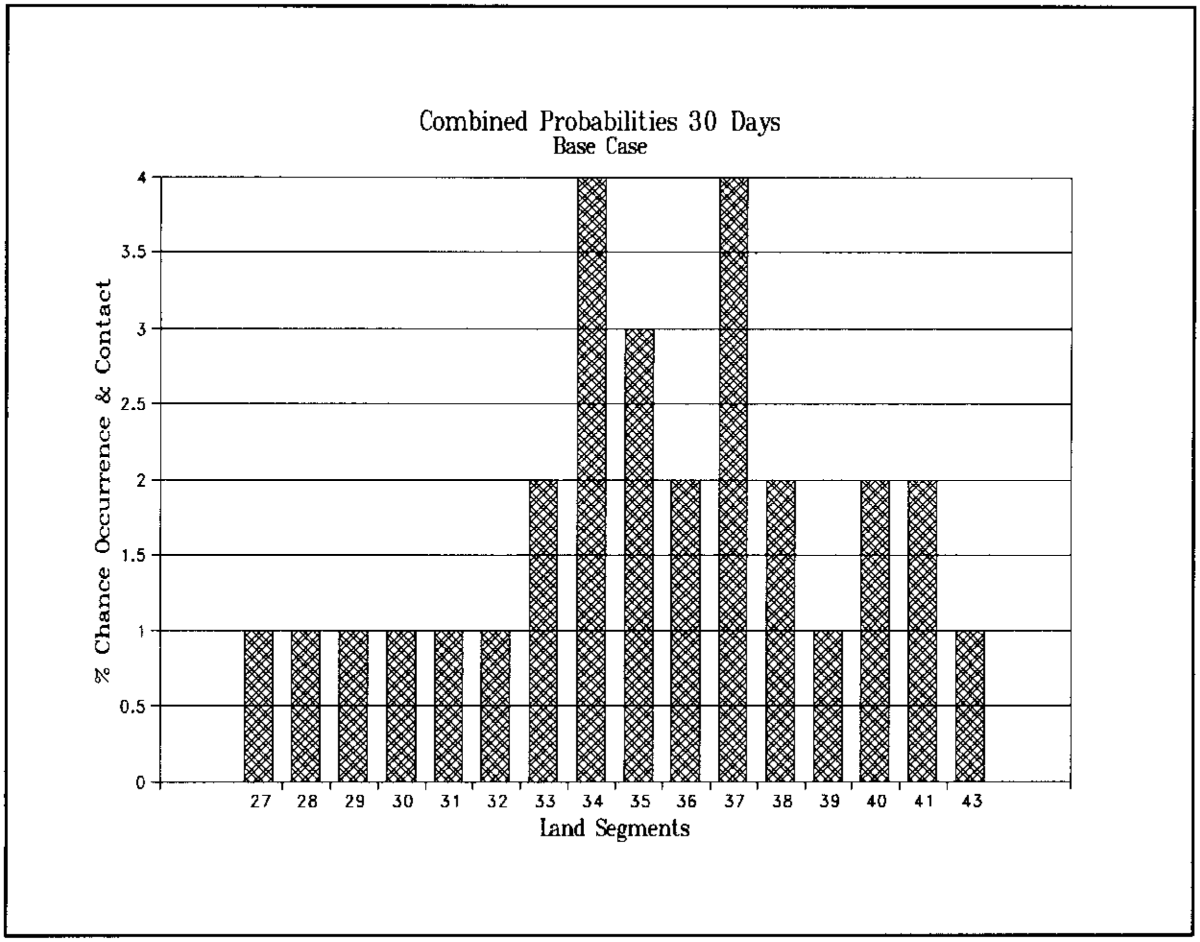


Figure IV.B.7-1. Combined Probabilities (expressed as a percent chance) of One or More Spills Greater Than or Equal to 1,000 bbl Occurring and Contacting Certain Land Segments Over the Assumed Production Life of the Sale 144 Area Base Case (land segments with probabilities <0.05% within 30 days are not shown in the figure)

Assuming the two spills (7,000 bbl) occurred during the open-water season or during the winter and melted out of the ice during the spring, caribou of the TLH, CAH, and PCH that frequent coastal habitats from Cape Halkett (LS 27) to the Colville River Delta (LS 29), Oliktok Point to Camden Bay (LS's 33-38), and Barter Island (LS 41) could be directly exposed to and contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities (Fig. IV.B.7-1; LS's 27 through 29, LS's 33 through 38, and LS 41 have a ≥3% chance of spill occurrence and contact). However, even in a severe situation, a comparatively small number of animals (a few hundred to perhaps a thousand) is likely to be directly exposed to the oil spill and die as a result of toxic-hydrocarbon inhalation and absorption. This loss probably would be small for any of the caribou herds, with these losses replaced within less than one generation (about 1 year).

Under the base case, a total of about 1,500 small spills <50 bbl and 9 spills ≥50 bbl but <1,000 bbl of either crude oil or petroleum products also are assumed to occur onshore in association with pipeline facilities, including the Trans-Alaska Pipeline (Appendix B, Table B-59). These minor spills are expected to have an additive effect on caribou, perhaps increasing contamination of terrestrial habitats along pipeline and road corridors by 1-2 percent.

(3) Onshore Oil-Spill Effects: In the event of an onshore-pipeline spill, some tundra vegetation in the pipeline corridor would become contaminated. An estimated 295 small oil spills ≥1 and <1,000-bbl are assumed to be associated with the base case. 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). 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 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.

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, the effect of 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 corridors.

(4) Effects of Disturbance from Oil-Spill Cleanup: In the event of a large oil spill contacting and extensively oiling coastal habitats with herds or bands of caribou during the insect season, the presence of several thousand humans, hundreds of boats, and several aircraft operating in the area involved in cleanup activities is expected to cause displacement of some caribou in the oiled areas and contribute temporarily to seasonal stress on some caribou. This effect is expected to occur during cleanup operations (perhaps 1 or 2 seasons) but is not expected to significantly affect the caribou herd movements or the foraging activities of the population.

c. Effects of Development:

(1) General Disturbance Effects Associated With Pipelines: Recent studies (Roby, 1978; Cameron, Whitten, and Smith, 1981, 1983; Cameron et al., 1992; Pollard and Ballard, 1993) indicate significant seasonal avoidance of habitat near (within 1-2 km [0.62-1.2 mi]) some existing Prudhoe Bay area facilities by cows and calves during calving and early postcalving periods (May through June). Therefore, disturbance from vehicle traffic and human presence associated with present levels of oil development in the Prudhoe Bay area apparently has affected local distribution on a small percentage (an estimated 5%) of the caribou's summer range. However, caribou abundance and overall distribution have not been affected—the CAH has greatly increased since oil development began, although this increase in caribou numbers is not to be inferred as caused by oil development.

Cameron, Whitten, and Smith (1983) also reported that caribou cow/calf groups avoid the 200-km- (124-mi-) long northern portion of the TAPS 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 typically avoid using during the postcalving season because of 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 TAPS corridor and other riparian habitats on the summer range of the CAH. Also, caribou cow/calf groups did not avoid a portion of the TAP corridor on the North Slope, which is separate (4 km [2.5 mi] 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 pipeline during periods of high levels of truck traffic. The mere physical presence of the pipeline and associated facilities probably has no apparent 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 distribution of caribou. Onshore pipeline corridors across the Arctic Slope (east-west) also could hamper the movements of the caribou herds (Brower, 1986, pers. comm.). However, such an effect is expected to be temporary, with the caribou moving across the corridors when vehicle traffic has passed.

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 behavior and movement while caribou are crossing the Prudhoe Bay and Kuparuk oil fields and pipeline corridors (Murphy and Curatolo, 1984; Lawhead and Flint, 1993). 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 crossings do occur. Caribou have returned to areas of previous disturbance after construction was complete in other development areas (Hill, 1984; Northcott, 1984). Since the pipeline road crossing NPR-A is not expected to be open to the public (except for a limited number of public tours that are restricted to certain areas and times-dates) during the life of the oil fields and road traffic on the oil fields would be restricted to oil-support traffic, the frequency of vehicle-traffic disturbance of caribou by nonindustrial activities would be limited because such traffic is allowed only by oil-company permit on the oil fields.

(2) General Effects of Habitat Alteration: 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. However, the several square kilometers of caribou tundra-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 also provides the caribou with additional insect-relief habitat on the roads and gravel pads, particularly when there is little or no road traffic present.

(3) Effects of Site-Specific Onshore Development: Assuming oil development takes place in the Beaufort Sea, the following potential oil-transportation (pipeline) projects and facility-construction projects could take place and affect the caribou herds. The following assumptions are made under the base case: (1) gas will be uneconomical to develop and produce for the foreseeable future, (2) the TAP will have the capacity to handle production from the lease sale, and (3) three pipeline routes will be required to connect the TAP with the acreage offered (see Sec. II.B.2.a). These routes would include the following landfalls: one at a point about 32 km (20 mi) east of Bullen Point, one west (Oliktok Point) of Prudhoe Bay, and one adjacent to Prudhoe Bay at the Point McIntyre-West Dock area.

(a) Oil Transportation East of Prudhoe Bay: Oil transportation from assumed platforms located northeast and northwest of Barter Island and connecting with the leases from Sale 124 in this area is assumed to be by offshore pipeline connecting to an onshore pipeline with a landfall at a point about 32 km (20 mi) east of Bullen Point. An onshore pipeline would connect to TAP through the Endicott pipeline facilities. Effects of oil development on the PCH probably could be avoided if no extensive onshore system of roads, pipelines, pump stations, and other facilities would cross the calving or summer range of this herd.

However, decisions on whether there would be onshore or offshore pipelines east of the Canning River Delta would be influenced by the decision of the U.S. Congress on possible exploration and development in the ANWR. The onshore pipeline and road from a point about 32 km (20 mi) east of Bullen Point to TAP would increase vehicle traffic by perhaps several hundred vehicles per day during construction, which could temporarily disturb some of the 23,000 caribou of the CAH within about 2 km (1.2 mi) of Bullen Point and along the pipeline and road corridors to TAP, particularly during construction activities. Disturbance and habitat effects on the CAH are expected to be short term because interference with caribou movements would be temporary (probably a few minutes to less than a few days); caribou would eventually cross the pipeline-road complex. Additionally, disturbance reactions would diminish after construction is complete, and vehicle-traffic levels are likely to decrease to <100 per day at the most. The abundance and overall distribution of the CAH and PCH are not likely to be affected by the construction and operation of oil-transportation facilities east of Prudhoe Bay that are assumed to be associated with the base case. Local distribution of caribou cows and calves within about 1 to 2 km (0.62-1.2 mi) of the pipeline-road could be affected during construction of the pipeline and road due to heavy traffic levels (such as >100 vehicles/day), and such an effect on local distribution and habitat use may be expected to persist beyond the construction period (2 years) and may persist over the life of the field. The assumed pipeline landfall at Point McIntyre is assumed to connect up with existing facilities at West Dock in the Prudhoe Bay area and not significantly increase road traffic and disturbance of caribou.

(b) Oil Transportation West of Prudhoe Bay: It is assumed that oil would be transported from offshore platforms located west of Prudhoe Bay, with the landfall located at Oliktok Point. From there, it would be connected to TAP through existing facilities of the Kuparuk River Oil Field. Construction and support activities associated with this pipeline-landfall would temporarily disturb some caribou of the CAH, particularly when high levels (several hundred vehicles/day) of vehicle traffic are present during construction-gravel hauling. After construction is complete, disturbance levels would subside within 2 years or one generation (because of the great reduction in vehicle traffic to less than 100 vehicles/day at most for 4-5 hours). This level of effect is expected because the animals eventually would cross the pipeline and road, and their numbers and the herd's distribution are not expected to be affected.

Overall Summary: The primary source of disturbance to caribou is vehicle traffic (perhaps as much as several hundred vehicles/day) that could be associated with onshore transportation of oil from offshore leases. Possible oil spills, offshore construction, and marine transportation probably would represent the loss of small numbers (perhaps 100) of caribou. The construction and presence of onshore pipelines and roads and the development of other facilities and associated motor-vehicle traffic are disturbance factors to caribou, particularly cow/calf groups of the CAH, TLH, and WAH, on their summer range. The CAH-caribou surveys have shown some displacement of cow/calf groups from coastal habitats (an estimated 5% of their summer range) within 2 km (1.2 mi) of some but not all Prudhoe Bay-area industrial facilities on the calving range of the CAH.

Disturbance of caribou along the pipelines and roads from Point McIntyre, Oliktok Point, and a point about 32 km (20 mi) east of Bullen Point to TAP through existing facilities in the Prudhoe Bay and adjacent oil fields would be most intense during the construction period (perhaps 6 months), 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 (a few minutes to a few days) during breaks in the traffic flow, even during high traffic periods, with little or no restriction in movements because caribou successfully cross other roads and TAP during spring and fall migrations (Cameron, Whitten, and Smith, 1986; Eide, Miller, and Chihuly, 1986); and a local reduction in cow-calf distribution within about 1 to 2 km (0.62-1.2 mi) along the pipeline-road corridor from Bullen Point to the Endicott pipeline may be expected to persist for more than one generation (and perhaps over the life of the oil fields).

Because oil transportation for development of Federal offshore leases east of the Canning River is expected to be located offshore of ANWR, caribou of the PCH that calve on the ANWR are not likely to be affected. However, a pipeline from offshore blocks east of Flaxman Island running onshore along the coast of Camden Bay could be a possibility if the U.S. Congress allows oil exploration and development to occur on the ANWR. The local distribution of some PCH caribou cows and calves would be affected during the high-traffic construction season, and this local effect may to persist for more than one generation (perhaps over the life of the field). Overall movements and distribution of PCH caribou and abundance of PCH caribou are not likely to be significantly affected by the base case. Brief interruptions in caribou movements during high traffic levels along pipelines and roads are expected to occur.

Assuming the two spills (7,000 bbl) occurred during the open-water season, caribou of the TLH, CAH, and PCH that frequent coastal habitats from Cape Halkett (LS 27) to Barter Island (LS 41) possibly could be directly exposed to and contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities (Fig. IV.B.7-1). However, even in a severe situation, a comparatively small number of animals (a few hundred to perhaps a thousand) is likely to be directly exposed to the oil spill and die as a result of toxic-hydrocarbon inhalation and absorption. This loss probably would be small for any of these caribou herds and would be replaced within less than one generation (about 1 year). For the most part, the effect of 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 corridors.

Effectiveness of Mitigating Measures: The ITL No. 1, Information on Bird and Mammal Protection, is expected to indirectly reduce noise and disturbance effects of air and vessel traffic on caribou occurring along the coast of the sale area. This measure recommends air- and vessel-traffic distances to avoid disturbance of marine and coastal birds and marine mammals that generally use many of the same coastal habitats as caribou and is expected to prevent frequent disturbance of caribou from air and vessel traffic along the coast of the sale area. However, on occasion, air traffic is expected to disturb individual or bands of caribou. This effect is expected to be short term and local and is not expected to affect caribou populations.

Other stipulations that are part of the proposal and other proposed mitigating measures are not expected to provide any additional protection for terrestrial mammals nor reduce potential adverse effects. If these measures are not part of the proposal, the effects of noise and disturbance on caribou are expected to be about the same as with the measures in place because the harassment of wildlife would be bad public relations for the oil industry; and lessees are likely to avoid such conflicts whenever possible.

Conclusion: The effects of the base case on caribou are expected to include local displacement of cow-calf groups within about 1 to 2 km (0.62-1.2 mi) along the pipeline and roads, with this local effect persisting for more than one generation (and perhaps over the life of the proposal). Brief disturbances (a few minutes to a few days) of large groups of caribou are expected to occur along the road and pipeline corridor during periods of high traffic over the life of the project, but these disturbances are not expected to affect caribou migrations and overall distribution. The two assumed oil spills are likely to result in the loss of small numbers of caribou (a few hundred to perhaps a thousand), with recovery expected within 1 year or less.

8. Economy of the North Slope Borough: Increased revenues and employment are the most significant economic effects that would be generated by the base case of the proposal. Increased property-tax revenues and new employment would be created with the construction, operation, and servicing of facilities associated with OCS activities. These facilities are described in Table IV.A.1-1 and are summarized as follows: during the exploration phase between 1997 and 2004, 8 exploration and 14 delineation wells would be drilled; and during the development and production phase between 2001 and 2009, 273 production wells would be drilled and 8 platforms and 128 km of offshore pipeline would be installed. The number of workers needed to operate the infrastructure is determined by the scale of the infrastructure and not the amount of oil produced. A wide range of production volume can be handled by a given level of infrastructure. Once the infrastructure is constructed, the number of workers needed to operate it does not depend on the amount of product flowing through it. Some temporary employment is generated by assumed oil spills.

Analysis of economic effects resulting from proposed Sale 144 is limited to effects on the NSB. The information that follows is from the Rural Alaska Model, prepared for MMS by the Institute for Social and Economic Research (ISER), and from the NSB 1993/1994 Economic Profile and Census Report (Harcharek, 1995).

a. North Slope Borough Revenues and Expenditures: Under existing conditions, total property taxes in the NSB and NSB revenues are in general projected to decline, as discussed in Section III.C.1. These revenues will be determined by several different factors; and, therefore, the revenue projections should be considered with the understanding that many uncertainties exist. The proposed sale is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 2 percent each year through the production period. Also under existing conditions, the two expenditure categories that affect employment—operations and the Capital Improvements Program (CIP)—are projected to decline. Of these two categories, only expenditures on operations would be affected by the proposed sale's effects on taxable property value. Those CIP expenditures that have generated many high-paying jobs for residents would not be affected.

b. Employment: The gains from Sale 144 in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. A peak employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 by 2026. See Appendix E for a description of the methodology for employment and population forecasts.) All of these jobs would be filled by commuters who would be present at the existing enclave-support facilities 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 from the enclaves to permanent residences outside of Alaska, especially during the exploration phase. Because economic effects in other parts of Alaska would be insignificant, only employment increases in the North Slope region are discussed.

The proposed sale is projected to affect employment of the region's permanent residents in two ways: (1) more residents would obtain petroleum-industry-related jobs as a consequence of Sale 144 exploration and development and production activities and (2) more residents would obtain NSB-funded jobs as a result of higher NSB expenditures, as discussed above.

While the proposed sale is projected to generate a large number of petroleum-industry-related jobs in the region, the number of jobs filled by permanent residents of the region is not projected to be large. Total base-case resident employment is expected to be about 4-percent greater than existing-condition employment. Therefore, overall employment should not decline as far by the end of the production period as it would under existing conditions. The increase in employment opportunities may partially offset declines in other job opportunities and delay expected outmigration.

Appendix E presents a comparison of total resident employment and total resident Native employment (a subset of total resident employment) for the no-sale case and for the base case. It is assumed that all of the direct petroleum-industry-related employment of residents is filled by Natives. However, most of the sale-induced employment is not with the petroleum industry. As petroleum-industry-related employment in the region declines, there probably would be less effort made to recruit and retain Native workers.

Employment generated by oil-spill-cleanup activities also would have economic effects. The most relevant historical experience of a spill in Alaskan waters was the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Similar effects on the NSB would be mitigated due to the likelihood that cleanup activities, including administrative personnel and spill-cleanup workers, would be located in existing enclave-support facilities.

The number of workers actually used to clean up the assumed two oil spills of 7,000 bbl associated with Sale 144 would depend to a great extent on what procedures were called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities. Activities associated with Sale 144 could generate cleanup work for about 3 percent of the workers associated with the EVOS—or 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

c. Effects of Subsistence Disruptions on the NSB Economy:
Disruptions to the harvest of subsistence resources could affect the economic well-being of NSB residents in a number of ways. Adverse effects would be felt primarily through the direct loss of subsistence resources. In addition, loss of subsistence resources would increase demand for store-brought goods and result in an inflation of prices.

Subsistence activities are an integral component of the NSB economy as well as the culture. Subsistence is the "body and soul" of Native culture (I. Nukapigak, 1995). If one or more subsistence resources became unavailable for harvest, the economic well-being of NSB residents would be harmed. There are two components to the economic well-being associated with subsistence resources—the value of subsistence resources as a source of food and the cultural value of the resources. Both of these values can be represented as a direct source of economic well-being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased in the marketplace. This food source is a substitute for income earned in the marketplace that would have to be used to purchase food. Subsistence activities and the value derived from these pursuits, however, go beyond a substitute for food bought in the market. As a way of life, there is a real, measurable economic value gained from NSB residents having access to such activities. As explained below, disruption of a subsistence harvest would result in a real loss of economic well-being to residents.

The interaction between the "Western" market-oriented economy and subsistence activities is a complex relationship that does not fit neatly into standard economic theory. Much of the reason for this is because the unit of analysis in standard economic theory is the household, whereas the extended-kinship network is important for economic decision making in the Inupiat culture of the NSB. The kinship-sharing network that is characteristic of Inupiat culture distorts the standard economic outlook on an economy. For example, jobs in the market economy often are held in order to support subsistence activities. Earnings from these jobs frequently are not earned by the principal harvester of subsistence resources but rather are contributed to the harvester's subsistence effort by the market-wage earner. Likewise, subsistence resources are contributed to those engaged in market-oriented activities. This, however, is only one possible combination of the relationship between the market economy and subsistence activities. Market-wage earners also may directly engage in subsistence activities. Furthermore, the sharing of resources among the kinship network is not a simple trade of equally valuable goods. Rather, it is based on tradition and status among the individuals within the network.

Because of this extensive subsistence-user/kinship network, a disruption to a subsistence resource caused by, for example, an oil spill could have ramifications that extend beyond the immediate family of the subsistence harvester to households that, by all appearances, principally engage only in market-economy activities. "Our food would be devastated by an oil spill" (E. Itta, 1995). For example, an MMS survey-research project on the North Slope found that for six North Slope communities (Barrow, Wainwright, Nuiqsut, Point Hope, Anaktuvuk Pass, and Kaktovik), about 70 percent of all households (regardless of ethnicity) obtained the majority of meat and fish in their diet from subsistence activities. A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. There is considerable evidence that Western foods are not considered equivalent to Native foods (Kruse et al., 1983). Even if an equal portion of Western foods were substituted for the lost subsistence foods, there still would be a loss in well-being and, in turn, a loss in income because the substitute foods would be an inferior product. This aspect of the loss does not begin to address the lost value associated with having to forego participating in subsistence activities and, in general, the lost value associated with not being able to participate in the Native culture. This is not to deny the possibility of local residents earning additional income through cleanup jobs; however, cleanup opportunities are not expected to fully compensate for the lost value resulting from being denied use of subsistence resources.

The extent of loss to the subsistence economy of the base case is directly related to effects on the subsistence harvest. The effects on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. In Barrow (Atqasuk), effects are expected to affect subsistence resources for a period not exceeding 1 year and make no resource unavailable, undesirable for use, or greatly reduced in number. Overall effects on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities would render one or more important subsistence resources unavailable, undesirable for use, or reduced in available numbers for a period of 1 to 2 years (see Sec. IV.B.10, Subsistence-Harvest Patterns).

Summary: For the base case of the proposal, increased revenues and employment are the most significant economic effects that would be generated. Increased property-tax revenues and new employment would be created with the construction, operation, and servicing of facilities associated with OCS activities. The base case of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 2 percent each year through the production period. The gains in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. A peak employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 by 2026. While the base case of the proposal is projected to generate a large number of petroleum-industry-related jobs in the region, the number of jobs filled by permanent residents of the region is projected to be about 4 percent greater than existing-condition employment. The number of workers actually used to clean up the assumed two oil spills of 7,000 bbl would depend to a great extent on what procedures were called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

There are two components to the economic well-being associated with subsistence resources—the value of subsistence resources as a source of food and the cultural value of the resources. Both of these values can be represented as a direct source of economic well-being for NSB residents. Because of this extensive subsistence-user/-kinship network, a disruption to a subsistence resource would have ramifications that extend beyond the immediate family of the subsistence harvester. A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy of the base case is directly related to effects o the subsistence harvest. The effects on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. In Barrow (Atqasuk), effects are expected to affect subsistence resources for a period not exceeding 1 year and make no resource unavailable, undesirable for use, or greatly reduced in number. Overall effects on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities would render one or more important subsistence resources unavailable, undesirable for use, or reduced in available numbers for a period of 1 to 2 years.

Conclusion: The base case of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 2 percent each year through the production period. A peak employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 by 2026. The number of jobs filled by permanent residents of the region is projected to be about 4 percent greater than existing-condition employment. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy of the base case is directly related to effects on the subsistence harvest. The effects on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. In Barrow (Atqasuk), effects are expected to affect subsistence resources for a period not exceeding 1 year and make no resource unavailable, undesirable for use, or greatly reduced in number. Overall effects on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities would render one or more important subsistence resources unavailable, undesirable for use, or reduced in available numbers for a period of 1 to 2 years.

9. Sociocultural Systems: This discussion is concerned with those communities that could be affected by Beaufort Sea Sale 144. Under the base-case scenario for this sale (see Sec. II.B.2.a), potentially Barrow, Nuiqsut, and Kaktovik could serve as air-support bases. The main support infrastructure would be upgraded facilities at the Prudhoe Bay and Kuparuk units. The offshore pipeline landfall closest to Nuiqsut would be located at Oliktok Point. Landfalls at Point McInyre and a point about 32 km (20 mi) east of Bullen Point would be close to Nuiqsut and Kaktovik. The sociocultural systems of Atqasuk also are analyzed primarily because of possible effects as a result of Sale 144 that could render one or more resources unavailable or undesirable or could greatly reduce Barrow's subsistence-harvest numbers (Atqasuk residents harvest sea mammals with Barrow residents.).

The primary aspects of the sociocultural systems covered in this analysis are (1) social organization and (2) cultural values, as described in Section III.C.2. 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, increased employment, and 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 are 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 generally are based on kinship and marriage systems, as well as on nonbiological alliance groups formed by such characteristics such as age, sex, ethnicity, community, and trade. 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 also could 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.2). 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, and the distribution of specific tasks reflects and reinforces the roles of husbands, wives, grandparents, children, friends, and others (see Sec. III.C.2). Disruption would damage the social bonds that hold the community together. Any serious disruption of sharing networks could appear as a threat to the way of life in that community and could trigger an array of negative emotions: fear, anger, and frustration, as well as a sense of loss and helplessness. Because of subsistence's psychological importance in these sharing networks, perceived threats to subsistence activities are a major cause for anxieties about oil development.

An analysis of cultural values looks at those values shared by most members of a social group. Generally, these values are shared conceptions concerning what is desirable. They are ideals that members of a social group accept, explicitly or implicitly. Forces powerful enough to change the basic values of an entire society would include a seriously disturbing change in the physical conditions of life: a fundamental cultural change imposed or induced by external forces, such as when an incoming group induces acculturation of the residing group, or when a series of fundamental technological inventions change existing physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly or suddenly and dramatically (Lantis, 1959). Cultural values on the North Slope include strong ties to Native foods, to the land and its wildlife, to the family, to the virtues of sharing the proceeds of the hunt, and to independence from institutional and political forces outside the North Slope (see Sec. III.C.2). 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 obviously more difficult for a household to produce a surplus than to simply satisfy its own needs. For this reason, sharing, and the supply of subsistence foods in the sharing network, could be more sensitive to harvest disruptions than the actual harvest and consumption of these foods by active producers.

(2) Effects Agents: The agents associated with Sale 144 that could affect the sociocultural systems in communities in the sale area (described in Sec. III.C.2) are industrial activities, changes in population and employment, and effects on subsistence-harvest patterns.

(a) Industrial Activities: During the exploration phase (in the base case), the communities of Barrow, Nuiqsut, and Kaktovik could be used as air-support bases where personnel and air freight would be transferred to helicopters. One helicopter trip per day per drill unit is assumed for exploration. The existing facilities at these airports are adequate to handle the projected needs during exploration. During the development and production phase, air support gradually would shift to the shore-base facility at Prudhoe Bay. Eight production platforms are assumed in the Beaufort Sea, three in nearshore waters and five in deeper waters from 11 to 28 m. Atqasuk is too far from the proposed lease activities for its sociocultural systems to be directly affected by associated development and production. Other industrial activities associated with oil and gas development that could have an effect on sociocultural systems would be the result of cleanup if an oil spill did occur.

(b) Population and Employment: Sale 144 is projected to affect the population of the North Slope Borough through two types of effects on regional employment: (1) more petroleum industry-related jobs as a consequence of Sale 144 exploration and development and production activities and (2) more NSB-funded jobs as a result of higher NSB operating revenues and expenditures (see Sec. IV.C.8.a). Employment projections as a consequence of Sale 144 are provided in Section IV.C.8.b. Throughout the development and production phase, total petroleum-related employment would peak in 2006 at 3,553. Resident employment as a result of Sale 144 would peak at 327 in the year 2007. Most workers are expected to permanently reside outside of the North Slope. Sale 144 is projected to increase resident employ- ment by an average of 6 percent or more above the declining existing-condition projections between 1997 and 2007.

Sale 144 is projected to increase the NSB population at an average of 6 percent per year, peaking at 12 percent above the existing-condition level in 2007. The Native proportion of the population is not expected to change much: from 74 percent Native in 1994 to a projected 77 percent Native in 2009, and Native employment is expected to improve slightly as a consequence of Sale 144 (see Fig. III.C.1-1). It is expected that Nuiqsut's and Kaktovik's proximity to the three proposed pipeline landfalls (at Point McIntyre, Point Oliktok, and a point about 32 km [20 mi] east of Bullen Point) would encourage more residents from these communities to apply for sale-related jobs (see Sec. IV.C.8). Atqasuk is 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.

(c) Subsistence-Harvest Patterns: Subsistence is important to the Inupiat sociocultural system through sharing subsistence foods, creating community task groups and crew structures, and through the strengthening of social bonds (see Sec. III.C.3 for a detailed description). Regional effects could be expected on subsistence-harvest patterns in the Sale 144 area as a result of effects on Nuiqsut's bowhead whale harvest due to possible construction activities at the three proposed pipeline landfalls; disruption from construction activities on subsistence resources would be for a period of <1 year with no overall tendency toward unavailability, undesirability, or reduction in harvest numbers likely to occur. Less substantial effects are expected in Barrow, Atqasuk, and Kaktovik subsistence-harvest patterns as a result of noise and disturbance effects on subsistence resources. These resources could be periodically affected, but no apparent effects on subsistence harvests are likely to occur (see Sec. IV.C.10 for these analyses).

b. Effects on Barrow, Atqasuk, Nuiqsut, and Kaktovik: The relatively homogenous nature of the communities whose sociocultural systems may be affected by Sale 144—they are all predominantly Inupiat—indicates that changes in the communities would be similar. The exception to this may be Barrow, which is larger, has a larger percentage of non-Natives, and already has experienced more change than the other, smaller North Slope communities (see Sec. III.C.2). This section analyzes effects of industrial activities, population and employment changes, and subsistence-harvest-pattern impacts 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 communities that might be affected by Sale 144 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 in the subsistence harvest, and access to subsistence technology (see Sec. III.C.2). These non-Western elements of social organization could be altered to become less oriented toward the family, and changes would be exhibited in a breakdown of kinship networks as a result of OCS-induced social conditions. However, activities generated by Sale 144 are not likely to bring about these effects in the communities in question. Increased air traffic during exploration is unlikely to have a large effect on any of the communities where exploration activities are taking place, although it is not known at this time where actual exploration will occur. Air-traffic delays potentially could strand workers in the villages 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 North Slope communities during the peak of the CIP-construction years in the 1980's. Other OCS industrial activities (the pipeline landfalls at

Oliktok Point, Point McIntyre and a point about 32 km [20 mi] east of Bullen Point) would occur close to Nuiqsut and Kaktovik, respectively, but not within the actual communities. Changes in population and employment would not be greater than those already experienced in the past by these communities.

In Barrow, there has been a decrease in the Inupiat population from 91 percent to 64 percent from 1970 to 1990 and an increase in the non-Native, non-Caucasian, and the Caucasian populations, as well (see Sec. III.C.2). The increase is related to the increase that occurred in high-paying jobs during the peak of CIP-project construction in the 1980's (see Sec. IV.C.9). The greatest difference between other NSB Native communities and Barrow is that Barrow's non-Native resident population is permanent (see Sec. III.C.2). While disruptions would occur to Barrow's social institutions as a result of increases in temporary or permanent population growth, these disruptions would not be significantly higher than those that already have occurred as a result of NSB CIP development; it is likely that the social institutions of Nuiqsut and Kaktovik would experience more disruption due to population growth.

The construction of winter ice roads between Oliktok Point and Nuiqsut or between Bullen Point and Kaktovik could cause disruptions to Nuiqsut and Kaktovik social organization because of an increase of social interaction between residents and oil-industry workers. The Sale 144 scenario stresses that staging will occur primarily from existing or enhanced facilities at the Prudhoe Bay/Kuparuk units, a situation that would significantly reduce disruption to nearby Native communities. Other instances of increased interaction would occur if local residents were 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 communities as small as Nuiqsut and Kaktovik (population 354 and 224, respectively, in 1990); while in Barrow, the higher population (3,469 in 1990) and larger proportion of non-Natives (38.2%) are more likely to absorb any additional interaction with non-Natives if Barrow also were used for air support. Nuiqsut and Kaktovik already have been exposed to oil workers due to their proximity to Prudhoe Bay. It is not likely that the number of oil workers associating with local residents would increase much above the number that already is occurring. Atqasuk is not expected to experience any of these effects because it is not located close to sale-related industrial activities and thus would experience insignificant, indirect population and employment growth. Social interaction of oil-industry workers with Barrow, Nuiqsut, or Kaktovik residents would be long term; but while there might be a disruption of their social organization, there would not be a tendency toward displacement of their social institutions.

Overall effects on Barrow's (Atqasuk's), Nuiqsut's, and Kaktovik's subsistence-harvest patterns are expected to make one or more of its subsistence resources unavailable, undesirable for use, or available in reduced numbers for <1 year (see Sec. IV.C.10 for this analysis). These effects are expected on bowhead whale harvests as a result of oil spills, noise and traffic disturbance, and construction activities. Subsistence is a naturally cyclical activity. It is expected that harvests would vary from year to year, sometimes substantially, as they have in the past. Numerous species are hunted to compensate for a reduced harvest of any particular resource in any one year. Multiyear disruptions to even one resource, particularly one as important as the bowhead whale, 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 and a decrease in the importance of subsistence as a cultural value.

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 144 area do not perceive OCS development as a benefit to the Inupiat people. Construction activities at Bullen Point could interfere with Nuiqsut's bowhead whale harvest. Although traditionally Nuiqsut is a community that has not always gotten a bowhead whale and thus can cope with a zero harvest, Nuiqsut residents might view a zero harvest differently if harvest interference resulted from oil-industry activities versus what the Inupiat considered "an act of God." A zero harvest that is perceived to be the fault of the oil industry is more likely to generate additional stress on the sociocultural system—with possible tendencies toward disruption of the sharing networks and task groups, something that also could disrupt the social organization. Lesser effects from disruptions on social organization for a period <1 year are expected in Barrow (Atqasuk) and Kaktovik where bowhead quotas and harvests are larger; no social institutions would be displaced.

(2) *Cultural Values:* Cultural values and orientations (as described in Sec. III.C.2) can be affected by changes in the population, social organization and demographic conditions, economy, and alterations of the subsistence cycle. Of these, the only changes expected in Nuiqsut, primarily, and somewhat in Barrow and Kaktovik are in the social organization (see discussion above) and the subsistence cycle (see Sec. IV.C.10 and discussion above). The cultural institutions expected to be challenged in Atqasuk by the proposal are subsistence-harvest patterns.

A trend toward displacement of the social institutions 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.10). 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 disruptive effects that could be expected to occur under the proposed lease sale in the base case. These changes already are 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 engendered by these changes are not yet documented, nor are they easily quantifiable, it appears that they are trends that could increase rapidly with the development that could result from this lease sale. However, in Barrow, many of these changes already have occurred to a much greater extent than in the remainder of the smaller North Slope communities. Additional effects as a result of the base case would not be felt in Barrow to the same extent that they be would in the smaller communities. Subsistence is considered the core value and central feature of Inupiat cultural values (see Sec. III.C.2). While a year-long disruption to only one subsistence resource would not likely cause long-term, chronic disruption of the socio- cultural system with a displacement of existing social systems, multiyear disruptions throughout the 30-year life of the project could 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 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. Nuiqsut is the most likely community to experience such effects on the bowhead whale. Multiyear disruptions of the bowhead whale harvest could occur as a result of Sale 144 activities because of locations of the proposed landfalls and the anticipated noise and disturbance in the Nuiqsut bowhead harvest area during the exploration and development and production phases of the lease sale. Such disruptions could be long term but more likely would last only 1 to 2 years and probably cause some strain on Nuiqsut and Kaktovik cultural institutions.

Lesser effects on subsistence-harvest patterns in Barrow, Atqasuk, and Kaktovik are expected as a result of proposed lease-sale activities. These effects on subsistence-harvest patterns would be shorter term and would create disruptions of <1-year duration on the cultural values in Barrow, Atqasuk, and Kaktovik.

(3) *Social Health:* Effects on sociocultural systems often are 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); however, 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). Traditional Native communities help buffer the individual by providing a sense of continuity and control.

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.2.d)—also are issues of direct concern in this analysis of sociocultural systems. Local residents participating in the cleanup of the *Exxon Valdez* oil spill in Prince William Sound in 1989 tended to: (1) not participate in subsistence activities, (2) have a surplus of cash to spend on material goods as well as drugs and alcohol, and (3) not seek or continue employment in other jobs in the community (because oil-spill-cleanup wages typically were higher than those earned in the com- munity). Indications are that the sudden, dramatic increase in income as a result of working on the oil-spill cleanup, as well as being unable or unwilling to pursue subsistence harvests because of the *Exxon Valdez* oil spill, caused considerable social dislocation—particularly seen in increases in depression, violence, and substance abuse (Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990e).

Additional problems could arise if roads (even if only ice roads) were constructed between Nuiqsut and the shore base at Oliktok Point or between Kaktovik and Bullen Point from the increased presence of oil workers in the community. Other problems could arise from Nuiqsut and Kaktovik residents working in the oil industry. This situation has the potential for creating new access to alcohol and drugs. Although the oil industry strictly forbids the consumption of alcohol and drugs by camp workers, many such events frequently occur in Prudhoe Bay and Kuparuk. In Prudhoe Bay, it is often the service industries that have not complied with enforcing the ban on alcohol. The increased availability of drugs and alcohol in Nuiqsut and Kaktovik as a result of increased traffic through the airport, visitors in town, and shore-base workers associating with local residents could be disruptive to the social well-being of these communities. These problems already have occurred in Nuiqsut, which is within 56 km (35 mi) of Kuparuk and 105 km (65 mi) 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. An increase in social problems (consumption of alcohol and drugs, sexual abuse, domestic violence) in Nuiqsut at a rate slightly higher than in other North Slope communities has been observed (Armstrong, 1985).

Although there may be additional reasons for differences in social problems in Nuiqsut, it is clear that the proximity to industrial enclaves enables residents easier access to drugs and alcohol, thereby affecting the social health of the community, a situation that also could occur in Kaktovik and intensify in Nuiqsut as a result of this lease sale. Any effects on social health would have ramifications in the social organization, but NSB Native communities have proven quite resilient to such effects with the NSB's continued support of Inupiat cultural values and its strong commitment to health, social service, and other assistance programs.

Several salient points in the evaluation of possible sociocultural effects from oil-related developments due to this lease sale should be made:

1. Change itself, even though induced primarily by forces outside the communities, does not necessarily cause the levels of psychic stress that lead to pathology (see Inkeles, 1973).

2. Related to the first point is the fact that 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. Additionally, income from oil-industry revenue and employment could improve living conditions, although major dependence on a nonrenewable-resource-based economy could cause long-term social disruption at the time of resource depletion.

3. What drives the disruption of sociological change ". . .is the manner in which changes occur" (Murphy, 1965).

4. 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.

Nuiqsut and Kaktovik are the most likely communities in the North Slope region to experience additional sale-related effects in social health and well-being above those effects already experienced as a result of NSB CIP employment and the indirect effects from current oil development. These effects on social health could have direct consequences on the sociocultural system but would not have a tendency toward displacement of existing institutions above the displacement that already has occurred with the current level of development. Disruption of sociocultural systems in

Barrow and Atqasuk are expected to occur for a period of < 1 year without a tendency toward the displacement of existing institutions.

Summary: Some effects on the sociocultural systems of communities in the Sale 144 area are likely to occur as a result of industrial activities, changes in population and employment, and effects on subsistence-harvest patterns. These effect agents could affect the social organization, cultural values, and social health of the communities. Subsistence activities in Nuiqsut and Kaktovik are the most likely to be affected by Sale 144 due to their proximity to the (possible) landfalls at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point, respectively; however, the resultant effects on their bowhead whale harvest are expected be no more than periodic and have no apparent long-term effects on overall subsistence harvests. Biological analysis indicates that oil-spill effects could be lethal to a few individual whales, with population recovery lasting 1 to 3 years. Therefore, multiyear periodic disruptions, even if minimal, of Nuiqsut's subsistence-harvest patterns, especially that of the bowhead whale, which is an important species to the Inupiat culture, could adversely affect sharing networks, subsistence-task groups, and crew structures and could cause disruptions of the central Inupiat cultural value: subsistence as a way of life.

Nuiqsut and Kaktovik are likely to feel effects from changes in population structure because they are small, relatively homogenous communities that would not absorb the presence of non-Natives as well as a community like Barrow. Increased non-Native population, as well as Natives interacting with non-Natives or leaving the community to work in the industrial enclave, could influence some breakdown of kinship networks as well as an increase of 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.

Kaktovik and Nuiqsut could experience an increase in social problems due to the increased presence of oil workers in their communities and the possible construction of roads connecting Nuiqsut to Oliktok Point and Kaktovik to Bullen Point. Both of these factors could facilitate access to drugs and alcohol and thereby affect 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 Nuiqsut. With these factors, there could be a tendency for additional stress on the sociocultural systems but without tendencies toward displacement of Nuiqsut's and Kaktovik's sociocultural systems.

Sale-related increases in population and employment predicted for the Sale 144 area are expected to occur primarily in Barrow. Although Barrow would be in proximity to industrial activities, would have increases in population and employment, and could sustain periodic effects on the overall subsistence harvest, particularly the bowhead whale harvest, these changes should not be more significant than those changes that already have been felt in Barrow, particularly from 1975 to 1985 during CIP activity. Barrow is a much larger community that is more heterogenous than the other communities of the North Slope, and it could withstand some degree of increased population and employment opportunities. Even if these disruptions on sociocultural systems were long term (1-2 years), however, they most likely would not lead to a displacement of existing institutions. Atqasuk is too distant from onshore industrial activities to be directly affected by Sale 144 and is not expected to experience direct, sale-related population and employment increases. Atqasuk may experience some indirect rises in population and increases in employment, but they are not expected to be significant. As a result of lease-sale activities, disruptions in Atqasuk would be short term and would not have a tendency toward displacement of existing sociocultural institutions.

Effectiveness of Mitigating Measures: Mitigating measures are assumed to be in place for the base-case analysis, and base-case-effects levels reflect this assumption. Mitigation that would apply to sociocultural systems includes the Orientation Program stipulation, the Industry Site-Specific Bowhead Whale-Monitoring Program stipulation, and the stipulation on Subsistence Whaling and Other Subsistence Activities.

The Orientation Program stipulation requires the lessee to conduct a program that educates personnel working on exploration or development and production activities about the environmental, social, and cultural concerns that relate to the area and area communities. The program is expected to increase personnel sensitivity and understanding of local Native community values, customs, and lifestyles and to prevent any conflicts with subsistence activities. The Industry Site-Specific Bowhead Whale-Monitoring Program stipulation requires a site-specific monitoring program during exploratory drilling to determine if bowhead whales are present in the vicinity and to assess the behavioral effects on bowheads from these activities. If the lessee holds a NMFS Letter of Authorization for incidental, nonlethal taking of bowhead whales for exploratory drilling, no additional MMS plan is needed. The stipulation on Subsistence Whaling and Other Subsistence Activities requires lessees to conduct all exploration, development, and production in a manner that minimizes any potential conflicts with subsistence activities, especially the bowhead whale hunt. This stipulation requires the lessee to contact potentially affected Native communities and the Eskimo Whaling Commission to discuss possible siting and timing conflicts and to assure that exploration, development, and production activities are compatible with subsistence whaling and do not result in interference with other subsistence harvests. The Orientation Program, Industry Site-Specific Bowhead Whale-Monitoring Program, and Subsistence Whaling and Other Subsistence Activities stipulations would serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices. If these mitigation measures were not in place, increased disturbance effects would not raise overall effects levels above those already assessed for the base case.

Conclusion: Proposed Sale 144 base-case effects from industrial activities, changes in population and employment, and effects on subsistence-harvest patterns are expected to disrupt sociocultural systems. Chronic disruptions to sociocultural systems are expected to occur for a period of 1 to 2 years, and possibly longer, but these disruptions are not expected to cause permanent displacement of ongoing community activities and traditional practices for harvesting, sharing, and processing subsistence resources.

10. Subsistence-Harvest Patterns: Section III.C.3 (1) describes the subsistence-harvest patterns characteristic of Inupiat communities adjacent to the Sale 144 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. Sections III.C.2 and 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.9.

a. Introduction: This section analyzes the effects of the proposed action for the base case on subsistence-harvest patterns of communities close to the proposed Sale 144 area. This analysis is organized by subsistence resource and discusses effects on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities. The discussion of effects on subsistence-harvest patterns that follows this analysis is organized by community.

Effects on communities outside of the lease-sale area are not discussed in this analysis because: (1) effects of noise and disturbance on subsistence are very localized and would not affect the subsistence harvests of Alaskan (or Canadian) communities other than Barrow (Atqasuk), Nuiqsut, and Kaktovik; (2) it is extremely unlikely that an oil spill would contact subsistence-harvest areas of Alaskan (or Canadian) communities other than Barrow (Atqasuk), Kaktovik, and Nuiqsut; and (3) and pipelines would be constructed only in the lease-sale area, and effects from construction would be localized.

The Sale 144 area includes the eastern portion of the marine-subsistence-resource area of Barrow (also used by Atqasuk residents [see Sec. III.C.3]) and the entire marine-subsistence-resource areas of Nuiqsut and Kaktovik. Moreover, if economically recoverable amounts of oil were discovered, onshore pipelines and roads associated with its development could affect the terrestrial-subsistence resources that are harvested by these three coastal communities as well as the inland community of Atqasuk.

As noted in Sections III.C.2 and 3, onshore-oil developments at Prudhoe Bay already have 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 NSB. Wage employment has led to an upgrading of hunting technology but, alternatively, has constricted the total time available for hunting. Currently, diminished household incomes, reduced by the loss of high earnings from the NSB CIP period in the early to mid-1980's, tend to only more encourage subsistence and an increase in harvest levels for many subsistence resources.

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 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 144 area, with specific information by community, wnere applicable. This analysis includes the marine and terrestrial resources harvested by the residents of Barrow, Nuiqsut, and Kaktovik and the terrestrial resources, fishes, and marine and coastal birds harvested by the residents of Atqasuk. 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. All subsistence-harvest effects on marine mammals in Barrow also would occur in Atqasuk.

The factors affecting the subsistence-harvest patterns of Barrow, Nuiqsut, Kaktovik, and Atqasuk 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; Braund 1989a; ADF&G 1993a,b]):

□□ Heavy reliance on caribou in the annual average harvest for Barrow (28.6-58.2%), Nuiqsut (37.5-90.2%) and Kaktovik (11.1-45%). No data are available for Atqasuk (see Table III.C.3-4; Stoker, 1983, as cited by ACI/Braund, 1984; Braund 1989a; ADF&G 1993a,b).

□□ Heavy reliance on bowhead whales in the annual average harvest for Barrow (21.3-40.7%), Kaktovik (0-63.2%), and Nuiqsut (8.6-37.5%) (see Tables III.C.3-4 and III.C.3-3; Stoker, 1983, as cited by ACI/Braund, 1984; Braund 1989a; ADF&G 1993a,b). Percentages have continued to rise because IWC quotas have almost doubled in recent years.

□□ Reliance on fish in the annual average harvest for Barrow (6.6-9.5%), Nuiqsut (4.4% in 1985), and Kaktovik (8.2-21.7%) (see Table III.C.3-4; Braund 1989a; ADF&G 1993a,b).

□□ Hunting ranges overlap for many species harvested by Barrow, Atqasuk, Nuiqsut, and Kaktovik.

□□ Hunting and fishing are cultural values that are central to the Inupiat way of life and culture.

□□ In 1990, the population of Barrow was 3,469; Atqasuk, 216; Nuiqsut, 354; and Kaktovik, 224.

Causal Agents Affecting Subsistence-Harvest Patterns

Oil Spills: Subsistence-resource areas for Barrow, Atqasuk, Nuiqsut, and Kaktovik are shown in Figure IV.A.2-4 to indicate important marine-mammal-harvest areas used by communities that would be vulnerable if an oil spill occurred and contacted these areas. The OSRA estimates 2 spills ≥1,000 bbl, with an estimated 88-percent chance of one or more oil spills (platform and pipeline spills) occurring in the Beaufort Sea over the assumed production life of the proposed lease sale (Table IV.A.2-2). The average size of such a spill is 7,000 bbl. For this analysis, two spills of 7,000 bbl each are assumed to occur in the sale area. Combined probabilities of spill occurrence and contact factor in the volume of oil assumed to be produced and the estimated spill rates for platforms, pipelines, and tankers and express the percent chance of one or more spills ≥1,000 bbl occurring and contacting a specific Subsistence Resource Area (SRA) within a specific timeframe during a particular season. Probabilities in this discussion are combined probabilities estimated by the OSRA model (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting an SRA important to subsistence harvests within 30 days (Fig. IV.A.2-3). The threshold combined probability at which damaging effects on subsistence resources would occur is 5 percent.

Subsistence Resource Areas B (SRAB), C (SRAC), and D (SRAD) (see Fig. IV.A.2-4 and Appendix B, Tables B-32, B-18, B-19, B-24, B-25) are used to indicate important marine-mammal subsistence-harvest areas. The SRAB includes much of the area used by Barrow hunters to harvest marine mammals. There is a 4-percent chance of one or more oil spills ≥1,000 bbl occurring and contacting this area within 30 days during the winter (October-June) and open-water (July-September) seasons. During the winter, such contact could affect sealing and polar bear hunting; during the spring season, it could affect sealing, whaling, and bird hunting; during the fall, it could affect whaling and ocean-fish netting. If a spill did occur during the open-water season, it could affect sealing, whaling (belukha), walrus hunting, and bird hunting.

The SRAC indicates Nuiqsut's and a portion of Kaktovik's marine-mammal-harvest areas. There is a 68- percent chance of one or more oil spills ≥1,000 bbl occurring and contacting this SRA within 30 days during the winter and open-water seasons. Oil-spill contact in winter could affect polar bear hunting and sealing. Bird hunting, sealing, and whaling, as well as the ocean-netting of fish, could be affected by a spill during the open-water season.

The SRAD indicates Kaktovik's and a portion of Nuiqsut's marine-mammal-harvest areas. There is a 63-percent chance of one or more spills ≥1,000 bbl occurring and contacting this SRA within 30 days during the winter and open-water seasons. The same resources mentioned in the SRAC discussion would be vulnerable to oil-spill contact in this SRA.

Subsistence harvests by Barrow and Nuiqsut residents also occur between SRAB and SRAC. The probability of one or more oil spills >1,000 bbl occurring and contacting the area between SRAB and SRAC (LS's 24-27) is 1 percent in winter and in the open-water season (Appendix B, Table B-33). The low probability of an oil spill occurring and contacting this area indicates little likelihood of an oil spill contacting or affecting this portion of Nuiqsut's and Barrow's subsistence-harvest areas.

Analyses of the effects of oil spills on each subsistence resource are provided in Section IV.B.10.b.

Noise and Disturbance: Noise and disturbance would be associated with the (1) seismic surveys that are part of the preliminary activities of the lease-sale exploration 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 and development and production. The following activities are predicted for the base case: 22 exploration and delineation wells would be drilled, one vessel would support each platform during the open-water season, and there would be at least one supply-boat trip a week and one round-trip helicopter flight per day per platform for each day of drilling. Eight production platforms and offshore trunk pipelines would be installed, and there would be two helicopter flights per week per platform during production. The pipelines from production platforms would have landfalls in the central Beaufort at Oliktok Point and Point McIntyre and in the eastern Beaufort at a point about 32 km (20 mi) east of Bullen Point. The onshore segments of the pipelines total about 168 km (104 mi) and connect with TAPS Pump Station No. 1.

Construction Activities: Construction activities that could adversely affect subsistence include the installation of mobile bottom-founded drilling units such as the Concrete Island Drilling System or Single Steel Drilling Caisson and bottom-founded concrete production platforms; the excavation of glory holes if floating units are used in exploration and laying 128 km (80 mi) of trenched offshore pipeline (see Sec.II.A.1) and in onshore construction of pipelines and roads. During construction, disturbance from such activities could cause some animals to avoid areas in which they normally are harvested or to become more wary and difficult to harvest. The latter could be a concern in the case of bowhead whaling, but current research indicates bowheads do not seem to travel more than a few kilometers out of their original swimming direction due to noise-disturbance events, and that these changes in swimming direction are temporary, last from a few minutes for aircraft and vessel noise to up to 1 hour in response to seismic activity (see Sec.IV.B.5). 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, landfalls, and pipelines) in order to protect oil workers and valuable equipment from harm. Finally, structures such as onshore pipelines may limit hunter access to certain active hunting sites.

Trenches for the offshore pipeline would be cut and the pipe would be laid during the open-water season, although these pipelaying activities may require ice-management operations. Construction of the onshore segments of pipelines and support roads from the landfalls to TAPS Pump Station No. 1 would take about 2 years. These onshore-construction activities could take place at anytime of the year. Construction activities associated with the onshore pipelines and support roads could affect Nuiqsut's and Kaktovik's subsistence- harvest patterns.

b. Effects on Subsistence Resources, by Resource: The following discussion analyzes the potential effects of oil spills, noise and disturbance, and construction activities on specific subsistence resources within the Sale 144 area. Section IV.C.10.c follows this resource-specific discussion and summarizes and assesses the effects on each community that might be directly affected by Sale 144.

(1) Bowhead Whales: The bowhead whale is the Inupiat's most culturally important subsistence resource (see Sec. III.C.2). It also is the resource that provides the most meat to Barrow and Kaktovik residents (see Sec. III.C.2 [Table III.C.3-4; see Fig. III.C.3-2 for harvest areas]). Section

IV.B.6.a concludes biological effects from oil spills on bowhead whales would cause lethal effects to a few whales, with population recovery in 1 to 3 years. Only 1 to 4 whales are harvested annually by each whaling community (with the exception of Barrow, which recently has had a higher quota of 5-11 whales). Whaling begins in late March to early April and ends in late May to early June in Wainwright and Barrow. Barrow also conducts fall whaling in late August-early October, but spring whaling is their major whaling time. Nuiqsut and Kaktovik harvest the bowhead whale from mid- to late August through the beginning of October. Although the whaling season is approximately 1½ to 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: a virtual 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. This perception could extend beyond the Sale 144 whaling communities and include the whaling communities of Wainwright, Kivalina, Point Hope, Wales, Savoonga, and Gambell. In the proposed lease-sale area, two spills ≥1,000 bbl (the spills are assumed to be 7,000 bbl) are expected during the life of the project. Although it is possible that an oil spill might greatly reduce or eliminate the whale harvest for one season, it is more likely that a spill would force hunters to move to a new location. The forced move would shorten the whaling season for certain communities and decrease the number of whales harvested—an effect that is most likely to occur in the Nuiqsut and Kaktovik subsistence-harvest areas (68% and 63% chances, respectively, of an oil spill occurring and contacting SRAC and SRAD in winter and during the open-water season). An oil spill in winter still could be a problem during the spring as the ice melts, and the oil would then be present in the lead system. Oil-spill-cleanup activity could cause additional noise and disturbance to migrating bowheads. An oil spill during Nuiqsut's and Kaktovik's spring bowhead hunt could cause the whale harvest to be discontinued because bowheads could become unavailable and undesirable for use for up to 1 year. Barrow's bowhead-harvest area (SRAB) has a 4-percent chance of an oil-spill occurrence and contact; thus, it is not expected that Barrow's bowhead harvests will be substantially affected: bowheads could be periodically affected, but no apparent effects on the subsistence hunt would occur.

Yet, even the suspicion of tainting could be detrimental to the whale hunt, as Barrow whaler Daniel Leavitt testified at the public hearings for Beaufort Sea Sale 124 on April 17, 1990:

> . . .And if I should go out hunting, leaving my family with nothing to eat, and if I should catch something from the sea, like a sea mammal that has been taken in the oil spill, this thing that I caught to feed my family, when all the while when I left them there was nothing in the house for them to eat, and that's very bad. It really hurts me to think about it. (Beaufort Sea Sale 124 FEIS, USDOI, MMS, 1990)

Caleb Pungowiyi at Barrow stressed that even if effects may not seem significant, the emotional, spiritual, and cultural impact on local people is extreme. He continued: "Even when whales aren't caught, the *effort* has value unless that effort is hindered by manmade activity" (Kuvlum LOA Hearing Minutes, 1993).

Although a precedent has been set for curtailing a scientific catch of gray whales without evidence of oil-spill effects (during the 1969 Santa Barbara oil spill), this does not mean that NOAA would suspend the Native catch of bowheads in the event of an oil spill in the Beaufort Sea. There currently is much more information known about the effects of oil spills on whales (see Sec. IV.B.6). If evidence were produced to indicate that the bowhead whale population was affected by an oil spill, it is more likely that either the Alaska Eskimo Whaling Commission (AEWC), NOAA, or the International Whaling Commission would propose decreasing the quota; suspension is not likely because the whale-population count has been increasing (and should continue to increase during the 24-year life of the Sale 144 fields), and only lethal effects on a few bowheads—with population recovery in 1 to 3 years—are expected in the Sale 144 area (see Sec. IV.B.6).

Industrial activity is not expected to result in distributional changes in the bowhead population (Sec. IV.B.6). However, support vessels and platforms in the vicinity of the subsistence-harvest area could disturb the harvest without disturbing the general bowhead population. According to Burton Rexford, chairman of the Alaska Eskimo Whaling Commission: "Loud noises drive the animals away. . . . We know where whales can be found; when the oil industry comes into the area, the whales aren't there. It is *not* the ice; it is the noise" (Kuvlum LOA Hearing Minutes, 1993). Exploration drillships and their associated support activities are not likely to affect Barrow's (spring) bowhead whaling in the Sale 144 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 km (10-15 mi) offshore; and later in the spring, when the leads widen, Barrow whalers could travel an additional 25 km (16 mi) offshore to look for whales. Hattie Long (wife of former Barrow mayor Frank Long), Sadie Rexford, and Charlotte Brower, all wives of Barrow whalers, expressed the concern that whale meat can be lost from spoiling when whalers are forced by oil-industry operation to hunt whales outside of their normal whaling areas and then must tow whales back to the community over longer-than-normal distances for butchering (Kuvlum LOA Hearing Minutes, 1993). Former Barrow mayor Jeslie Kaleak relates: "It takes longer to tow a whale back to the village when it must be taken further away than usual, which means, more of the meat is spoiled" (Kuvlum LOA Hearing Minutes, 1993).

To mitigate such conflicts, the Beaufort Sea Sale 124 FEIS contained stipulations requiring industry to (1) monitor for bowheads during exploratory drilling and (2) consult with Native communities to ensure exploration and development and production operations are conducted to minimize any potential conflicts with the subsistence bowhead whale hunt. These same stipulations are expected to be in place for Sale 144. Also, NMFS incidental take regulations require industry to perform bowhead whale monitoring and to consult with subsistence whaling communities to minimize effects to the subsistence bowhead hunt. The MMS assumes these stipulations to be in effect if NMFS requirements are being met by industry.

In the Nuiqsut and Kaktovik subsistence areas, exploration drillships would be operating during the bowhead whale-hunting season. Noise from exploration drillships, bottom-founded exploration-drilling units, production platforms, support vessels, and icebreakers associated with the platforms could disrupt the whaling effort. If a vessel or rig were in the path of a whale chase, it could cause that particular harvest to be unsuccessful. Herman Aishanna, former mayor of Kaktovik and head of the community's Whaling Captains' Association, maintains that in 1985 when the SSDC was present in the area it did affect the whale subsistence hunt, even though it was idle. He affirms: "We got no whales that year" (Kuvlum LOA Hearing Minutes, 1993). Noise from icebreakers moving through the whale-harvest area also could contribute to an unsuccessful harvest. Icebreakers could be sent to the Sale 144 area prior to the open-water season during the spring bowhead whale migration (beginning mid-April [see Sec. III.C.3]) and the whale-hunting season. Barrow 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 bowheads react to vessel-engine noise, although disruption is likely to be short term and temporary (Sec. IV.B.6). Such disturbance would most likely be short term and temporary enough that, during a normal whaling season of about 2 months' duration, there would be ample 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 brief periods when harvesting a whale is possible. Edward Itta, president of the Barrow Whaling Captains' Association, has stated that: "The impacts of seismic are what we know as a fact. We're always asked to prove our knowledge and never industry. More credit must be given to the knowledge we have collected over many, many years" (Kuvlum LOA Hearing Minutes, 1993).

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 avoided with consultation by industry and affected Native communities as stipulated in Sale 144 mitigation measures. Because 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 in 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. 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 interested in conducting geophysical studies and exploration-drilling activities in the Beaufort Sea. This program was approved through a Memorandum of Understanding between 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 for 2 years; however, it has been discontinued due to difficulties with communication systems and equipment. Presently, MMS and NMFS require individual companies to coordinate with subsistence whalers, and a plan for cooperation must be submitted as a part of their exploration plan.

During the development and production phase, construction of offshore pipeline landfalls at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point could disturb Nuiqsut's bowhead whale harvest. The landfall at the point about 32 km (20 mi) east of Bullen Point, approximately 80 km (50 mi) from Kaktovik, is outside of the Kaktovik whale-harvest area (see Fig. III.C.3-2), but Flaxman Island, the area most commonly used by Nuiqsut hunters for their base camp for hunting bowhead whales, is directly offshore of the landfall. A landfall there would concentrate noise and traffic disturbance in this harvest area. It is likely that construction activities would begin after the onset of the open-water season and would end during or after the fall whale migration; this analysis assumes that such activities would occur during the whaling season. Bowhead whales' sensitivity to stationary noise and boat-traffic disturbance from construction activities (which would occur over a period of 2 years), probably would result in only periodic and short-term avoidance (see Sec. IV.B.6). Therefore, Nuiqsut's bowhead whale harvest would not become locally unavailable or reduced in harvest numbers. The same effects level applies to Barrow and Kaktovik bowhead whale subsistence-harvest areas.

(2) Belukha Whales: Coastal communities in the Sale 144 area depend on belukhas much less than other marine resources, primarily because these communities are able to harvest the bowhead whale, which is a preferred food (see Sec. III.C.3; see Fig. III.C.3-3 for harvest areas). In a subsistence study in Barrow from 1987 to 1989, no belukha whale harvests were recorded (Stephen R. Braund and Associates, 1989a). However, during years when a bowhead is not harvested or the harvest is decreased, other marine resources, including belukhas, become more crucial to compensate for the lost bowhead harvest. Belukha whales are sometimes harvested in Barrow 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.

Biological effects on belukha whales (Sec. IV.B.5) from oil spills associated with Sale 144 are not expected to be significant on belukha whale distribution and abundance. Although oil spills are not likely to affect belukha whales, even if they were oiled or ingested oil, the belukhas likely would be rendered inedible or be perceived as such and consequently would be unharvestable. The harvest also could be hindered by oil-spill-cleanup efforts if cleanup were conducted during the harvest. The belukha hunting season in Barrow lasts from the beginning of the bowhead whaling season (late March) until August; consequently, an oil spill most likely would not eliminate the entire belukha hunting season. Although belukha whales would not become unavailable, the Barrow belukha harvest could be affected for a period of <1 year. During the past 20 years, Barrow has annually harvested only an estimated five belukhas (estimated 0.5% of their total annual subsistence harvest [Table III.C.3-4]). However, if the whalers could not harvest a bowhead, they would most likely actively hunt belukhas. The Barrow belukha harvest (SRAB) has a 4-percent chance of being affected by an oil spill in winter and during the open-water season. The higher chance of spills occurring and contacting Nuiqsut's and Kaktovik's SRA's C and D (68% and 63%, respectively) indicate that effects on their belukha harvests would be higher. A spill could eliminate an entire belukha harvest season for up to 1 year, but because of low harvest dependence on belukhas, overall effects on the subsistence harvest would not be high.

Belukha whales are not as likely as bowhead whales to avoid industrial activities in the Arctic. Although belukha whales can react to active icebreaker noise 35 to 50 km (22-31 mi) away from the source (Sec. IV.B.5), it is not anticipated that this reaction to noise would cause interference to the belukha whale harvests. Disruptions are most likely to be short term and are not expected to affect harvest levels. In the early summer, belukhas are harvested in the pack-ice leads. Vessels, other than icebreakers, probably would not be in the leads at that time because moving ice makes it is too dangerous; however, icebreakers or platforms in the area could cause disturbance (Sec. IV.B.5). Because the belukha hunting season for Barrow, Nuiqsut, and Kaktovik 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 during the belukha hunting season.

During construction of landfall facilities at Oliktok Point and a point about 32 km (20 mi) east of Bullen Point and construction of an offshore pipeline from drilling platforms to these facilities, the belukha whale hunt might be disturbed by construction noise. Because these areas are not areas of intensive belukha whale hunting, however, noise would result only in short-term, local displacement, causing no apparent effects on the belukha whale harvests of Barrow, Nuiqsut, and Kaktovik.

(3) Caribou: Caribou, the largest source of meat for the communities adjacent to the Sale 144 area, contribute an estimated 16 to 90 percent of the subsistence diets of Barrow, Nuiqsut, and Kaktovik. Annual harvest levels (averaged from 1962-1982) were 3,500 in Barrow (1,523 in 1988-1989); 400 in Nuiqsut (513 in 1985); and 75 in Kaktovik (158 in 1992). The Atqasuk harvest is not reported (see Sec. III.C.2 [Table III.C.3-3]; see Fig. III-C-9 for harvest areas). Atqasuk and Barrow harvest caribou from the Western Arctic herd; and Nuiqsut, Kaktovik, and Barrow harvest caribou from the Central Arctic herd. Caribou that move to barrier islands and shallow coastal waters in summer could become oiled or could ingest contaminated vegetation; but because only a small number of animals (a few hundred to a thousand) are likely to be involved, biological effects on the overall caribou population would be insignificant (Sec. IV.B.7); therefore, effects on the subsistence harvest of caribou in the communities near the Sale 144 area as a result of oil spills are expected to be insignificant as well. Similar effects to the Teshekpuk and Porcupine Caribou herds are expected. An oil spill from onshore pipelines connecting to landfalls at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point would contaminate tundra vegetation. However, onshore oil spills are expected to have minimal biological effects on caribou because they are very selective grazers and would move to other areas to graze if tundra habitat were contaminated (see Sec. IV.B.7). Effects would be localized and are not expected to significantly contaminate or alter caribou range within the pipeline corridor.

Noise- and vehicle-traffic-disturbance effects on caribou are more likely to occur as a result of construction of the onshore pipeline projected to carry oil from Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point to TAPS Pump Station No.1, as well as the associated support road. Effects also would 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.7 concludes that some biological effects on caribou from disturbance associated with noise and vehicle traffic, causing short-term delays in caribou movements near roadways and construction areas; however, recent research indicates that local distribution of a small percentage of caribou (5%) on their summer range could result from vehicle-traffic disturbance but overall caribou abundance and distribution would not be affected (see Sec. IV.B.7). Also, vehicle traffic would be controlled by permit and diminish after construction activities were completed.

An onshore pipeline could create a physical barrier to subsistence access that could make Barrow, Atqasuk, Nuiqsut, and Kaktovik hunters' pursuit of caribou more difficult (Kruse et al., 1983). But because arctic pipelines are constructed to allow for the passage of caribou, the pipeline corridor would pose no major problems to migration. During construction, caribou movement could be temporarily blocked and crossings might be slower; but successful crossing still would occur (see Sec. IV.B.7). Although traffic associated with a support road might serve as a temporary barrier to cow/calf movements, it would not block migration movements. The mere physical presence of pipelines, support roads, and associated facilities probably would cause no more than temporary interference with caribou movements and distribution (see Sec. IV.B.7). Development of the pipeline corridor would increase hunter access to the Western and Central Arctic caribou herds and thus increase pressure on the population, but current regulation of the harvest and of road access should prevent overhunting. There also may be some disturbance from aircraft surveillance of the pipeline, but this would cause only 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.7). Also to be noted is the disturbance to caribou from scientific study noted by Noah Itta in 1993 public testimony, where he related having to kill a caribou that was suffering from rubbing the hair and skin off its legs trying to get free of a radio collar (Kuvlum LOA Hearing Minutes, 1993). Periodic disruptions from pipeline construction and placement would have no lasting effects on subsistence caribou harvests in Barrow, Atqasuk, Nuiqsut, and Kaktovik.

(4) Fishes: 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 communities adjacent to the Sale 144 area, fish provide an estimated 6.6 to 21.7 percent of the total annual subsistence harvest (Table III.C.3-3; see Fig. III.C.3-7 for harvest areas). However, there currently are no data on proportions of specific fish species harvested. A rough estimate of total kilograms of fishes harvested annually is 27,955 kg (6.6% of total harvest) in Barrow; 32.095 kg (44.1% of total harvest) in Nuiqsut; and 7,045 kg (21.7% of total harvest) in Kaktovik (Table III.C.3-1, ACI/Braund, 1984; ADF&G, 1993a,b; Stephen R. Braund, 1993b). No data are available for Atqasuk. The nearshore areas of the Beaufort, particularly the fish-overwintering areas in and near the major river estuaries in the Barrow, Nuiqsut, and Kaktovik SRA's, would be the most sensitive to the effects of the base case. The 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 would be lethal to a small portion of the fish populations (especially anadromous fish) that could affect several generations (Sec. IV.B.3).

The high combined probability of an oil spill occurring in Nuiqsut and Kaktovik SRA's indicates that it is likely that an oil spill would affect the subsistence harvest of fishes in these areas. There is a diversity of fishes harvested (capelin, char, cod, grayling, salmon, sculpin, trout, ling cod, rainbow smelt, Bering and least ciscoes, flounder, saffron cod, Pacific herring, and tomcod) and large harvest areas involved (fish are harvested along most of the Beaufort Sea coast near the communities and along all major rivers [see Sec. III.B.3 and Fig. III.C.3-7]), yet each community's fishing area is localized. In Nuiqsut, traditional knowledge indicates fishing to be more locally confined: ". . .all the animals, fish and seals, come up the Colville River from the ocean and we use them for food. The fish never come from inland; they come from the ocean" (Sarah Kunaknana, in Shapiro and Metzner, 1979). Fishes in subsistence fish resources in Nuiqsut and Kaktovik would be affected for <1 year and no fish resources would be unavailable, undesirable for use, or greatly reduced in harvest numbers.

If a large oil spill occurred and contacted the Barrow subsistence-harvest area, effects on fish-subsistence harvests could render subsistence fish resources undesirable, not only because of the biological consequences (see Sec. IV.B.3) but also due to a fear of tainting (Ellanna, 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 fishes in the Barrow or Kaktovik areas were oiled, fishing probably would continue in a wide area (see Fig. III.C.3-7), and the overall harvest levels would not be affected. Barrow residents harvest marine fishes from Peard Bay to Pitt Point. Peak harvest periods occur from September through October, although fishing occurs all summer and fall. The variety of fishes harvested as well as the number of different areas and the longer season for harvesting fishes would enable Barrow residents to harvest other subsistence fishes, or the same fishes in other areas, if an oil spill contacted the Barrow subsistence-harvest area, but any alteration that caused hunting in nontraditional areas to occur could cause disruption to subsistence harvests. Effects from oil spills associated with Sale 144 on the Barrow fish-subsistence harvest are expected to be affect fish resources for <1 year and render no resources unavailable or undesirable for use.

Noise and disturbance are expected to have insignificant effects on subsistence-fish stocks (see Sec. IV.B.3). Disturbance from seismic activity associated with Sale 144 would occur <5 km (3 mi) from subsistence-fishing areas, and boat noise would have only transitory effects on fishes. While some access problems may arise due to the placement of onshore facilities at Oliktok Point and a point about 32 km (20 mi) east of Bullen Point, harvest pressures are not expected to increase significantly. Effects from noise and disturbance and construction activities associated with Sale 144 might periodically affect fish resources, but there would be no apparent effects on subsistence harvests.

(5) Seals: Bearded and hair seals comprise between 11.5 and 16.7 percent, respectively, of the total subsistence-resource harvests for the communities in the Sale 144 area (Sec. III.B.3 [Table III.C.3-3]; see Fig. III.C.3-5 for harvest areas). Bearded seals comprised (over a 20-year average) 2.9 percent (150 seals) of Barrow's total harvest; 7.4 percent (30 seals) of Kaktovik's; and in 1985, seals comprised 2.7 percent (57 seals) of Nuiqsut's total subsistence harvest. No information on seals is available for Atqasuk. Hair seals comprise 4.3 percent (955 seals) of Barrow's total harvest; 4.7 percent (70 seals) of Kaktovik's total harvest; and in 1985, 42 hair seals represented 1 percent of Nuiqsut's total harvest (see Table III.C.3-3).

Section IV.B.5 concludes that as a result of Sale 144, 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 likely would be rendered inedible or perceived as such and consequently would be unharvestable. Oil-spill effects are most likely to occur in the Nuiqsut and Kaktovik seal-harvesting areas. Barrow would experience lesser effects due to the low probabilities of an oil spill occurring and contacting SRAB. One overriding mitigating factor is that seal harvests occur over a longer period of time (harvests are possible during the entire year [see Sec. III.C.3]) than harvests of other subsistence resources. However, the potential effects on seals from an oil spill associated with Sale 144 could cause harvesters to hunt longer or take extra trips. This might create 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, but industrial activity associated with Sale 144 is not expected to result in distributional changes in seal populations (Sec. IV.B.5). Nuiqsut whaling captain Frank Long, Jr., has stated that oil-industry activity offshore has not only affected whales but seals and birds as well (Kuvlum LOA Hearing Minutes, 1993). Others have stated that they don't hunt near Prudhoe Bay anymore because of oil development (Sarah Kunaknana, in Shapiro and Metzner, 1979). Disturbance from aircraft or vessels used in exploration and development and production 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. Such localized, short-term effects on seal harvests due to noise and traffic disturbance are expected in the Barrow, Nuiqsut, and Kaktovik SRA's (SRAB, SRAC, and SRAD).

Onshore development for offshore-pipeline landfalls at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point could disturb the hunting of ringed, spotted, and bearded seals by Nuiqsut and Kaktovik residents. Flaxman Island, nearby the point about 20 mi east of Bullen Point, is an important area for Nuiqsut and Kaktovik spotted, ringed, and bearded seal harvests. The area in the vicinity of Oliktok Point also is an important area for Nuiqsut seal harvests. Landfalls at Oliktok Point, Point McIntyre, and the point about 20 mi east of Bullen Point would concentrate noise and disturbance in these harvest areas. If construction occurred during peak harvest periods (June and July), the harvests of bearded and ringed seals could be affected in the Nuiqsut and Kaktovik SRA's. However, the long seal-harvest period would enable residents to harvest seals during other times of the year. Effects on Barrow, Nuiqsut, and Kaktovik seal harvests could be expected as a result of Sale 144-related construction activities at Oliktok Point, Point McIntyre, and a point about 20 miles east of Bullen Point that would last for < 1 year, rendering no subsistence seal resource unavailable, undesirable for use, or greatly reduced in numbers.

(6) Walruses: In Barrow, walruses comprise <4.6 percent (55 walruses) of the total annual subsistence harvest (see Table III.C.3-3]); no data are available for Nuiqsut, and walruses are rarely seen as far east as Kaktovik. Section IV.B.5 concludes that several hundred walruses could die from oil contamination as a result of oil spills associated with Sale 144, but this loss is likely to be replaced by natural recruitment in one generation. Walruses that were oiled likely would be rendered inedible or perceived as such and consequently would be unharvestable. Barrow's SRA (SRAB) has a 4-percent chance of being contacted by one or more oil spills ≥1,000 bbl. Walrus hunting is concentrated in SRAB 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 would result in walruses becoming locally unavailable for not more than 1 year. Similar effects would occur on the walrus harvests in Nuiqsut and Kaktovik due to an oil spill occurring and contacting SRAC and SRAD (67% and 63% chances, respectively) because although the percent chance of spill contact is greater, the dependence on the harvest of walrus in these communities is much smaller.

Noise and disturbance generally do not affect walrus-distribution patterns (Sec. IV.B.5); 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. Effects on walruses due to noise and disturbance are expected in the Barrow (Atqasuk), and Nuiqsut, and Kaktovik SRA's, but no apparent effects on subsistence harvests would occur.

Construction of offshore pipelines to landfalls at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point would concentrate noise and traffic disturbance in these areas; however, none of these areas generally are locations of walrus harvests. Disturbance and displacement from construction activities associated with Sale 144 on walrus hunting Nuiqsut and Kaktovik SRA's would be short term. In Barrow (Atqasuk), where landfall and pipeline construction is not a factor, there would be no apparent disturbance to walrus harvests.

(7) ***Birds:*** Waterfowl are considered an important subsistence resource, not because of the quantity of meat harvested (Table III.C.3-3) or the time spent hunting them (see Sec. III.C.3), but because of their dietary importance during spring and summer and because they are a preferred food. Waterfowl comprised <3 percent of the total annual subsistence harvest over the 20-year period 1962-1982 (0.9% or 3,636 kg of meat in Barrow; 0.4% or 136 kg of meat in Kaktovik; in 1985, waterfowl comprised 5 percent of Nuiqsut's total subsistence harvest; no data are available for Atqasuk [Table III.C.3-3]).

According to Section IV.B.4, if an oil spill occurred during breakup or the open-water season, the seasons when bird hunting takes place, it likely would have immediate effects on birds. Eiders and oldsquaw (both subsistence species) would be the most likely to suffer direct mortality; brant and other waterfowl could be harmed indirectly through contamination of saltmarshes.

The probability of one or more spills occurring and contacting SRA's C and D within 30 days for both the winter and open-water seasons is quite high (68% and 63%, respectively). Because most eider hunting occurs on the oceans and along the coasts during two spring months, and most brant hunting occurs along the coasts during two fall months, the probability that an oil spill could affect subsistence-bird hunting is quite high. Also, 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 Barrow (SRAB), Nuiqsut (SRAC), or Kaktovik (SRAD) bird-hunting areas, birds would become unavailable. However, it is not likely that the entire subsistence-bird harvest would be affected. Effects from oil spills would affect Barrow, Nuiqsut, and Kaktovik subsistence-bird harvests for a period up to 1 year, but no subsistence-bird resource would be significantly reduced.

Noise caused by construction of both offshore and onshore oil facilities could disturb waterfowl-feeding and waterfowl-nesting activities. Construction of offshore pipelines also could 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 144 area. Effects on all bird harvests in the Sale 144 area from noise and traffic disturbance and from construction activities are expected to be periodic, short term, and have no apparent effect on subsistence harvests.

(8) ***Polar Bears:*** Polar bears contributed <1 percent to the total annual subsistence harvest for community residents near the Sale 144 area during the 20-year period from 1962 to 1982 (0.4% or 7 bears in Barrow; 2.8% or 4 bears in Kaktovik; 0.1% or 1 bear in Nuiqsut; no data are available for Atqasuk [see Table III.C.3-3 and Sec. III.C.3]). In Barrow, 11 bears were taken in the 1988 to 1989 harvest period (1.3% of total harvest), and 0 were taken in Nuiqsut in 1985. In Kaktovik, 1 bear was taken in 1986 (1% of total harvest), and 2 bears both in 1987 and 1992 (1.4% and 0.7% of total harvest, respectively) (Braund, 1989a; ADF&G, 1993a,b). Section IV.B.5 concludes that oil spills could cause some contamination of seals (polar bear prey), loss of subsistence, and the loss of some of one season's young in affected areas. Prey contamination also could cause some mortality in the polar bear population. Twenty to 30 bears could be contaminated by an oil spill along the ice-flaw zone from north of Camden Bay to Cape Halkett and offshore of Point Barrow, an area including the polar bear-harvest areas of Barrow, Nuiqsut, and Kaktovik. These 20 to 30 bears would all die; and while annual recruitment probably would replace this lost portion of the population in less than one generation (see Sec. IV.B.5), the loss could affect the number of bears available to any coastal communities. The polar bear harvest occurs year-round; and while the effects that could occur on polar bears from an oil spill associated with Sale 144 could cause residents to hunt longer or take extra trips, these effects would not reduce harvests for an entire year. Effects from oil spills related to Sale 144 would affect polar bear harvests in Barrow, Nuiqsut, and Kaktovik for a period not exceeding 1 year, and polar bears would not become unavailable for use.

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. Effects due to noise and traffic disturbance on polar bear harvests in Barrow, Nuiqsut, and Kaktovik would affect harvests for up to 1 year, but polar bears would not become unavailable. Barrow, Nuiqsut, and Kaktovik polar bear harvests could be temporarily disturbed by construction activities at Oliktok and the point about 32 km (20 mi) east of Bullen Point, but effects would be short term.

c. *Effects on Subsistence Resources by Community:*

The following discussion summarizes the preceding section by community; see Sections IV.C.10.b(1) through (8) for the complete analysis.

(1) Barrow (Atqasuk):

A major portion of Barrow's marine subsistence-harvest area lies within the Sale 144 area. An oil spill could affect the availability of bowheads for Barrow's spring or fall whaling for no more than 1 year. Oil spills are unlikely to have long-term biological effects on bowhead whales, belukha whales, seals, walruses, polar bears, caribou, or fishes and would not make these resources unavailable, undesirable for use, or greatly reduced in number for overall subsistence harvests. While an oil spill also could make some waterfowl locally unavailable for 1 year, the large numbers of waterfowl harvested in a large area, in addition to harvests occurring in both the spring and the fall, might work against decreases in waterfowl harvests.

Localized, short-term effects from noise and disturbance are not expected to have long-term biological consequences on bowhead whales. Disturbance from such activities is not likely to occur to the extent that no whales are harvested for more than one season in Barrow because there are more bowheads harvested in Barrow than in any other community (7 in 1988, 11 in 1989, and 22 in 1992). Belukha whales also may be sensitive to noise and traffic disturbance; however, like the harvests of seals and polar bears, the harvests of belukhas occur over a longer time period and in a larger geographical range. For these reasons, belukha whales, seals, walruses, and polar bears could be affected by these effect-causing agents for periods <1 year, but these resources are not likely to be made unavailable. Construction activities are not likely to greatly affect Barrow's subsistence harvests.

Conclusion: In the base case, effects from the proposed lease sale on Barrow's (Atqasuk's) subsistence-harvest patterns could render one or more important subsistence resources unavailable, undesirable for use, or greatly reduced in numbers for a period not exceeding 1 year.

(2) Nuiqsut:

Nuiqsut's entire marine-subsistence harvests occur within the proposed Sale 144 area. In the immediate vicinity of Nuiqsut, there is a high probability of an oil spill occurring and contacting the Nuiqsut SRAC (68%). The OSRA estimated conditional probabilities range from 14 percent to 94 percent that a spill $\geq 1,000$ bbl would contact SRAC within 30 days during winter, assuming the spill originated from Launch Areas L8 through L16 and from 4 percent to >99.5 percent assuming a spill originated from Pipeline Segments P4 through P12. The estimated conditional probabilities range from 9 percent to 90 percent of a spill $\geq 1,000$ bbl contacting SRAC within 30 days during summer, assuming the spill originated from the same Launch Areas and 2 percent to >99.5 percent assuming the same Pipeline Segments. Effects from oil spills could cause Nuiqsut residents to travel longer distances to harvest marine mammals or to harvest bowheads in areas closer to Kaktovik. The high probability of an oil spill contacting Nuiqsut's harvest areas in the winter and open-water seasons is likely to have effects on the harvests of bowhead and belukha whales, seals, walruses, polar bears, caribou, and fishes that could make one or more of these subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period up to 1 year.

Localized, short-term effects from noise and disturbance are not expected to have long-term biological consequences on bowhead whales and belukha whales or on the availability of seals, walruses, caribou, fishes, polar bears, and birds.

Under the base-case scenario, landfalls are suggested at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point. The landfalls at Oliktok Point and Point McIntyre are nearby Flaxman Island, the primary location for Nuiqsut bowhead whale harvests. Construction activities could cause some short-term avoidance of the area but probably would not force Nuiqsut whalers to travel out of their traditional bowhead whaling grounds; therefore, construction activities at Oliktok Point and Point McIntyre are likely to cause short-term effects on Nuiqsut subsistence resources with no apparent effects on subsistence harvests.

Conclusion: In the base case, effects from the proposed lease sale on Nuiqsut subsistence-harvest patterns could render one or more important subsistence resources unavailable, undesirable for use, or greatly reduced in numbers for a period not exceeding 1 year.

(3) *Kaktovik:* Kaktovik's entire marine-subsistence-harvest area lies within the proposed Sale 144 area. In the vicinity of Kaktovik, there is a high probability of an oil spill occurring and contacting the Kaktovik SRAD (63%). The OSRA estimated conditional probabilities range from <.5 percent to >99.5 percent of a spill ≥1,000 bbl contacting SRAD within 30 days during winter, assuming the spill originated from Launch Areas L8 through L16 and from 7.5 percent to >99.5 percent, assuming a spill originated from Pipeline Segments P4 through P12. The estimated conditional probabilities range from 6 percent to >99.5 percent of a spill ≥1,000 bbl contacting SRAD within 30 days during summer, assuming a spill originated from the same Launch Areas and 7 percent to >99.5 percent assuming the same Pipeline Segments. The high probability of an oil spill contacting Kaktovik's SRAD in the winter and open-water seasons would have effects on the harvests of bowhead and belukha whales, seals, walruses, polar bears, caribou, and fishes that could make one or more of these subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of up to 1 year.

During exploration and development, noise from support vessels could disrupt whaling at Kaktovik, but such a disruption would not make bowheads locally unavailable. Belukha whales may be sensitive to noise and traffic disturbance; however, like the harvests of seals and polar bears, the harvests of belukhas occur over a longer time period and in a larger geographical range. For this reason, neither are belukha whales, seals, walruses, and polar bears likely to be made unavailable.

Noise and traffic along the onshore-pipeline corridor could disturb caribou and cause temporary disruption of caribou harvests, but such disruptions would not make caribou unavailable. Effects on caribou harvests are most likely to occur from the placement of landfall facilities and pipelines. Construction of a landfall at a point about 32 km (20 mi) east of Bullen Point and a pipeline from the same location to TAPS could locally reduce the availability of caribou for <1 year for some areas harvested by Kaktovik, but this would not cause the harvest to be unavailable. Construction activities should not affect other harvests in Kaktovik's subsistence-harvest area.

Conclusion: In the base case, effects from the proposed lease sale on Kaktovik's subsistence- harvest patterns could render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year.

Summary: Effects on the subsistence-harvest patterns of the communities in the Sale 144 area would occur as a result of oil spills, noise and disturbance, and construction activities. The Sale 144 area includes the eastern portion of the marine-subsistence-resource area of Barrow (also used by Atqasuk residents) and the entire marine-subsistence-resource areas of Nuiqsut and Kaktovik. If economically recoverable amounts of oil were discovered, landfalls, onshore pipelines, and roads associated with oil development could affect the terrestrial-subsistence resources harvested by the three coastal Inupiat communities of Barrow, Nuiqsut, and Kaktovik, as well as the inland community of Atqasuk.

Access to subsistence resources, subsistence hunting, and the use of subsistence resources could be affected by reductions to subsistence resources and changes to subsistence-resource-distribution patterns. These changes could result from oil spills, noise and disturbance, and construction activities. Major factors considered in the effects analysis of subsistence-harvest patterns of the communities of Barrow, Atqasuk, Nuiqsut, and Kaktovik are: (1) heavy reliance on caribou, bowhead whales, and fishes in the annual average harvest; (2) the overlap of subsistence-hunting ranges for many species harvested by the four Native communities; and (3) subsistence hunting and fishing as central cultural values in the Inupiat way of life.

In terms of oil-spill effects, the OSRA estimates only a 4-percent chance of one or more oil spills of ≥1,000 bbl occurring and contacting SRAB (Barrow's subsistence-resource area) within 30 days during the winter and open-water seasons. Contrastingly, the OSRA estimates a 68-percent chance of one or more spills occurring and contacting SRAC (Nuiqsut's subsistence-resource area) and a 63-percent chance of one or more spills occurring and contacting SRAD (Kaktovik's subsistence-resource area). Spills occurring during the winter season could affect sealing and polar bear hunting. In spring, sealing, whaling, and bird hunting could be affected. In the open-water season, sealing, whaling, walrus hunting, and bird hunting could be impacted.

In Barrow, oil spills are unlikely to have long-term biological effects on bowhead whales, belukha whales, seals, walruses, polar bears, caribou, or fishes and would not make these resources unavailable, undesirable for use, or greatly reduced in numbers for overall subsistence harvests. While an oil spill also could make some waterfowl locally unavailable for 1 year, the large numbers of waterfowl harvested in a large area, in addition to harvests occurring in both the spring and the fall, might work against decreases in waterfowl harvests. Effects from oil spills could cause Nuiqsut residents to travel longer distances to harvest marine mammals or to harvest bowheads in areas closer to Kaktovik. The high probability of an oil spill contacting Nuiqsut's harvest areas in the winter and open-water seasons is likely to have effects on the harvests of bowhead and belukha whales, seals, walruses, polar bears, caribou, and fishes that could make one or more of these subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period up to 1 year. The high probability of an oil spill contacting Kaktovik's harvest areas in the winter and open-water seasons would have effects on the harvests of bowhead and belukha whales, seals, walruses, polar bears, caribou, and fishes that could make one or more of these subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of up to 1 year.

Noise and disturbance effects could result from (1) seismic-survey activities; (2) the movement, installation, and operation of drilling and production platforms; (3) the trenching and laying of offshore pipeline; (4) the construction of onshore pipelines and roads; (5) aircraft and marine support of the preceding activities; and (6) cleanup activities in the event of an oil spill. Anticipated activities for the base case would be the drilling of 22 exploration and delineation wells, weekly supply-boat trips, and one daily helicopter flight per day per platform. Eight production platforms with trunk pipelines would be installed; they would be serviced by twice-weekly helicopter flights per platform during production. Production pipelines would have landfalls at Oliktok Point, Point McIntyre, and a point 32 km (20 mi) east of Bullen Point. Onshore pipelines totalling 168 km (104 mi) would be constructed. Noise and disturbance could cause temporary disruptions to subsistence species' feeding and migration patterns.

In Barrow, localized, short-term effects from noise and disturbance are not expected to have long-term biological consequences on bowhead whales. Belukha whales also may be sensitive to noise and traffic disturbance; however, like the harvests of seals and polar bears, the harvest of belukhas occurs over a longer time period and in a larger geographical range. For these reasons, belukha whales, seals, walruses, and polar bears could be affected by these effect-causing agents for periods <1 year, but they are not likely to be made unavailable. In Nuiqsut, localized, short-term effects from noise and disturbance are not expected to have long-term biological consequences on bowhead whales and belukha whales or on the availability of seals, walruses, caribou, fishes, polar bears, and birds, even though according to Billy Oyagak, former Nuiqsut Whaling Captains' Association president, Nuiqsut whalers have experience with supply and support vessels interfering with the whale migration (Kuvlum LOA Hearing Minutes, 1993). In Kaktovik, during exploration and development, noise from support vessels could disrupt whaling, and local Kaktovik residents believe that noise is a disrupting factor (Herman Aishanna, in Kuvlum LOA Hearing Minutes, 1993), but such a disruption would not make bowheads locally unavailable. Belukha whales may be sensitive to noise and traffic disturbance; however, like the harvests of seals and polar bears, the harvest of belukhas occurs over a longer time period and in a larger geographical range; therefore, belukha whales, seals, walruses, and polar bears are not likely to be made unavailable.

Effects from construction activities would occur from (1) the installation of drilling units and platform, (2) the laying of offshore pipelines, and (3) onshore pipeline and road construction. Construction activities could cause periodic disturbance to the feeding and migration patterns of subsistence species and cause access problems for Native subsistence hunters.

Construction activities are not likely to greatly affect Barrow's subsistence harvests. In Nuiqsut, under the base-case scenario, landfalls are suggested at Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point. The landfalls at Oliktok Point and Point McIntyre are nearby Flaxman Island, the primary location for Nuiqsut bowhead whale harvests. Construction activities could cause some short-term avoidance of the area but probably would not force Nuiqsut whalers to travel out of their traditional bowhead whaling grounds; therefore, construction activities at Oliktok Point and Point McIntyre are likely to cause short-term effects on Nuiqsut subsistence resources with no apparent effects on subsistence harvests. In Kaktovik, effects on caribou harvests are most likely to occur from the placement of landfall facilities and pipelines. Construction of a landfall at a point about 32 km (20 mi) east of Bullen Point and a pipeline from the same location to TAPS could locally reduce the availability of caribou for <1 year for some areas harvested by Kaktovik, but this would not cause the harvest to become unavailable. Construction activities should not affect other harvests in Kaktovik's subsistence-harvest area.

Inupiat subsistence hunters believe that any effects to subsistence harvests, particularly the bowhead whale but also including seals, birds, and caribou as well, would have significant impacts on subsistence harvests. Resources tainted from the effects of an oil spill, from seismic activity, and from supply and support vessel noise would reduce hunters' abilities to harvest and in this way contribute to cultural stress (Beaufort Sea Sale 124 FEIS, USDOI, MMS, 1990). As Caleb Pungowiyi has stated "Even when whales aren't caught, the effort has value unless the effort is hindered by man-made activity" (Kuvlum LOA Hearing Minutes, 1993). Of major concern are the effects from seismic activity, that is perceived by Inupiat whalers as clearly disturbing normal bowhead behavior. Furthermore, such activity forces whalers to range outside of their normal whaling areas, thereby creating longer tows of whales back to the communitities for butchering. Generally, subsistence hunters are disappointed that their own indigenous knowledge of subsistence species and practices--gathered over generations of observation--are not acknowledged more by State and Federal agencies that manage onshore and offshore resources on the North Slope (Kuvlum LOA Hearing Minutes, 1993; Shapiro and Metzner, 1970).

Effectiveness of Mitigating Measures: Mitigating measures are assumed to be in place for the base-case analysis, and base-case-effects levels reflect this assumption. Mitigation that would apply to subsistence-harvest patterns includes the Orientation Program stipulation, the Industry Site-Specific Bowhead Whale-Monitoring Program stipulation, and the stipulation on Subsistence Whaling and Other Subsistence Activities. The Orientation Program stipulation requires the lessee to conduct a program that educates personnel working on exploration or development and production activities about the environmental, social, and cultural concerns that relate to the area and area communities. The program is expected to increase personnel sensitivity and understanding of local Native community values, customs, and lifestyles and to prevent any conflicts with subsistence activities. The Industry Site-Specific Bowhead Whale-Monitoring Program stipulation requires a site-specific monitoring program during exploratory drilling to determine if bowhead whales are present in the vicinity and to assess the behavioral effects on bowheads from these activities. If the lessee holds a NMFS Letter of Authorization for incidental, nonlethal taking of bowhead whales for exploratory drilling, no additional MMS plan is needed. The stipulation on Subsistence Whaling and Other Subsistence Activities requires lessees to conduct all exploration, development, and production in a manner that minimizes any potential conflicts with subsistence activities, especially the bowhead whale hunt. This stipulation requires the lessee to contact potentially affected Native communities and the Eskimo Whaling Commission to discuss possible siting and timing conflicts and to assure that exploration, development, and production activities are compatible with subsistence whaling and do not result in interference with other subsistence harvests.

The Orientation Program, Industry Site-Specific Bowhead Whale-Monitoring Program, and Subsistence Whaling and Other Subsistence Activities stipulations would serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices. If these mitigation measures were not in place, increased disturbance effects would not raise overall effects levels above those already assessed for the base case.

Conclusion: The effects of the Sale 144 base case on subsistence-harvest patterns in Nuiqsut and Kaktovik are expected to render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Effects on the bowhead whale harvest would be expected, causing disruptions on overall subsistence harvests lasting up to 3 years. In Barrow (Atqasuk), effects from the Sale 144 base case are expected to affect subsistence resources for a period not exceeding 1 year and make no resource unavailable, undesirable for use, or greatly reduced in number. Overall effects on subsistence-harvest patterns from the Sale 144 base case as a result of oil spills, noise and disturbance, and construction activities would render one or more important subsistence resources unavailable, undesirable for use, or reduced in available numbers for a period of 1 to 2 years.

11. Archaeological Resources: The Prehistoric Resource Analysis discussion included in Section III.C.4 concludes that there is little potential for prehistoric archaeological sites to occur within the Sale 144 area; therefore, there should be no effect to prehistoric archaeological resources on the OCS as a result of this lease sale.

Under the base case of the proposal, the greatest effects on shipwreck sites would result from any bottom- disturbing activity, such as pipeline construction, platform installation, or the anchor pattern from drilling vessels. The 14 known shipwrecks within the Sale 144 area were derived from literature sources and have not yet been ground-truthed (see Table III.C.4); therefore, the precise locations of these shipwrecks are uncertain. Regulations at 30 CFR 250.26

replace the former Archaeological Lease Stipulation and allow the Regional Director to require that an archaeological report based on geophysical data be prepared if there are indications that a significant archaeological resource may be present within a lease area. Because the locational information on the 14 known shipwrecks within the Sale 144 area is insufficient to assign the shipwrecks to specific lease blocks, the geophysical survey data from all blocks leased in this sale will be reviewed and an archaeological report will be prepared to address whether the data show any evidence of a shipwreck within a lease area. If the geophysical data do show evidence of a potential shipwreck within a lease area, MMS will require that the location of the potential shipwreck either be avoided by all lease activities or that further investigation be conducted to determine the identity of the seafloor object.

The greatest effects to onshore archaeological sites would be from accidental oil spills. The most important understanding obtained from past large oil-spill cleanups is that archaeological resources generally were not directly affected by the spilled oil (Bittner, 1993). The State University of New York at Binghamton conducted a study to evaluate the extent of petrochemical contamination of archaeological sites as a result of the EVOS (Dekin, 1993). The study concluded that the three main types of damage to archaeological deposits were oiling, vandalism, and erosion. However, data from the EVOS indicate that <3 percent of the resources within a spill would be significantly affected.

Following the EVOS, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. This type of damage increases as the population and activities increase during the cleanup process. Direct physical disturbance of archaeological sites during cleanup work also was identified as an effect-causing factor. However, the effects of the EVOS cleanup were slight because the work plan for cleanup was constantly reviewed, and cleanup techniques were changed as needed to protect archaeological and cultural resources (Bittner, 1993). Various mitigating measures used to protect archaeological sites during oil-spill cleanup are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifact collection, and cultural resource-awareness programs (Haggarty et al., 1991).

Two studies of the numbers of archaeological sites damaged by the EVOS came to similar findings. In the first study by Mobley et al. (1990), of 1,000 archaeological sites in the area affected by the EVOS, about 24 sites, or <3 percent, were damaged. In the second study by Wooley and Haggarty (1993), of 609 sites studied, 14 sites, or 2 to 3 percent of the total, suffered major effects.

However, in determining the effect of damage to archaeological sites, it is not necessarily the numbers of sites that are disturbed that is important but the significance of the site that is affected. For example, the effect of disturbing 20 archaeological sites that do not contain significant or unique information may not be as great as the effect of disturbing one very significant site. Because there has not been a complete and systematic inventory and evaluation of the archaeological resources in the coastal region of the sale area, the potential for significant effects, should an oil spill occur, cannot be determined. However, it should be noted that during the emergency situation created by the EVOS, the Advisory Council on Historic Preservation declared that all archaeological sites were to be treated as if they were significant and eligible for the National Register of Historic Places (Mobley et al., 1990).

Summary: The Prehistoric Resource Analysis completed for Sale 144 indicates that there should be no preserved prehistoric archaeological sites within the sale area; therefore, there would be no effects on submerged prehistoric sites. The requirement for review of geophysical survey data prior to any lease activities would ensure to the greatest degree possible that any historic shipwreck within the sale area would be identified and avoided by bottom-disturbing activities resulting from this lease sale; therefore, the expected effect on historic shipwrecks is low. The expected effect on onshore archaeological resources from an oil spill is uncertain, but data from the EVOS indicate that <3 percent of the resources within a spill area would be significantly affected.

Conclusion: There should be no effects on submerged prehistoric sites as a result of Sale 144 because it is unlikely that there are preserved prehistoric sites within the sale area. The expected effect on historic shipwrecks should be low because of the requirement for review of geophysical data prior to any lease activities. Although oil-spill effects on onshore archaeological resources are uncertain, data from the EVOS indicate that few onshore archaeological resources (<3%) are likely to be significantly affected by an oil spill.

12. *Air Quality:* This discussion analyzes the potential degrading effects on air quality by the activities and developments induced by the Sale 144 Alternative I (base case). Supporting materials and discussions are presented in Section III.A.6 (descriptions of Beaufort Sea air-quality status).

Air pollutants discussed include nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), and volatile organic compounds (VOC). Ozone (O_3) is not emitted directly by any source but is formed in a series of complex photochemical reactions in the atmosphere involving VOC and NO_X.

Nitrogen oxides consist of both nitric oxide (NO) and nitrogen dioxide (NO_2). The NO_x is formed from the oxygen and nitrogen in the air during combustion processes, and the rate of the formation increases with combustion temperature. Nitric oxide, the major component of the combustion process, will slowly oxidize in the atmosphere to form NO_2; NO_2 and VOC perform a vital role in the formation of photochemical smog. Nitrogen dioxide breaks down under the influence of sunlight, producing NO and atomic oxygen, which then combine with diatomic oxygen to form O_3 or with VOC to form various gaseous and particulate compounds that result in the physiological irritation and reduced visibility typically associated with photochemical smog.

Carbon monoxide is formed by incomplete combustion. It is mainly a problem in areas where there is a high concentration of vehicle traffic. High concentrations of carbon monoxide present a serious threat to human health because they greatly reduce the capacity of the blood to carry oxygen.

Sulfur dioxide is formed in the combustion of fuels containing sulfur and, in the atmosphere, SO_2 slowly converts to sulfate particles. Sulfates in the presence of fog or clouds may produce sulfuric-acid mist. It is generally recognized that entrainment of sulfur oxides or sulfate particles into storm clouds is a major contributor to the reduced pH levels observed in precipitation (acid rain) in the northeast U.S.

Emissions of particulate matter associated with combustion consist of particles in the size range $< 10\mu$ in diameter (PM-10). Emissions of particulate matter associated with combustion consists of particulates, especially those in a certain size range of 1 to 3μ, can cause adverse health effects. Particulates in the atmosphere also tend to reduce visibility.

The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are basically three phases: exploration, development, and production. For a more detailed discussion of emission sources associated with each phase, refer to "Air Quality Impact of Proposed OCS Lease Sale No. 95" (Jacobs Engineering Group, Inc., 1989). Significant emission sources are summarized below.

For the exploration phase, emissions would be produced by (1) diesel power-generating equipment needed for drilling exploratory and delineation wells; (2) tugboats, supply boats, icebreakers, and crew boats in support of drilling activities; and (3) intermittent operations such as mud degassing and well testing. Pollutants generated primarily would consist of NO_X (these would consist of NO and NO_2; ambient air standards are set only for NO_2), CO, and SO_2.

For the development phase, the primary offshore-emission sources would be (1) piston-driven engines or turbines used to provide power for drilling, (2) heavy construction equipment used to install platforms and pipelines, and (3) tugboats, ice breakers, and support vessels. The principal development-phase emissions would consist of NO_2 with lesser amounts of SO_2, CO, and PM.

For the production phase, the primary source of offshore emissions would be from power generation for oil pumping and water injection. The emissions would consist primarily of NO_2 with smaller amounts of CO and PM. Another source of air pollutants would be evaporative losses (VOC) from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring could be an intermittent source of VOC and SO_2.

Other sources of pollutants related to OCS operations are accidents such as blowouts and oil spills. Typical emissions from OCS accidents consist of hydrocarbons; only fires associated with blowouts or oil spills produce other pollutants.

(1) Air-Quality Regulation and Standards: Federal and State statutes and regulations define air-quality standards in terms of maximum allowable concentrations of specific pollutants for various averaging periods (see Table III.A.6-1). These maxima are designed to protect human health and welfare. However, one exceedance per year is allowed except for standards based on an annual averaging period. The standards also include Prevention of Significant Deterioration (PSD) provisions for NO_2, SO_2, and PM-10 to limit deterioration of existing air quality that is better than that otherwise allowed by the standards (an attainment area). Maximum allowable increases in concentrations above a baseline level are specified for each PSD pollutant. There are three classes (I, II, and III) of PSD areas, with Class I allowing the least degradation. Class I also restricts degradation of visibility. The areas adjacent to the sale area are Class II. Baseline PSD pollutant concentrations and the portion of the PSD increments already consumed are established for each location by the USEPA and the State of Alaska prior to issuance of air-quality permits. Air-quality standards do not directly address all other potential effects such as acidification of precipitation and freshwater bodies or effects on nonagronomic plant species.

With the enactment of the Clean Air Act Amendments of 1990, the USEPA has jurisdiction for air quality over blocks leased under this lease sale. The lease operators shall comply with the requirements promulgated by USEPA for OCS sources, including the provisions of Title I, Part C, of the Clean Air Act (Prevention of Significant Deterioration of Air Quality). Section 328 states that for a source located within 25 mi of the seaward boundary of a State, requirements would be the same as those that would be applicable if the source were located in the corresponding onshore area.

The State of Alaska shall have jurisdiction over the blocks leased, once the State of Alaska has promulgated, with USEPA concurrence, regulations to implement and enforce the requirements of Section 328 of the Clean Air Act.

For the Alternative I base case, peak-year emissions from exploration would be from drilling one to two exploration wells and two to four delineation wells from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 54 production wells from 11 rigs. Peak-year production emissions would result from operations (producing 101 MMbbl of oil) and transportation. Table IV.B.12-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration, peak-development, and peak-production years. The USEPA-approved Offshore and Coastal Dispersion (OCD) model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Under Federal and State of Alaska PSD regulations, a PSD review would be required because the estimated annual uncontrolled NO_x emissions for the peak-development year would exceed 250 tons per year. The lessee would be required to control pollutant emissions through the application of Best Available Control Technology (BACT) to emissions sources. Table IV.B.12-2 shows the model-estimated pollutant concentrations and compares them with the PSD increments and the national ambient-air-quality standards. The OCD model air-quality analysis performed for air pollutants emitted for exploration and development and production under the Alternative I base case showed that maximum NO_2 concentration, averaged over a year, would be 1.45, 0.81, and 0.22 $\mu g/m^3$, (6, 3, and 1%, respectively) for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) Ambient concentrations in Pruhoe Bay have been provided in Table III.A.6-2 and are well within ambient air-quality standards. Additional contributions from proposed Lease Sale 144 activities would not increase ambient concentrations above the Federal ambient air-quality standards. Regarding the PSD Class II increments, we do not know how much of the increment has been consumed at the Prudhoe Bay sites, because the values in Table III.A.6-2 include baseline, but we may assume that the incremental consumption is low. Therefore, air-quality levels also would remain within the PSD Class II incremental standards.

(2) Other Effects on Air Quality: Other effects of air pollution from OCS activities and other sources on the environment not specifically addressed by air-quality standards include the possibility of damage to vegetation and acidification of coastal areas. Effects may be short term (hours, days, or weeks), long term (seasons or years), regional (Arctic Slope), or local (nearshore only).

A significant increase in ozone concentrations onshore is not likely to result from exploration, development, or production under the Alternative I base case. Photochemical pollutants such as ozone are not emitted directly but rather form in the air from the interaction of other pollutants in the presence of sunshine and heat. Although sunshine is present in the sale area most of each day during the summer, temperatures remain relatively low (Brower et al.,

Table IV.B.12-1
Estimated Uncontrolled Emissions for the Beaufort Sea Sale 144
Alternative I Base Case (in tons per year)

	Regulated Pollutants				
	CO	NO_x	PM-10	SO_2	VOC
Base Case[1]					
Peak Exploration Year	625.2	3222.0	124.8	141.2	229.6
Peak Development Year	538.1	2813.5	172.3	119.8	146.6
Peak Production Year	380.8	1034.4	48.7	22.4	36.8

Source: USDOI, MMS, 1995.

[1] Assumes peak-year emissions from exploration from drilling four exploration/ delineation wells from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 54 production wells from 11 rigs. Peak-year production emissions would result from operations (producing 101 MMbbl of oil) and transportion.

Table IV.B.12-2
Comparison of Modeled Air-Pollutant Concentrations with Regulatory Limitations
(measured in micrograms per cubic meter)

Averaging Time	PSD Increment[2]
Base-Case Exploration NO_2 (annual)[3]	2.5/25
Base-Case Development NO_2 (annual)	2.5/25
Base-Case Production NO_2 (annual)	2.5/25

Source: USDOI, MMS, 1995.

[1] Offshore and Coastal Dispersion Model.
[2] Increment above ambient concentration allowed in a designated PSD area. Ambient baseline concentration for PSD is not established for this area.
[3] Modeling was done on other pollutants, and results were lower than those shown for NO_X.

1988). Also, activities under the Alternative I base case are offshore and separated from each other, diminishing the combined effects from sale-related activities and greatly increasing atmospheric dispersion of pollutants before they reach shore.

Olson (1982) reviewed susceptibility of fruticose lichen, an important component of the coastal tundra ecosystem, to sulfurous pollutants. There is evidence that SO_2 concentrations as low as 12.0 micrograms per cubic meter ($\mu g/m^3$) for short periods of time can depress photosynthesis in several lichen species, with damage occurring at 60 $\mu g/m^3$. Also, the sensitivity of lichen to sulfate is increased in the presence of humidity or moisture, conditions that are common on coastal tundra. However, because of the small size and number of sources of SO_2 emissions, the ambient concentrations at most locations may be assumed to be near the lower limits of detectability. Because of the distance of the proposed activities from shore, attendant atmospheric dispersion, and low existing levels of onshore pollutant concentrations, the effect on vegetation under the Alternative I base case is expected to be minimal.

(3) Effects of Accidental Emissions: Accidental emissions result from gas blowouts, evaporation of spilled oil, and burning of spilled oil. The number of OCS blowouts, almost entirely gas and/or water, has averaged 3.3 per 1,000 wells drilled since 1956 (Fleury, 1983). The data show no statistical trend of a decreasing rate of occurrence. The blowout rate actually has averaged somewhat higher since 1974, at 4.3 per 1,000 wells drilled; but the difference between the post-1974 period and the longer 1956 to 1982 record is statistically insignificant.

A gas blowout could release 20 tons/day of gaseous hydrocarbons, of which about 2 tons/day would be nonmethane hydrocarbons classified as VOC. The probability of experiencing one or more blowouts in drilling the maximum 295 wells projected for the Alternative I base case is estimated to be 15 to 19 percent. If a gas blowout occurred, it would be unlikely to persist >1 day; and it would very likely release <2 tons of VOC. Since 1974, 60 percent of the blowouts have lasted ≤ 1 day; and only 10 percent have lasted >7 days.

Oil spills are a second accidental source of gaseous emissions. Section IV.A.2, Oil-Spill-Risk Analysis, discusses the probabilities for and size of oil spills associated with the base case.

Gas or oil blowouts may catch fire. In addition, in situ burning is a preferred technique for cleanup and disposal of spilled oil in oil-spill-contingency plans. For catastrophic oil blowouts, in situ burning may be the only effective technique for spill control.

Burning could affect air quality in two important ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98 percent and very slightly increase emissions—relative to quantities in other oil and gas industrial operations—of other pollutants (Table IV.B.12-3). If an oil spill were ignited immediately after spillage, the burn could combust 33 to 67 percent of the crude oil or higher amounts of fuel oil that otherwise would evaporate. On the other hand, incomplete combustion of oil would inject about 10 percent of the burned crude oil as oily soot, plus minor quantities of other pollutants, into the air (Table IV.B.12-4). For a major oil blowout, setting fire to the wellhead could burn 85 percent of the oil, with 5 percent remaining as residue or droplets in the smoke plume in addition to the 10-percent soot injection (Evans et al., 1987). Clouds of black smoke from a burning 360,000-bbl oil spill 75 km off the coast of Africa locally deposited oily residue in a rainfall 50 to 80 km inland. Later the same day, clean rain washed away most of the residue and allayed fears of permanent damage.

Based on qualitative information, burns that are two or three orders of magnitude smaller do not appear to cause noticeable fallout problems. Along the Trans-Alaska Pipeline, 500 bbl of a spill were burned over a 2-hour period, apparently without long-lasting effects (Schulze et al., 1982). The smaller volume Tier II burns at Prudhoe Bay had no visible fallout downwind of the burn pit (Industry Task Group, 1983).

Coating portions of the ecosystem in oily residue is the major, but not the only, potential air-quality risk. Recent examination of polycyclic aromatic hydrocarbons (PAH's) in crude oil and smoke from burning crude oil indicates that the overall amounts of PAH change little during combustion, but the kinds of PAH compounds present do change. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of PAH, is present in crude-oil smoke in quantities approximately three times larger than in the unburned oil. However, the amount of PAH is very small (Evans, 1988). Investigators have found that, overall, the oily residue in smoke plumes

Table IV.B.12-3
Emissions from Burning 20 Tons of Natural Gas per Day
During a Blowout
(in 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
Nitrogen Oxides	0.04	0.15	0.26

Source: Calculated from emission factors in Frazier, Maase, and Clark, 1977.

Table IV.B.12-4
Emissions from Burning Crude Oil
(in tons)

	Size of Burn	
	10,000 Barrels	200,000 Barrels
Total Suspended Particulates[1]	130	2,600
Sulfur Dioxide[2,3]	86	1,720
Volatile Organic Compounds[2]	0.5	10
Carbon Monoxide[4]	89	1,780
Nitrogen Oxides[4]	3.8	76

Source: USDOI, MMS, Alaska OCS Region, 1990.

1 Estimated as 10 percent of the total burn, less residue (Evans et al., 1987).
2 Burning assumed to be the same as residual oil firing in industrial burners. Emissions calculated from factors in Frazier, Maase, and Clark (1977).
3 Assumes a sulfur content of 2.9 percent.
4 Emissions calculated from factors in Evans et al. (1986, 1987).

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 >250 $\mu g/m^3$ to be a health hazard for bronchitis.

Over the life of oil exploration and development and production in the sale area, a 7,000-bbl oil spill could be set on fire accidentally or deliberately. Potential contamination of the shore would be limited because exploration and development and production activities under the proposal would be at least 4.8 km (3 mi) offshore, with the exception of the oil-transport pipelines. Also, large fires create their own local circulating winds—toward the fire at ground level—that affect plume motion. In any event, soot produced from burning oil spills tends to slump and wash off vegetation in subsequent rains, limiting any health effects. Accidental emissions are, therefore, expected to have a minimal effect on onshore air quality.

Summary: Effects on onshore air quality from Alternative I base-case air emissions are expected to be 6 percent of the maximum allowable PSD Class II increments. The concentrations of criteria pollutants in the onshore ambient air would remain well within the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally, because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development and production activities or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

Conclusion: The effects of these activities would not increase the concentrations of criteria pollutants in the onshore ambient air to the point that they would remain well within the air-quality standards. Therefore, effects from the base case would be low.

13. Land Use Plans and Coastal Management Programs:

Onshore activities and some offshore activities resulting from Sale 144 would be subject to the NSB Comprehensive Plan and Land Manage- ment Regulations (LMR's) and the Alaska Coastal Management Program (ACMP), as amended by the NSB CMP. The NSB LMR's are applied to all developments occurring on private and State lands. In the Sale 144 base-case scenario, these developments would include portions of road/pipeline corridors, including the offshore portions within the NSB boundary. All development that occurred within the coastal management boundaries identified in the approved NSB CMP or affected uses of the coastal zone, including activities described in Exploration Plans and Development and Production Plans, would be subject to the Statewide standards and NSB district policies of the ACMP. The policies of the LMR's and the ACMP are examined for potential conflicts with the potential effects identified in Sections IV.B.1 through IV.B.12.

Development on the coastal plain of ANWR still has not been authorized by Congress. None of the pipeline route is assumed to traverse the refuge; no conflict with ANWR policy is inherent in the scenario.

a. NSB Comprehensive Plan and Land Management Regulations:

During exploration, most onshore support would be based in existing facilities in the Prudhoe Bay area. Any permits that are requested probably would be conditional-use permits for specific temporary activities; these are permissible in the Conservation District. The extensive and more permanent development associated with production would require that a master plan be prepared describing anticipated activities and non-Federal land be rezoned from the Conservation District to the Resource Development District or Transportation Corridor.

Areawide policies in the revised LMR's are the same as those for the NSB CMP policies. The primary difference would be the process used for implementation and the geographic areas covered. The LMR's have been applied to all lands within the NSB that are not in Federal ownership. Policies in the ACMP cover only activities within the coastal zone but can be applied to Federal lands in many instances (see Sec. IV.B.13[b]). Therefore, development assumed to occur following this lease sale usually would be subject both to the LMR's areawide policies and the ACMP policies. To avoid a redundant analysis, potential conflicts with the LMR's areawide policies are included with the NSB CMP policies in the analysis of the ACMP rather than here.

Policies considered in this section are those in the other LMR policy categories: Villages, Economic Development, Offshore Development, and Transportation Corridors. Potential conflict with these policies is limited to some extent by the locations assumed for the development that accompanies this lease sale.

No development is anticipated to occur within Village boundaries; therefore, the four policies directly related to developing within NSB communities would not be applicable.

Economic Development policies afford special consideration for projects during land use reviews that have features the NSB considers beneficial impacts (NSBMC [NSB Municipal Code] 19.70.030[A] through [G]). Economic Development policies foster hiring practices favorable to NSB businesses and residents, including special work schedules for those who pursue subsistence activities, and generate excess tax revenues over demand for expenditures.

Offshore Development policies are intended to guide the approval of development and uses in the portion of the Beaufort Sea within the NSB. Policy 19.70.040.E is the only one of these that applies to activities other than drilling. This policy requires that "(a)ll nonessential boat, barge and air traffic associated with drilling activity. . . occur prior to or after the period of whale migration through the area." Moreover, essential traffic is required to avoid disrupting the migration and subsistence activities and be coordinated with the AEWC. This policy will be especially applicable during development.

The last category of policies covers the Transportation Corridor. It is assumed that if a pipeline corridor were built from a point about 20 miles east of Bullen Point to TAPS (1) the area would become zoned as a Transportation Corridor and (2) these policies would apply as the pipeline crossed land subject to NSB LMR's. Two additional pipeline segments and landfall sites are assumed for Oliktok Point and Point McIntyre/West Dock; however, these will tie into existing infrastructure and result in minimal additions to existing pipeline corridors. Conflict with policies for transportation corridors is not inherent in the scenario, but developers would be held responsible for minimizing airport use, ensuring proper sand and gravel extraction and reclamation, buffering stream banks, locating away from active floodplains, avoiding sensitive habitats, and identifying and documenting archaeological sites prior to construction (NSBMC 19.70.060.C, D, E, F, G, H, I, and J, respectively).

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. Policy areas of concern in the past related to deposition of toxic materials and untreated solid wastes, emissions, subsistence resources, sensitive areas, pollution, habitat changes and disturbance, and permafrost.

b. Alaska Coastal Management Program: Section 307 (c)(3)(B) requires lessees to certify that each activity that is described in detail in the lessee's exploration and development and production plans that affects any land use or water use in the coastal zone complies with, and will be implemented consistent with, the State's coastal program. The State has the responsibility to concur with or object to the lessees' certification. Activities within the coastal zone include the pipeline landfalls, the offshore pipeline within 3 geographical (nautical) statute miles of the coast, and transportation facilities. 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 in other sections of this EIS. Policies of the NSB CMP are assessed in conjunction with the most closely associated Statewide standard. As noted in Section IV.B.13.a, the NSB CMP policies have been incorporated into the LMR's. Therefore, the corresponding LMR policy number is listed following that of the NSB CMP policy.

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 highly unlikely that all the events that are hypothesized will occur as assumed in this EIS. Changes made by lessees as they explore, develop, and produce petroleum products from leases offered in this sale could affect the accuracy 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 and activities that can be placed inland do not displace activities dependent upon shoreline locations. The only OCS developments or activities hypothesized in the scenario that require a shoreline location are the landfall sites for the pipelines. It is unlikely that the hypothetical development would conflict with this policy.

State standards also require that the placement of structures and discharges 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 the COE regulations. Hypothetical developments along the Beaufort Sea coast that would require COE permits include constructing a berm for the shoreline approaches for the pipelines, dredging and possibly burying offshore pipelines, and placing pipelines and associated roads onshore. None of these projects necessarily is 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.

(2) Geophysical Hazard Areas (6 AAC 80.050): This Statewide standard requires coastal districts and State agencies to identify areas in which geophysical hazards are known and in which there is a substantial probability that geophysical hazards may occur. Development in these areas is prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life have been provided.

Several hazards are evident in the lease area. Sea ice is the principal physical hazard in the development of the oil and gas resources in the lease-sale area of the Beaufort Sea. However, drilling and completing wells in the Arctic is possible with existing technology (Sec. IV.A.5). In the EIS, permafrost, storm surges, faults and earthquakes, hydrates and shallow gases, and factors affecting the geotechnical characteristics of the seafloor sediments are related specifically to offshore activities. The summary in Section IV.A.5 identifies three measures that can be taken to lessen the effects of these hazards. These include scheduling activities appro- priately, conducting surveys for best locations, and designing facilities to withstand a range of environmental forces. Through these strategies and conformance with the MMS regulations of 30 CFR 250, Oil and Gas and Sulphur Operations in the OCS, hazards can be addressed.

The MMS regulations, including the platform verification program, regulate lessees to ensure that geophysical hazards, such as those identified, are accommodated in the exploration and development and production plans that must be approved before lessees may commence activities. Conformance with these regulations also should alleviate conflict that could occur with respect to two NSB CMP policies. Policy 2.4.4(b) (NSBMC 19.70.050. I.2) requires that "offshore structures must be able to withstand geophysical hazards and forces which may occur while at the drill site." These structures also "must have monitoring programs and safety systems capable of securing wells in case unexpected geophysical hazards or forces are encountered." Policy 2.4.4(h) (NSBMC 19.70.050.I.8) requires that "Offshore oil transport systems (e.g., pipelines) must be specially designed to withstand geophysical hazards, specifically sea ice."

Onshore development and some offshore development will be sited in areas of permafrost. Development in these areas must "maintain the natural permafrost insulation quality of existing soils and vegetation" (NSB CMP 2.4.6[c] and NSBMC 19.70.050.L.3). More than likely, some of the onshore development (e.g., pipelines) will be located in wetlands, in floodplains subject to a 50-year recurrence level, and in geologic-hazard areas identified on Map 22 of the NSB CMP Resource Atlas. These last two areas are specifically identified in the NSB CMP policies (NSB CMP 2.4.5.1[k] and NSBMC 19.70.050.J.11). For developments to proceed in these areas, there would have to be a significant public need, no feasible and prudent alternatives, and all feasible and prudent steps taken to avoid the adverse effects the policy is intended to prevent. A final requirement is that development in floodplains, shoreline areas, and offshore areas be "sited, designed, and constructed to minimize loss of life or property" due to geologic forces (NSB CMP 2.4.6[f] and NSBMC 19.70.050.L.6). Safeguards offered by these policies are enforced at the time an activity or project is proposed; there is no inherent conflict with these policies prior to that time.

(3) Energy Facilities (6 AAC 80.070): The State CMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent feasible and prudent, on 16 standards.

The ACMP standards require that facilities be sited to (1) minimize adverse environmental and social effects while satisfying industrial requirements and (2) be compatible with existing and subsequent uses (6 AAC 80.070 [1] and [2]). The projected pipeline landfalls along the Beaufort Sea coast at Oliktok Point and Point McIntyre are expected to tie into existing nearby production lines and to use the existing support infrastructures located at Kuparuk and Prudhoe Bay. The landfall assumed at the point about 20 mi east of Bullen Point would use infrastructure planned for future development in the Point Thomson area. Flaxman Island, the area most commonly used by Nuiqsut hunters for their base camp for hunting bowhead whales, is directly offshore of the landfall. It is likely that construction activities would occur during the whaling season. However, disturbance from these construction activities probably would result in only periodic and short-term avoidance (Sec. IV.B.6). The bowhead whale harvest would not become locally unavailable or reduced in harvest numbers (Sec. IV.B.10).

Other ACMP standards require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability (6 AAC 80.070 [3]). The NSB CMP also requires that "transportation facilities and utilities must be consolidated to the maximum extent possible" (NSB CMP 2.4.5.2[f] and NSBMC 19.70.050. K.6). Onshore activities hypothesized for the base case are consolidated at Oliktok Point, Point McIntyre, and the point about 20 mi east of Bullen Point where the pipelines come onshore. Existing facilities can accommodate the support services, thereby conforming with another standard (6 AAC 80.070 [7]). These locational decisions conform to NSB CMP policy 2.4.5.2(c) (NSBMC 19.70.050.K.3) that requires facilities not absolutely required in the field be located in designated compact service bases that are shared to the maximum extent possible.

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], NSB CMP 2.4.4 [i], and NSBMC 19.70.050.I.9). As is evidenced by the Endicott development, this standard 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. The projected short length of shore-approach berms or causeways for the Sale 144 base case may result in localized, short-term effects on the movement and migration of fish populations (Sec.. IV.B.3). Offshore pipelines should pose no barriers to migrating fish and wildlife. Conflict is not anticipated.

Finally, the Statewide standard requires that facilities be sited "so as to minimize the probability, along shipping routes, of spills or other forms of contamination which affect fishing grounds, spawning grounds, and other biologically productive or vulnerable habitats. . ." (6 AAC 80.070 [b][11]). The sites selected as landfall sites appear to conform with this requirement. For example, oil spills pose the greatest threat of all possible effect agents; however, the analysis in Section IV.B.10 (subsistence-harvest patterns) does not indicate that these sites accentuate the potential for adverse effects from an oil spill. The same conclusion also holds true for birds, pinnipeds, marine mammals, polar bears, and caribou (Secs. IV.B.4, 5, 6, and 7).

The NSB CMP has two additional requirements associated with this standard (State of Alaska, 1985). Policy 2.4.4(f) (NSBMC 19.70.050.I.6) requires that plans for offshore drilling include "a relief well drilling plan and an emergency countermeasure plan" and describes the content of such plans. Policy 2.4.4(g) (NSBMC 19.70.050.I.7) requires "offshore drilling operations and offshore petroleum storage and transportation facilities . . .to have an oilspill control and clean-up plan" and describes what the plan should contain. Because these policies are not intended to establish new regulations for offshore facilities, conformance is assured through the implementation of MMS regulations.

Construction associated with energy-related facilities resulting from Sale 144 also must comply with siting standards that apply to all types of development. These more general standards are discussed under (g) Habitats and (h) Air, Land, and Water Quality.

(4) Transportation and Utilities (6 AAC 80.080): This Statewide standard requires that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Assuming that after an offshore pipeline crossed the beach it would continue inland of the beaches, conformance with this policy is possible.

The NSB CMP contains several additional policies related to transportation that are relevant to this analysis. All but one of the policies are "best-effort policies" and subject to some flexibility if (1) there is a significant public need for the proposed use and activity, (2) all feasible and prudent alternatives have been rigorously explored and objectively evaluated, and (3) all feasible and prudent steps have been taken to avoid the adverse effects the policy was intended to prevent. "Transportation development, including pipelines, which significantly obstructs wildlife migration" is subject to the three criteria (NSB CMP 2.4.5.1[g] and NSBMC 19.70.050.J.7). Conflict with this policy is not anticipated. Section IV.B.7 indicates that interference with caribou movements would be temporary and brief; caribou migrations and overall distribution are not expected to be affected.

As noted in the previous standard for energy facilities, transportation facilities are expected to be consolidated to the maximum extent possible. Therefore, there should be no conflict with either NSB CMP 2.4.5.1(i) (NSBMC 19.70.050.J.9), which discourages duplicative transportation corridors from resource-extraction sites, or NSB CMP 2.4.5.2(f) (NSBMC 19.70.050.K.6), which requires that transportation facilities and utilities be consolidated to the maximum extent possible. Although the NSB CMP limits support facilities for tankering oil to market, the scenario indicates that pipelines will be used; therefore, the policy is not relevant.

The final policy falls under the category of "Minimization of Negative Impacts." NSB CMP 2.4.6(b) (NSBMC 19.70.050.L.2) requires that alterations to shorelines, water courses, wetlands, and tidal marshes and significant disturbance to important habitat be minimized. In the discussion of habitats, it is recognized that alterations to wetland habitat and ponds and lakes will occur and birds could be disturbed during construction. This policy also requires that periods critical for fish migration be avoided. These requirements identify constraints for the siting, design, construction, and maintenance of transportation and utility facilities; conflict with these is not inherent in the assumed activities.

(5) Mining and Mineral Processing (6 AAC 80.110):

Extraction of sand and gravel is a major concern on the North Slope. Gravel resources are needed for construction pads for all onshore development to protect the tundra, including roadbeds, berms or causeways, and docks. The ACMP Statewide 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]). Substantial alteration of shoreline dynamics is prohibited (NSB CMP 2.4.5.1[j] and NSBMC 19.70.050.J.10). Constraints may be placed on extraction activities to lessen environmental degradation of coastal lands and waters and to ensure floodplain integrity (NSB CMP 2.4.5.2[a] and [d] and NSBMC 19.70.050.K.1 and 4). Although industry's preferences for gravel sources and removal procedures and the Statewide standards and NSB CMP policies may diverge on occasion from those that are deemed consistent, conflict is not inherent in the scenario.

(6) Subsistence (6 AAC 80.120): The Statewide standard for subsistence guarantees opportunities for subsistence use of coastal areas and resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. Potential conflicts with this Statewide standard and the supporting district policies are based on the analysis of effects of activities assumed for the base case on subsistence in the NSB (Sec. IV.B.10).

Access may be an issue. Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable subsistence-user access to a subsistence resource. Flaxman Island is the primary location for the Nuiqsut bowhead whale-harvest base camp. Flaxman Island is located just off the coast near the easternmost landfall site assumed for the base case. In addition to the potential for deflection of whales from the subsistence area, subsistence activities in the vicinity of pipe-laying activities may be considered unsafe and not allowed. Given the limited number of years involved, conflict is more likely to occur with the best-effort policy addressing reduced or restricted access (NSB CMP 2.4.5.1[b] and NSBMC 19.70.050.J.2). Where access is reduced or restricted, development can occur only if no feasible or prudent alternative is available, and then it is subject to the conditions of best-effort policies.

Several important NSB CMP policies relate to adverse effects to subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to "extensive adverse impacts to a subsistence resource" that "are likely and cannot be avoided or mitigated." In such an instance, "development shall not deplete subsistence resources below the subsistence needs of local residents of the Borough." Policy 2.4.5.1(a) (NSBMC 19.70.050.J.1) relates to "development that will likely result in significantly decreased productivity of subsistence resources or their ecosystems." The probabilities of an oil spill contacting the harvest areas of Nuiqsut and Kaktovik are high (68% and 63%, respectively). The primary concern is the effects of a spill on the harvest of bowhead whales. An oil spill during Nuiqsut's and Kaktovik's spring bowhead whale hunt could cause the whale harvest to be discontinued because bowheads could become unavailable or undesirable for use for a period of 1 to 2 years (Sec. IV.B.10). If an oil spill occurred and contacted the Barrow, Nuiqsut, or Kaktovik bird-hunting areas, birds would become unavailable for a period up to 1 year. However, it is not likely that the entire subsistence-bird harvest would be affected (Sec. IV.B.10). Conflict with these policies is possible.

(7) Habitats (6 AAC 80.130): The Statewide standard for habitats contains an overall standard policy plus policies specific to eight habitat areas: offshore areas; estuaries; wetlands and tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes; and important upland habitat (6 AAC 80.130 [a], [b], and [c]). Activities and uses that do not conform to the standards may be permitted if there is significant public need and no feasible prudent alternatives to meet that need, and all feasible and prudent measures are incorporated to maximize conformance (6 AAC 80.030 [d]). The NSB CMP contains a district policy that reiterates the applicability of the Statewide standard (NSB CMP 2.4.5.2[g] and NSBMC 19.70.050.K.7), plus several others that augment the overall policy or can be related to activities within a specific habitat.

The ACMP Statewide standard for all habitats in the coastal zone requires that habitats "be managed so as to maintain or enhance the biological, physical, and chemical characteristics of the habitat which contribute to its capacity to support living resources" (6 AAC 80.130 [b]). This overall policy is supported by an NSB CMP district policy requiring development "to be located, designed, and maintained in a manner that prevents significant adverse impacts on fish and wildlife and their habitat, including water circulation and drainage patterns and coastal processes" (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2). In addition, "vehicles, vessels, and aircraft that are likely to cause significant disturbance must avoid areas where species that are sensitive to noise or movement are concentrated at times when such species are concentrated" (NSB CMP 2.4.4 [a] and NSBMC 19.70.050.I.1). Some disturbances associated with exploration and development would be mitigated by the Stipulation on Protection of Biological Resources and the ITL clauses concerning Bird and Marine Mammal Protection and Areas of Biological and Cultural Sensitivity (Sec. II.E). The analyses in Sections IV.B.2 through 7 indicate that resources would not be subject to significant disturbance. If they are, however, the policy requires that, consistent with human safety, horizontal and vertical buffers will be required where appropriate. Although there are no inherent conflicts with the assumed activities at this point, some that may appear as specific proposals are brought forward at the time of development.

Activities may affect several of the habitats identified in the Statewide standard, including offshore; barrier islands and lagoons; wetlands; and rivers, lakes, and streams. Potential effects in each habitat are related to the applicable policies in the following paragraphs.

The offshore habitat is designated a fisheries conservation zone (6 AAC 80.130. [c][1]). In the Arctic, marine mammals are an important offshore resource and are included in the analysis of the offshore habitat. Some effects in the offshore habitat can be expected in the unlikely event that an oil spill occurred in a sensitive area, or in specific coastal areas during critical periods for several fishes. Effects identified in Sections IV.2 through IV.6 would not preclude offshore development, assuming the developer has undertaken all feasible and prudent steps to maximize conformance. Offshore seismic exploration is subject to specific constraints; NSB CMP 2.4.6 (g) (NSBMC 19.70.050.L.7) requires that seismic exploration be conducted in a manner that minimizes its impact on fish and wildlife. Conflict with this district policy is not anticipated.

Barrier islands and lagoons characterize the Beaufort Sea coast where some of the development associated with this lease sale is assumed to occur (NSB CMP Map 16). These habitats are managed to assure sediment and water conditions are maintained so 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]). Although disruptive activities could occur in this habitat during the laying of the pipeline and construction of the landfall site, effects of offshore construction on birds and marine mammals, potential effects on abundance and distribution of a population or portion of a population would be localized and would last for only a short period of time. Consequently, no substantial conflict with this habitat policy is anticipated.

Much of the uplands in the NSB are considered wetlands. Therefore, onshore development would need to be designed and constructed to avoid (1) adverse effects to the natural drainage patterns, (2) destruction of important habitat, and (3) the discharge of toxic substances (6 AAC 80.130 [c][3]). Pipelines and roadways would transect this habitat both to the east and to a very limited extent to the west of the TAPS. Water impoundments created by the pipeline/road corridor would carry both positive and negative effects. They would benefit waterfowl but displace some nesting shorebirds (Sec. IV.B.4). Caribou could be disturbed temporarily during construction but are expected to habituate to the traffic following construction (Sec. IV.B.7). This conclusion is based partially on the established policy that roads and pipelines are constructed to provide for unimpeded wildlife crossings. The NSB CMP policy 2.4.6(e) (NSBMC 19.70.050.L.5) emphasizes this practice and provides a set of guidelines and an intent statement specifically to implement the policy. There is no inherent conflict between the crossing requirements and the assumed activities. Restrictions on storing toxic substances are covered more completely by policies related to the following topics: air, land, and water quality.

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 of river deltas being contacted by oil is very low. However, pipeline/road construction, including gravel extraction, also could affect these waterways and would need to be conducted in a manner that ensures the protection of riverine habitat and fish resources. Gravel extraction also is regulated under policies that are described in the section on mining.

(8) Air, Land, and Water Quality (6 AAC 80.140): 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. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water- and air-quality regulations in several additional policies.

Water quality can be affected by oil spills, causeways, dredging, deliberate discharges and emissions, gravel operations, and solid-fill artificial-island removal. It is likely that an accidental oil spill would occur as a result of this sale. Two spills of at least 1,000 bbl have been assumed 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 above State and Federal standards (Sec. IV.B.1). As a precaution against accidental spills, the NSB CMP requires the use of impermeable lining and diking for fuel-storage units with a capacity >660 gal (NSB CMP 2.4.4[k] and NSBMC 19.70.050.I.11). In addition, development within 1,500 ft of the shoreline of the coast, lake, or river "that has the potential of adversely impacting water quality (e.g., landfills, or hazardous materials storage areas, dumps, etc.)" must comply with the conditions of the best-effort policies (NSB CMP 2.4.5.1[e] and NSBMC 19.70.050.J.4). These conditions are: (1) there must be a significant public need, (2) the developer has rigorously explored and objectively evaluated all feasible and prudent alternatives and cannot comply with the policy, and (3) all feasible and prudent steps have been taken to avoid the adverse effects the policy was intended to prevent. There is no inherent conflict between this policy and the assumptions used for the proposed action.

Three new or enhanced causeways are projected in the base case. Causeways already exist at Oliktok Point and Point McIntyre/West Dock, two access points in the base case. A third causeway at a point about 20 miles east of Bullen Point should be available by the time of Sale 144 development.

Effects of dredging are expected to be short term and local. No conflict with either the Statewide standard or the district policies is anticipated.

Some discharges and emissions would occur during exploration and development, and the NSB CMP policy 2.4.4(c) (NSBMC 19.70.050.I.3) requires that "development resulting in water or airborne emissions. . .comply with all state and federal regulations." This is consistent with the Statewide standard.

Discharges of muds, cuttings, and drilling fluids are regulated closely. Given the rate of discharge, changes in water quality during exploratory drilling would be local, persisting for only a few hours and remaining within a 100-m radius. During development, effects from muds and cuttings would be local and short term. Formation waters produced from the wells along with the oil are regulated through an EPA permit and, depending on the conditions of the permit, may be disposed of above or below ground. To date, for exploration in the Beaufort Sea, EPA has prohibited discharge of formation waters into waters < 10 m deep; reinjection and injection projects have been the standard. If formation waters were discharged into the water, the effect on water quality would be local but would last over the life of the field. If formation waters were reinjected or injected into a different formation, as is expected, no discharge of formation waters would occur and no effect would occur.

Offshore disposal of solid wastes also is regulated through Federal permits and restrained further by Annex V of the MARPOL Convention approved in 1988 by the United States Congress. Because these discharges are so carefully regulated, no conflict is anticipated with the Statewide standard or NSB CMP policy 2.4.4(d) (NSBMC 19.70.050.I.4), which requires that "industrial and commercial development. . .be served by solid waste disposal facilities which meet state and federal regulations." Onshore development associated with this sale also must meet the Statewide standard and the district policy related to solid-waste disposal. Assuming the regulations are implemented properly, there is no inherent conflict between the proposed activities and the ACMP water-quality provisions.

The district CMP also contains a policy that requires development without a central sewage system to impound and process effluent to meet State and Federal standards (NSB CMP 2.4.4[e] and NSBMC 19.70.050.I.5). This is the current practice aboard drilling vessels and production platforms; there is no inherent conflict with this district policy. This also has been the practice of the major developments on the North Slope.

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 (6AAC 80.110 [a]). Solid-fill islands may be constructed and used for shallow-water development. Island construction could be completed within one to two summers, and effects on water quality would be short term and local (Sec. IV.B.1). Conflict is not inherent in the proposal.

Air quality also must conform with Federal and State standards (6 AAC 80.140, NSB CMP 2.4.3[i] and 2.4.4[c], and NSBMC 19.70.050.H and I.3). The analysis in Section IV.B.12 indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

(9) Statewide Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): The ACMP Statewide standard requires that coastal districts and appropriate State agencies identify areas of the coast that are important to the study, understanding, or illustration of national, State, or local history or prehistory.

The NSB developed additional policies to ensure protection of its heritage. The NSB CMP 2.4.3(e) (NSBMC 19.70.050.E) requires that development that is "likely to disturb cultural or historic sites listed on the National Register of Historic Places; sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state, or local history or prehistory shall (1) be required to avoid the sites; or (2) be required to consult with appropriate local, state and federal agencies and survey and excavate the site prior to disturbance." The NSB CMP 2.4.3(g) (NSBMC 19.70.050.G) goes on to require that "development shall not cause surface disturbance of newly discovered historic or cultural sites prior to archaeological investigation." These NSB CMP policies establish clearly what is required. In the unlikely event such a site is encountered, there is no inherent reason to assume conflict with these policies.

Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). As noted in the discussion of policies related to subsistence, the latter is a best-effort policy that requires protection for transportation to subsistence-use areas as well as cultural-use sites. There is no inherent reason to assume conflict with these policies.

Summary: Potential conflict between activities assumed for this lease sale and the NSB LMR's and the Statewide standards and the NSB district policies of the ACMP is evident in two main areas:

□□ The first area where conflict with ACMP Statewide standards and district policies may arise is the potential for user conflicts between development activities at the landfall site at a point about 20 mi east of Bullen Point and the subsistence bowhead whale hunt. The Statewide standard for subsistence guarantees opportunities for subsistence use of coastal areas and resources (6 AAC 80.120). Conflict also is possible with two policies of the NSB. The first NSB policy relates to subsistence: NSB CMP 2.4.5.1[b] (NSBMC 19.070.050.J.2) requires development that restricts subsistence-user access to a subsistence resource meet three criteria: (1) there is a significant public need, (2) all feasible and prudent alternatives have been rigorously explored and objectively evaluated and cannot comply with the policy, and (3) all feasible and prudent steps have been taken to avoid the adverse effect the policy was intended to prevent. The second NSB CMP policy relates to both subsistence and cultural resource areas: NSB CMP 2.4.5.2(h) (NSBMC 19.70.050.K.8) requires development to be located, designed, and maintained so as not to interfere with the use of a site that is important for significant cultural uses or essential for transportation to subsistence-use areas; again, subject to the three criteria identified above.

□□ The second area where conflict with district policies may arise is the potential for adverse effects to subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to "extensive adverse impacts to a subsistence resource" that "are likely and cannot be avoided or mitigated." In such an instance, "development shall not deplete subsistence resources below the subsistence needs of local residents of the Borough." Policy 2.4.5.1(a) (NSBMC 19.70.050.J.1) relates to "development that will likely result in significantly decreased productivity of subsistence resources or their ecosystems." An oil spill during Nuiqsut's and Kaktovik's spring bowhead whale hunt could cause the whale harvest to be discontinued because bowheads could become unavailable or undesirable for use for a period of 1 to 2 years (Sec. IV.B.10). If an oil spill occurred and contacted the Barrow, Nuiqsut, or Kaktovik bird-hunting areas, birds would become unavailable for a period up to 1 year. However, it is not likely that the entire subsistence-bird harvest would be affected (Sec. IV.B.10).

Effectiveness of Mitigating Measures: Mitigating measures are assumed to be in place for the base-case analysis, and base-case-effects levels reflect this assumption. Mitigation that would apply to subsistence-harvest activities include the Orientation Program stipulation, the Industry Site-Specific Bowhead Whale-Monitoring Program stipulation, and the stipulation on Subsistence Whaling and Other Subsistence Activities.

The Orientation Program stipulation requires the lessee to conduct a program that educates personnel working on exploration or development and production activities about the environmental, social, and cultural concerns that relate to the area and area communities. The program is expected to increase personnel sensitivity and understanding of local Native community values, customs, and lifestyles and to prevent any conflicts with subsistence activities. The Industry Site-Specific Bowhead Whale-Monitoring Program stipulation requires a site-specific monitoring program during exploratory drilling operations, including seismic surveys, to determine if bowhead whales are present in the vicinity and to assess the behavioral effects on bowheads and other marine mammals from these activities. If the lessee holds a NMFS Letter of Authorization for incidental, nonlethal taking of bowhead whales for exploratory drilling, no additional MMS plan may be needed. The stipulation on Subsistence Whaling and Other Subsistence Activities requires lessees to conduct all exploration, development, and production in a manner that prevents unreasonable conflicts with subsistence activities, especially the bowhead whale hunt. This stipulation requires the lessee to contact potentially affected Native communities, the NSB, and the Eskimo Whaling Commission to discuss possible siting and timing conflicts and to assure that exploration, development, and production activities are compatible with subsistence whaling and do not result in interference with other subsistence harvests. This stipulation also provides a mechanism for attempting to resolve any conflicts that may remain after this consultation process.

The Orientation Program, Industry Site-Specific Bowhead Whale-Monitoring Program, and Subsistence Whaling and Other Subsistence Activities stipulations would serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices. If these mitigation measures were not in place, increased effects could raise overall effects levels above those already assessed for the base case.

Conclusion: For the base case of Alternative I, conflicts could occur with specific Statewide standards and NSB Coastal Management Plan policies related to the potential for user conflicts between development activities and the subsistence bowhead whale hunt. Conflicts are possible with the NSB Coastal Management Plan policy related to adverse effects on subsistence resources if spilled oil contacted the subsistence-hunting areas of Kaktovik and Nuiqsut.

C. EFFECTS OF ALTERNATIVE II, NO LEASE SALE:

This alternative would be tantamount to cancellation of Sale 144. As a result of such a cancellation, the 1.2 Bbbl of oil estimated to be produced in the base-case scenario would be neither discovered nor developed. Furthermore, the environmental effects from the base case of the proposal, as described in Section IV.B, would be eliminated. Should the sale be canceled, the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources. These alternatives are addressed in Appendix C.

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

1. Oil-supply substitutes
   - domestic onshore oil production
   - imported oil

2. Fuel substitutes in the transportation sector
   - imported methanol
   - gasohol
   - compressed natural gas
   - electric cars

3. Conservation
   - in the transportation sector
   - through reduced consumption of plastics

The provision of energy resulting from this alternative likely would result from a mix of the substitutes listed above. The mix would depend on economic and regulatory factors as well as the short-run availability of capacity to produce and transport quantities of the various substitutes.

Likely environmental effects from this alternative might include:

- From onshore oil production—local air pollution, greenhouse gases, water contamination, land effects, and health risks;

- From increased oil imports—greenhouse gases, water contamination, and spill-related degradation of water and adjacent land areas (effects of oil transport are discussed in Section IV.B);

- From imported methanol—air quality deterioration, water and land degradation, and health and safety risks;

- From production of ethanol to be used in gasohol blending—severe air pollution, significant water-quality degradation, extensive soil erosion and loss of wildlife habitat, and greatly increased areas devoted to land fills;

- From the natural gas used in compressed natural gas vehicles—both local and greenhouse gas pollution, water contamination, and land effects;

- From the electricity generated for use in electric cars—a variety of environmental effects that depends upon the type and location of the plant used to generate the electricity; and

- From conservation—only very minor negative environmental effects associated with the various approaches to petroleum product conservation.

A more detailed discussion of alternatives to the expected oil production from this lease sale, along with their environmental effects, can be found in Appendix C. Appendix C also discusses possible alternatives to natural gas in the unlikely event that natural gas from the lease-sale area is ever commercially produced. Tables C-3 and C-4 show the equivalent quantities of alternative energy sources that may be required should this lease be canceled.

Conclusion: The effects described for the base-case proposal would be eliminated by this alternative. However, cancellation of the sale would mean that the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources. The energy probably would derive from a mix of sources, each of which has negative environmental effects associated with its production and transportation.

D. EFFECTS OF ALTERNATIVE III - BARTER ISLAND DEFERRAL ALTERNATIVE:

Introduction: The Barter Island deferral comprises 1,440 blocks and 3.06 million ha (7.56 million acres) of submerged lands (see Fig. II.C-1). This alternative is 439 blocks and 940,000 ha (2.33 million acres) less than the proposed action. Resources estimated for this alternative are approximately 10 percent less than Alternative I (about 1.08 Bbbl). Accordingly, the resource-development timeframes are not different from those of Alternative I. Table IV.A.1-1 and Table A-7 in Appendix A shows the essential developmental timeframes for platforms and well numbers as well as other infrastructure requirements relevant for Alternative III.

The area that would be deferred under Alternative III includes blocks used for subsistence activities by the residents of the community of Kaktovik. This alternative also would ensure that no exploration and development drilling would occur in the deferred blocks, which encompass a key whale-feeding area; the potential for oil spills or use conflicts originating from the unoffered portion of the planning area would be reduced accordingly. Deferring this area was supported by the Fish and Wildlife Service and Native groups during the scoping process for Sale 144.

1. Water Quality: Alternative III would reduce the most likely number of major spills ≥1,000 bbl from two to one. There would be a factor of two decrease in the area temporarily affected by hydrocarbon concentrations above chronic criteria. This alternative also would lessen the slight risk of spills occurring or contacting waters of the deferred area, because spills elsewhere in the sale area would tend to drift westward, away from the Barter Island area. Oil lost in spills ≤1,000 bbl would total about 3,000 bbl, reflecting a 10-percent reduction in the number of small spills and total volume spilled. Only 20 exploration and delineation wells would be drilled for a 10-percent reduction in exploration discharge of drilling muds and cuttings. Neither would there be any pollution from artificial-island construction or removal and local, deliberate (permitted) discharges near Barter Island. Other agents would have the same effect as for the base case (Sec. IV.B.1).

Conclusion: The areal extent of effects on water quality would be on the order of half that of the proposal because of the reduction in the number, from two to one, of major spills. The magnitude of effects for Alternative III, however, would be similar to that for the base case: concentrations of contaminates may locally exceed sublethal but not acute (toxic) levels.

2. Lower Trophic-Level Organisms: Routine activities associated with the Barter Island Deferral Alternative (Alternative III) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.2) and are summarized below. The following analysis for Alternative III focuses on the differences in the amount of activity (the only variable) estimated for Alternative III, as compared with that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative III.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in <3 years.

The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, epontic, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., in bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hour) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. The one assumed 7,000-bbl oil spill for Alternative III is estimated to have sublethal and lethal effects on <3 percent of the epontic community in the sale area.

Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection). Due to the predominance of shorefast ice along the shoreline of the Beaufort Sea, most of the shoreline is thought to support little or no resident flora or fauna down to about 1 m in depth. Subtidal marine plants and invertebrates are not likely to be contacted by an oil spill, except for floating larval forms, which may be contacted anywhere near the surface. The organisms likely to be contacted by floating or dispersed oil include zooplankton (e.g., copepods, euphausiids, mysids, and amphipods), as well as the larval stages of annelids, mollusks, and crustaceans. In general, the percentage of marine invertebrates contacted by floating or dispersed oil is expected to be similar to that expected for plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate populations from the assumed large oil spill is expected to take less than a month.

Because Alternative III assumes only one 7,000-bbl oil spill, rather than the two assumed for the base case, it is expected to reduce base-case effects on lower trophic-level organisms by about 50 percent. Also, Alternative III would delete 439 partial and whole blocks, or about 24 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral area and would eliminate it as an area where a platform oil spill could originate. Because of the normal pattern of wind and water currents, the probability of spilled oil moving into the deferred area is very low. Hence, the removal of 24 percent of the sale area associated with Alternative III is expected to further reduce base-case effects on lower trophic-level organisms. Altogether, Alternative III is expected to reduce base-case effects on lower trophic-level organisms by about 70 percent.

Conclusion: The assumed 7,000-bbl oil spill is estimated to have lethal and sublethal effects on up to 1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spill also is estimated to have lethal and sublethal effects on <3 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

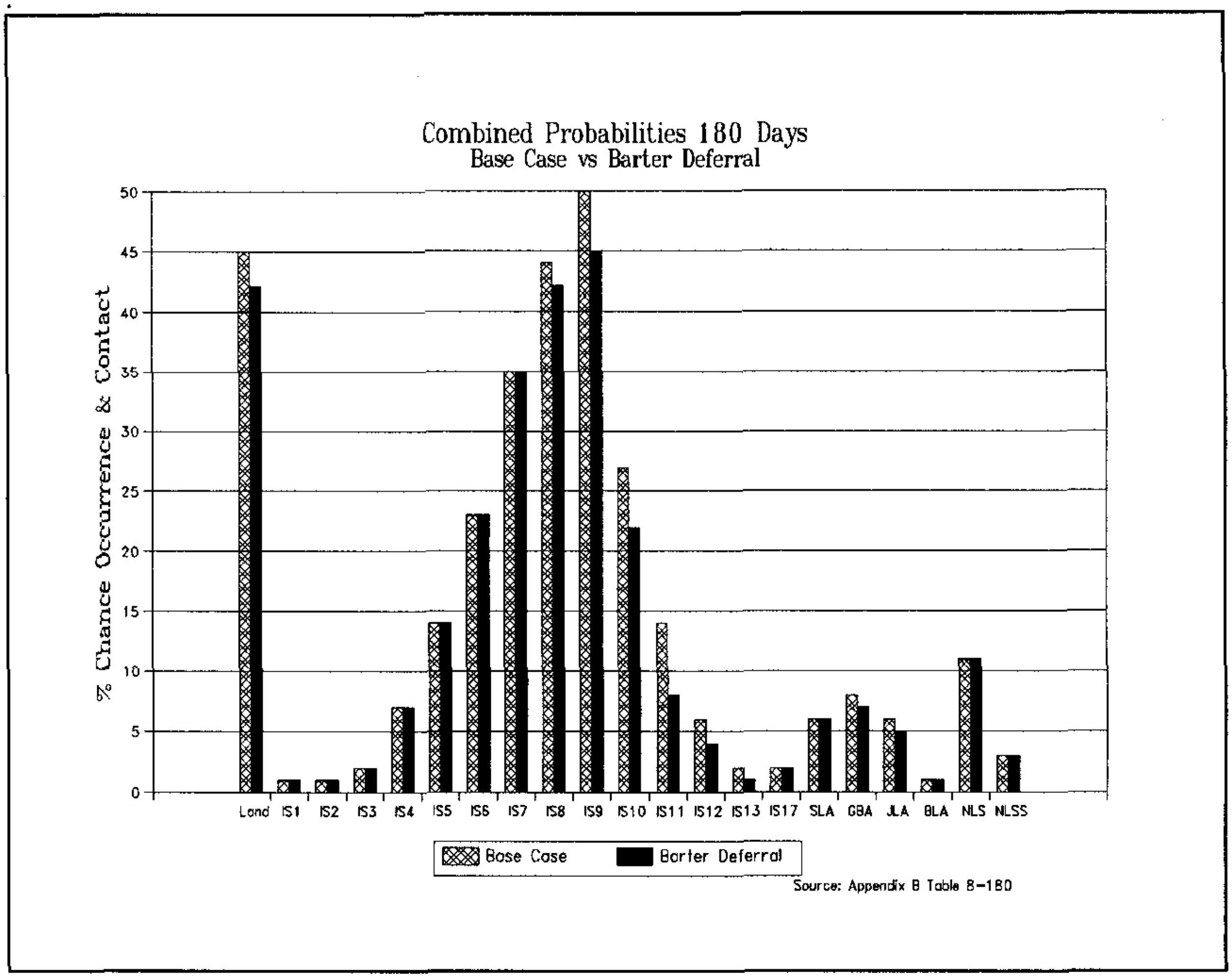
3. *Fishes:* The fish species in the slightly reduced Alternative III area are the same as the species in the entire base-case area. Also, the effects on fishes of activities in the Alternative III area, including seismic exploration, drilling, and construction, would be the same as for the entire area.

The probability of an oil spill affecting the Barter Island area and eastern Beaufort Sea is slightly lower for the Alternative III area. However, Alternative III would not reduce the probability of an oil spill occurring and contacting river deltas, such as the Sagavanirktok and Colville River deltas, which are the main overwintering habitats for anadromous fishes.

Conclusion: Overall, the activities associated with Alternative III are expected to be the same as for the base case. Because the major anadromous fish-overwintering habitats are still within the deferral alternative.

4. *Marine and Coastal Birds:* The Barter Island Deferral, Alternative III, would remove from the proposed lease-sale area 439 whole and partial leasing blocks (about 24% of the sale area) (marine and coastal bird habitats) west and offshore of Barter Island. Alternative III would provide a potential reduction in oil-spill effects on marine and coastal birds in habitats east of Barter island such as Beaufort Lagoon. One spill (7,000 bbl) is assumed under Alternative III compared with two spills (7,000 bbl) under the base case.

A comparison of the proposal, Alternative I, base case and Alternative III combined probabilities (expressed as a percent chance) of one or more ≥1000-bbl spills occurring and contacting environmental resources—important habitats of marine and coastal birds within 180 days—is shown in Figure IV.D.4-1. Alternative III slightly reduces the chance of spill occurrence and contact to Jago Lagoon (JLA, from 6% under the base case to 5% under Alternative III) and to Gwydyr Bay (GBA, from 8% under the base case to 7% under Alternative III) as shown in Fig. IV.D.4-1. The chance of spill occurrence and contact with offshore marine habitats of birds from Mackenzie



IV.D.4-1. Comparison of Base-Case with Alternative-III, Barter Island Deferral, Combined Probabilities (expressed as a percent chance) of One or More Oil Spills ≥1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas; Ice/Sea Segments (IS3 through IS13); Lagoons: Simpson Lagoon (SLA), Gwydyr Bay (GBA), Jago Lagoon (JLA), Beaufort Lagoon (BLA); and Ice Leads: Northern Lead System (NLS), Northern Lead System During the Spring (May through June) (NLSS), Within 180 Days Over the Assumed Production Life of Sale 144.

Bay west to Prudhoe Bay (as represented by Ice/Sea Segments IS13 through IS8 in Fig. IV.D.4-1) also are reduced under Alternative III. However, the chances of spill occurrence and contact with other marine and coastal bird habitats west of Camden Bay, such as Simpson Lagoon (SLA), and offshore habitats west of Prudhoe Bay (represented by Ice/Sea Segments IS1 through IS7) and probabilities of spill occurrence and contact to the Northern Lead System (NLS) are not reduced under Alternative III, and the chances of spill occurrence and contact with other coastal-shoreline habitats (as represented by chance occurrence and contact with land) is only slightly reduced under Alternative III (a 42% chance of spill occurrence and contact as compared with 45% under the base case) (Fig. IV.D.4-1).

Thus, potential oil-spill effects on marine and coastal bird habitats east of Barter Island would be avoided under this alternative; and there would be a reduction in the risks of oil-spill effects on marine and coastal bird habitats in Gwydyr Bay and offshore of Camden Bay. However, effects on marine and coastal birds and their habitats in Simpson Lagoon and in offshore habitats west of Camden Bay would not be reduced under Alternative III. Thus, the overall effect of oil spills on marine and coastal birds still is expected to include the loss of several thousand birds, with recovery taking place within about one generation (2-3 years).

Noise and disturbance effects on marine and coastal birds from air and vessel traffic under Alternative III are expected to be about the same as under the base case of Alternative I (short-term displacement of birds lasting a few minutes to < 1 day) because the same level of development activity (i.e, eight production platforms) is assumed under both alternatives.

Assuming for this alternative (as for the base case) that offshore pipelines would be built to support oil development and production in the eastern part of the proposed sale area with Bullen Point as a pipeline landfall, this alternative would not reduce onshore habitat and disturbance effects on marine and coastal birds from those effects described for the base case.

Conclusion: Under Alternative III, oil-spill effects on marine and coastal birds and their habitats east and offshore of Barter Island and Camden Bay could be avoided or reduced. However, the overall levels of effect on marine and coastal birds and their habitats west of Camden Bay, due primarily to spilled oil and noise disturbance, are expected to be the same as for the base case (a loss of several thousand birds with populations expecting to recover within 1 generation).

5. Pinnipeds, Polar Bears, and Belukha Whales: The Barter Island Deferral, Alternative III, would remove from the proposed lease-sale area 439 whole and partial blocks (24% of the sale area), leasing blocks (marine mammal habitats) west and offshore of Barter Island (Fig. II.C-1). Alternative III would provide a potential reduction in spill effects on pinnipeds, polar bears, and belukha whales in habitats east and offshore of Barter Island such as in the Beaufort Lagoon-Demarcation area.

A comparison of the proposal, Alternative I, base case and Alternative III combined probabilities (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting environmental resources—important habitats of seals, walruses, polar bears and belukha whales—is shown in Figure IV.D.4-1. Alternative III slightly reduces the chance of spill occurrence and contact to Jago Lagoon (JLA, from 6% under the base case to 5% under Alternative III) and to Gwydyr Bay (GBA, from 8% under the base case to 7% under Alternative III) as shown in Figure IV.D.4-1. The chance of spill occurrence and contact with offshore marine habitats of pinnipeds, polar bears, and belukha whales from Mackenzie Bay west to Prudhoe Bay (as represented by Ice/Sea Segments IS13 through IS8 in Fig. IV.D.4-1) also are reduced under Alternative III. However, the chances of spill occurrence and contact with other pinniped, polar bear, and belukha whale habitats west and offshore of Prudhoe Bay (represented by Ice/Sea Segments IS1 through IS7) and spill occurrence and contact to the Northern Lead System (NLS) are not reduced under Alternative III, and the chances of spill occurrence and contact with other coastal shoreline habitats of pinnipeds and polar bears (as represented by chance occurrence and contact with land) is only slightly reduced under Alternative III (a 42% chance of occurrence and contact compared with 45% under the base case) (Fig. IV.D.4-1).

Thus, potential oil-spill effects on pinnipeds (ringed, bearded, and spotted seals), polar bears, and belukha whales and their habitats east of Barter Island would be avoided under this alternative; and there would be a reduction in the risks of oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats offshore of Camden

Bay. However, oil-spill effects on pinnipeds and polar bears and their habitats in Simpson Lagoon and in offshore habitats west of Camden Bay would not be reduced under Alternative III. Thus, the overall effects of oil spills on pinnipeds, polar bears, and belukha whales (assuming the 7,000-bbl spill occurs and contacts marine mammal habitats) still are expected to include the loss of small numbers of ringed, bearded, or spotted seals (probably no more than 200 to 300 seals), walruses (no more than perhaps several hundred), polar bears (no more than perhaps 20-30 bears), and belukha whales (probably < 10 animals).

Noise and disturbance effects on pinnipeds, polar bears, and belukha whales from air and vessel traffic under Alternative III are expected to be about the same as under the base case of Alternative I (short term, with < 1 generation for recovery from potential losses of walrus calves or seal pups due to aircraft disturbance and local displacement [within 1-3 km (0.62-1.9 mi) of vessels] of seals, walruses, polar bears, and belukha whales for a few minutes to less than a few days) because the same level of development activity, including the installation of eight production platforms, is assumed under both alternatives.

Assuming for this alternative (as for the base case) that offshore pipelines would be built to support oil development and production in the eastern part of the proposed sale area with Bullen Point as a pipeline landfall, this alternative would not reduce onshore habitat and disturbance effects on pinnipeds, polar bears, and belukha whales from those effects described for the base case.

Conclusion: Under Alternative III, oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats east and offshore of Barter Island and Camden Bay could be avoided or reduced. However, the overall levels of effect on seals, walruses, polar bears, and belukha whales and their habitats west of Camden Bay are expected to be the same as for the base case (losses of seals, walruses, polar bears, and belukha whales replaced within 1 generation).

6. Endangered and Threatened Species: The Barter Island Deferral Alternative (Alternative III) would remove about 24 percent of the proposed sale area, deferring the offshore area east of Barter Island from petroleum exploration and development/production (Fig. II.C-1). Alternative III would provide a potential reduction in oil-spill effects on endangered and threatened species and their habitats east of Barter Island (see Figs. IV.A.2-1 and 2-1, and Table B-44 in Appendix B). One spill (7,000 bbl) is assumed under Alternative III, compared with two spills (7,000 bbl ea) under the base case (Alternative I). The probability of one or more oil spills > 1,000 bbl occurring declines from 88 percent under the base case to 85 percent under Alternative III.

a. Effects on the Bowhead Whale: This alternative would defer an area used by bowhead whales for feeding and migration during the late summer and fall and slightly reduce the potential for adverse effects from oil spills, noise, and disturbance as a result of exploration and development and production activities.

Noise and habitat disturbance from drilling units, postlease geophysical surveys, vessel and aircraft traffic, and production platforms to bowhead whales feeding in and migrating through the sale area would be reduced because these activities would not take place within the deferred area. Under this deferral alternative, 20 exploration and delineation wells would be drilled as compared with 22 under the base case. The number of platforms (8) and production wells (273) are expected to remain the same as for the base case. However, leases have been granted adjacent to the deferred area as a result of previous Federal lease sales, and aircraft and vessel traffic would cross the deferred area enroute to these leased blocks. This traffic could disturb low numbers of bowheads for a few minutes once or twice per day and cause bowheads to avoid areas near vessel activities. In addition, noise from seismic surveys within leased blocks could be transmitted into the deferred area, although the sound intensity within the deferred area would be at reduced levels and would be unlikely to significantly displace feeding or migrating whales. In the area remaining to be offered for lease, the effect on bowheads would be as described for the base case, with whales avoiding areas within a few miles of vessels, seismic surveys, drilling units, and production platforms. Exposure of bowhead whales to noise-producing activities is not expected to result in lethal effects, but some individuals could experience temporary, nonlethal effects.

Oil-spill risks to bowhead whales would be reduced as compared with the base case. The OSRA estimated one spill ≥ 1,000 bbl, with an estimated 85-percent chance of one or more such spills occurring over the production life of the proposed action. The OSRA model estimated a 7- to 40-percent probability (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting ERA's 5 to 10 (Ice/Sea Segments 5-10), where bowheads may be present during the fall migration, within 30 days over the production life of the proposed action. The probability of contact in Ice/Sea Segment 9, the area of highest probability of contact, is estimated at 40 percent. The greatest reduction in oil-spill risk for this alternative compared with the base case also occurs for ERA 9. The OSRA model estimated a 5-percent probability (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting ERA SLSN (Northern Spring Lead System), an area where bowheads may be present during the spring and fall migration, within 30 days over the production life of the proposed action. If spilled oil were to contact a whale-habitat area, resulting effects would be as discussed under the base case (Sec. IV.B.6). Some bowhead whales could experience one or more of the following: skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the consumption of contaminated prey items, and perhaps temporary displacement from some feeding areas. Some individuals might be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small. Overall, exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects.

Conclusion: The level of disturbance in the deferred area would be less with the alternative than without it; however, bowheads would be subject to the same level of disturbance in the area outside of the deferred area as they would be under the base case. Oil-spill effects would not be reduced substantially under this alternative, although fewer whales would be likely to be exposed to spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills would most likely experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years.

b. Effects on the Arctic Peregrine Falcon: Because arctic peregrines primarily nest inland 32 km (20 mi) or more from the coast, deferral of this area would result in no demonstrable reduction of effects determined under the base case of the proposal (Sec. IV.B.6). These include disturbance (rarely) by distant support aircraft, construction of onshore gathering pipelines, and gravel mining and potential contact with oil either directly or through contact with oiled prey. Neither disturbance nor oiling of peregrines is considered a likely result of the proposed action or this alternative because activities involving these adverse factors generally are far-removed from primary areas of falcon activity. Exposure of peregrines to oiled prey, likely to be infrequent in any case, is not expected to decrease significantly under this alternative because the decreased number of projected spills does not result in significantly decreased shoreline contact by oil.

Conclusion: As determined for the base case of the proposal, overall routine and spill-related effects of the Barter Island Deferral Alternative on the arctic peregrine falcon are expected to be minimal, with <5 percent of the population exposed to potentially adverse factors. Because exposure of falcons to oiled prey is expected to be insignificant under both the base case and this alternative, reduction of adverse effects also is expected to be insignificant. No mortality is expected to result from this alternative.

c. Effects on the Spectacled Eider: Because spectacled eiders are uncommon, except during two relatively brief staging and migration periods, in Beaufort coastal areas where probability of contact by an oil spill originating in the deferred eastern sale area is greatest (boundary segment 41 and eastward, Fig. IV.A.2-2), and because little reduction in spill-contact probability in areas potentially used by this species results from this alternative, deferral of the Barter Island area would result in no significant reduction of the effects determined under the base case of the proposal (Sec. IV.B.6). These include no significant effects from routine activities and relatively low mortality if there were an oil spill (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Conclusion: As determined for the base case of the proposal, overall routine effects of the Barter Island Deferral Alternative on the spectacled eider are expected to be minimal, affecting <2 percent of the population. Likewise, no significant reduction of the oil-spill mortality expected under the base case is anticipated because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur if population status is declining as at present.

d. Effects on the Steller's Eider: Because the only substantial occurrence of Steller's eiders in Alaska during the nesting season is in the Barrow area (they are rare east of Pt. Barrow), and because almost no reduction in spill-contact probability (e.g., Table B-53, Appendix B) in the areas potentially used by this species results from this alternative, deferral of the Barter Island area would result in no significant reduction of the effects determined under the base case of the proposal (Sec. IV.B.6). These include no significant effects from routine activities and relatively low mortality from an oil spill (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Conclusion: As determined for the base case of the proposal, overall routine effects of the Barter Island Deferral Alternative on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population. Likewise, no significant reduction of the oil-spill mortality expected under the base case is anticipated because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur if population status is declining as at present.

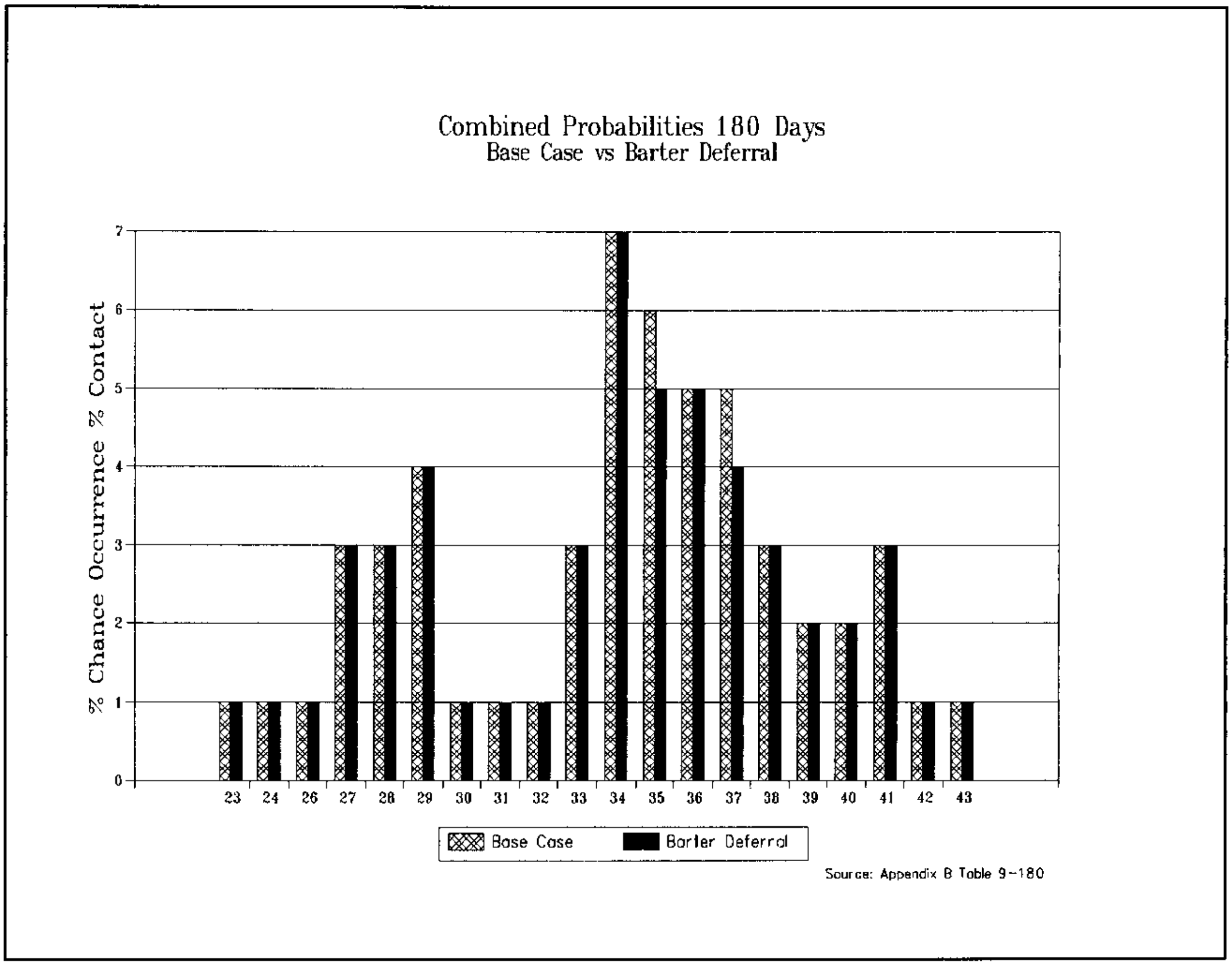
7. Caribou: If development were not to occur in the Barter Island deferred area, the same onshore-development scenario is expected to occur as that described for the base case. Oliktok Point, Point McIntyre, and Point Thomson would be the landfalls for the pipelines connecting to TAPS, with the same pipeline-road corridors being constructed under Alternative III. Thus, the effects of onshore-construction activities—vehicle-traffic disturbance of caribou and habitat alteration along the pipeline road—are expected to be the same as described for the base case (local but long term, >1 generation).

Compared with the base case, this alternative could slightly reduce the risks of oil-spill occurrence and contact (by 1%) with coastline habitats and potential oil-spill effects on caribou using coastal habitats for insect relief near Flaxman Island and Point McIntyre (Fig. IV.D.7-1, Land Segments LS37 and LS35, respectively). However, caribou of the TLH, CAH, and PCH still would be exposed to some oil contamination of coastline habitats under Alternative III: one spill (7,000 bbl) is assumed to occur under this alternative compared with two spills under the base case. A small number of caribou (such as a few hundred animals) are likely to be exposed to the spill and die as a result of toxic-hydrocarbon inhalation and absorption, with losses replaced within less than one generation (about 1 year).

Conclusion: This alternative is expected to have local (within 1 to 2 km or 0.62 to 1.2 mi of roads and pipelines) but long-term (>1 generation) displacement effects on caribou (due to road-traffic disturbance), about the same level of effect as under the base case.

8. Economy of the North Slope Borough: The Barter Island Deferral Alternative would decrease the area offered for leasing to industry and could decrease industry interest in Sale 144. However, for the purpose of analyzing potential changes to NSB revenues and expenditures and employment, this alternative would have the same effects as for the base case as discussed in Section IV.B.8. The effects on the subsistence economy are reduced.

Increased revenues and employment are the most significant economic effects that would be generated by this alternative. Increased property-tax revenues and new employment would be created with the construction, operation, and servicing of facilities associated with OCS activities. These facilities are described in Table IV.A. 1-1 and are summarized as follows: during the exploration phase between 1997 and 2004, 7 exploration and 13 delineation wells would be drilled; and during the development and production phase between 2001 and 2027, 273 production wells would be drilled and 8 platforms and 128 km of offshore pipeline would be installed. The number of workers needed to operate the infrastructure is determined by the scale of the infrastructure and not the amount of oil produced. Some temporary employment is generated by assumed oil spills.



IV.D.7-1. Comparison of Base-Case with Alternative-III, Barter Island Deferral, Combined Probabilities (expressed as a percent chance) of One or More Oil Spills ≥ 1,000 Barrels Occurring and Contacting Certain Land Segments Within 180 Days Over the Assumed Production Life of Sale 144 (land segments with probabilities <0.05% within 180 days are not shown in the figure)

Analysis of economic effects resulting from this alternative is limited to effects on the NSB. The information that follows is from the Rural Alaska Model, prepared for MMS by the ISER, and from the NSB 1993/1994 Economic Profile and Census Report (Harcharek, 1995).

a. NSB Revenues and Expenditures: Under existing conditions, total property taxes in the NSB and NSB revenues are in general projected to decline, as discussed in Section III.C.1. This alternative is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 averaging about 2 percent each year through the production period. Also under existing conditions, the two expenditure categories that affect employment—operations and the CIP—are projected to decline. Of these two categories, only expenditures on operations would be affected by the proposed sale's effects on taxable property value.

b. Employment: The gains from this alternative in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. A peak employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 jobs by 2026. (See Appendix E for a description of the methodology for employment and population forecasts.) All of these jobs would be filled by commuters who would be present at the existing enclave-support facilities approximately half of the days in any year.

This alternative is projected to affect employment of the region's permanent residents in two ways: (1) more residents would obtain petroleum-industry-related jobs as a consequence of Sale 144 exploration and development and production activities and (2) more residents would obtain NSB-funded jobs as a result of higher NSB expenditures.

While the Barter Island Deferral Alternative is projected to generate a large number of petroleum-industry-related jobs in the region, the number of jobs filled by permanent residents of the region is not projected to be large. Total Barter Island Deferral Alternative resident employment is expected to be about 4 percent greater than existing-condition employment. Overall employment should, therefore, not decline as far by the end of the projection period as it would under existing conditions. The increase in employment opportunities may partially offset declines in other job opportunities and delay expected outmigration.

Employment generated by oil-spill-cleanup activities also would have economic effects. The number of cleanup workers actually used to clean up the assumed oil spill of 7,000 bbl associated with this alternative would depend to a great extent on what procedures were called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities. Activities associated with Sale 144 could generate cleanup work for about 3 percent of the workers associated with the EVOS—or 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

c. Effects of Subsistence Disruptions on the NSB Economy: Disruptions to the harvest of subsistence resources could affect the economic well-being of NSB residents in a number of ways. Adverse effects would be felt primarily through the direct loss of subsistence resources. In addition, loss of subsistence resources would increase demand for store-brought goods and result in an inflation of prices.

Subsistence activities are an integral component of the NSB economy as well as the culture. Subsistence is the "body and soul" of Native culture (I. Nukapigak, 1995). If one or more subsistence resources became unavailable for harvest, the economic well-being of NSB residents would be harmed. There are two components to the economic well-being associated with subsistence resources—the value of subsistence resources as a source of food and the cultural value of the resources. Both of these values can be represented as a direct source of economic well-being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased in the marketplace. This food source is a substitute for income earned in the marketplace that would have to be used to purchase food. Subsistence activities and the value derived from these pursuits, however, go beyond a substitute for food bought in the market. As a way of life, there is a real, measurable economic value gained from NSB residents having access to such activities. A disruption of a subsistence harvest, for example by an oil spill, would result in a real loss of economic well-being to residents. "Our food would be devastated by an oil spill" (E. Itta, 1995).

The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest.. Overall effects of the Barter Island Deferral Alternative on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities are expected to render one or more subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. The effects of this alternative on subsistence-harvest patterns in Barrow (Atqasuk), Nuiqsut, and especially the community of Kaktovik are expected to affect subsistence resources for a period not exceeding 1 year, but no resource would become unavailable, undesirable for use, or greatly reduced in available numbers (see Section IV.D.10, Subsistence-Harvest Patterns).

Conclusion: For the Barter Island Deferral Alternative, the effects on revenues and expenditures and employment of the NSB are expected to be the same, overall, as for the base case of the proposal.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. Overall effects of the Barter Island Deferral Alternative on subsistence-harvest patterns as a result of oil spills, noise and disturbance, and construction activities are expected to render one or more subsistence resources unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. The effects of this alternative on subsistence-harvest patterns in Barrow (Atqasuk), Nuiqsut, and especially the community of Kaktovik are expected to affect subsistence resources for a period not exceeding 1 year, but no resource would become unavailable, undesirable for use, or greatly reduced in available numbers.

9. Sociocultural Systems: Alternative III, Barter Island Deferral, would not alter the onshore industrial activities and population and employment projections for this sale because the resource estimate for this alternative is only slightly lower (1.08 Bbbl) than for the base case (1.2 Bbbl), and all basic exploration, development and production, and transportation assumptions would remain the same as for the base case. The estimated number of total pipeline and platform spills ≥1,000 bbl would be reduced to one in this alternative, therefore reducing the possibility of spill contact to SRAC and SRAD. Effects on subsistence-harvest patterns would be reduced from the base case (see Sec. IV.B.10). The effect of this alternative on sociocultural systems would be to produce only short-term disruption of sociocultural systems without the displacement of existing institutions.

Conclusion: Under this alternative, effects on sociocultural systems from industrial activities, changes in population and employment, and effects on subsistence-harvest patterns are expected to produce only a short-term disruption of sociocultural systems—< 1 year—without a tendency to displace existing institutions. Effects in the community of Kaktovik would be even less pronounced and of shorter duration.

10. Subsistence-Harvest Patterns: Effects on subsistence from the proposed lease sale would result from oil spills; noise and disturbance; and the placement of exploration, development and production, and support facilities. Alternative III does reduce the oil-resource estimate slightly (from 1.2 Bbbl to 1.08 Bbbl), but the number of wells, platforms, and pipeline miles estimated for exploration, development and production, and transportation remains the same. However, Alternative III does remove activity from 439 blocks (940,000 ha) in the eastern Beaufort near the community of Kaktovik.

Subsistence activities occur locally, and many of them, such as Kaktovik whaling, seal and walrus hunting, and spring bird hunting, occur with high frequency in the area near Barter Island. An oil spill in the midst of this intensive subsistence activity would disrupt subsistence harvests more than an oil spill that might originate in another part of the sale area. If an oil spill occurred outside the immediate Barter Island Deferral area, it would be in a more weathered state when it reached the Barter Island area. In the base case, an estimated two spills ≥1,000 bbl are assumed with an 88-percent chance of occurrence. In the Barter Island Deferral, an estimated one spill ≥1,000 bbl is assumed with an 85-percent chance of occurrence. The OSRA model estimated a 56-percent chance of one or more spills ≥1,000 bbl occurring and contacting SRAD. The reduced probability of an oil spill contacting Kaktovik's subsistence-harvest areas would reduce effects from oil spills on Kaktovik's bowhead whale harvest that are expected for the base case in Alternative I.

Noise and disturbance also would affect Kaktovik's and some of Nuiqsut's subsistence activities. While this deferral alternative would not substantially change biological effects to regional populations of subsistence species, it would eliminate nearshore tracts of a portion of Kaktovik's subsistence-harvest area and thus may offer some mitigation of noise and traffic disturbance to this community's hunters. The areas protected presently are not those most intensely used by Kaktovik for marine-mammal and caribou hunting. However, such protection may be particularly significant, because the western half of Kaktovik's subsistence-harvest area has been and would continue to be affected by offshore oil development.

Barrow's (Atqasuk) and Nuiqsut's subsistence-harvest patterns would not be affected by this alternative; and effects are expected to remain the same for these communities as in the base case.

Conclusion: Under Alternative III, effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns in Barrow (Atqasuk), Nuiqsut, and especially the community of Kaktovik are expected to affect subsistence resources for a period not exceeding 1 year, but no resource would become unavailable, undesirable for use, or greatly reduced in available numbers.

11. Archaeological Resources: Under the Barter Island Deferral Alternative, 439 blocks east of Kaktovik would be removed from consideration. Of the 14 reported shipwrecks in the proposed sale area, one, the *Elvira*, would be removed from further analysis if the Barter Island Deferral Alternative were adopted (Tornfelt and Burwell, 1992).

Conclusion: The effects from the Barter Island Deferral Alternative would be the same as for the proposal.

12. Air Quality: The exploration and development and production scenario for the Barter Island Deferral Alternative is nearly the same as for the base case; the only difference is that an area along the coast of the Beaufort Sea immediately north and east of Barter Island would not be leased. This would not significantly affect the activities under the scenario; and, consequently, the effect on air quality is expected to be low (see Sec. IV.B.12).

Conclusion: The effects of this alternative on air quality are expected to be low, the same level of effects as for base case.

13. Land Use Plans and Coastal Management Programs: Deferring the 439 blocks east of Barter Island would lessen the risk of oil spills occurring and contacting waters of the deferred area; possible effects on coastal habitats in this area would be avoided. There also would be a reduction in the risk of oil-spill effects on habitats in Gwydyr Bay and offshore Camden Bay. There would be a reduction in the probability of an oil spill contacting Kaktovik's subsistence-harvest areas, as well as a reduction of noise and disturbance levels in the eastern half of Kaktovik's subsistence-harvest area. Pollution from artificial-island construction and local, permitted discharges near Barter Island would be eliminated.

Conclusion: For Alternative III, the effects of potential conflicts on land use plans and coastal management programs are expected to be almost the same as for the base case of Alternative I: conflicts could occur with specific Statewide standards and NSB Coastal Management Plan policies related to the potential for user conflict between development activities and the subsistence bowhead whale hunt, with the exception that the Barter Island Deferral Alternative would reduce the possibility of conflicts with the Kaktovik subsistence-harvest area by reducing the possibility of spilled oil and noise-related disturbances effecting the harvest area.

E. EFFECTS OF ALTERNATIVE IV - THE NUIQSUT DEFERRAL ALTERNATIVE:

Introduction: The Nuiqsut Deferral Alternative comprises 1,636 blocks and approximately 3.4 million hectares (8.3 million acres) (Fig II.D-1). This Alternative is 243 blocks and 559,873 hectares (1.5 million acres) less than the proposed action. The deferred area comprises about 14 percent of the area offered by Alternative I. The resource level forecast for this alternative is 720 MMbbl, approximately 40 percent less then the proposed action. Similarly, infrastructure, i.e., numbers of exploration and delineation wells as well as production platforms, also would be decreased by approximately 40 percent. However, the timing of field development would not be substantively different from Alternative I. Pipeline landfalls for this alternative would decline by one from the three forecast for the proposal. The landfalls handling crude oil production from the eastern and western Beaufort would remain; however, the landfall forecast for the West Dock would not be necessary. Total pipeline mileage forecast for this alternative would be 25 mi less than that of the proposal: 160 mi as opposed to 185. Please see Tables IV.A.1-1 and A-7 for platforms and well numbers as well as other infrastructure requirements relevant to the Nuiqsut Deferral.

Oil-field-support activities for this alternative would be in the same pattern as that for Alternative I, in that activities also would be supported from marine and air facilities located in and around Prudhoe Bay/Kuparuk. Produced crude would be transported to Valdez via the Trans-Alaska Pipeline System (TAPS) and then to the west coast of the U.S. or to the Far East via tanker.

The area proposed for deferral encompasses Cross Island—a location viewed by the community of Nuiqsut and the Inupiat Whaling Commission as Nuiqsut's primary harvest area for the bowhead whale and other marine mammals. The blocks offered in the Nuiqsut Deferral Alternative have been offered in other OCS lease sales and lie immediately offshore of the core of North Slope oil production and infrastructure.

1. ***Water Quality:***

Alternative IV would reduce the most likely number of major spills ≥1,000 bbl from two to one. There would be a factor of two decrease in the area temporarily affected by hydrocarbon concentrations above chronic criteria. This alternative also would lessen the risk of spills occurring or contacting waters of the deferred area, but a spill to the west in the sale area would tend to drift eastward toward the Nuiqsut area. Oil lost in spills ≤1,000 bbl would total about 2,000 bbl, reflecting a 40-percent reduction in the number of small spills and total volume spilled. There could be no possibility of a discovery offshore of the Endicott Causeway, ensuring that this alternative could not exacerbate the restricted circulation causing impairment of local water quality near this causeway. Increased turbidity from dredging (and dumping) during pipeline construction would be reduced by about 14 percent but still would be local and short term, exceeding the chronic criterion over a distance of ≤3 km (≤2 nmi) from the pipeline route—a local water-quality effect. Only 14 exploration and delineation wells would be drilled for a 36-percent reduction in exploration discharge of drilling muds and cuttings. There would be a 42-percent reduction in production discharge of drilling muds and cuttings. There would be no pollution from artificial-island construction or removal and local, deliberate (permitted) discharges near Nuiqsut. Other agents would have the same effect as for the base case (Sec. IV.B.1).

Conclusion: The areal extent of effects on water quality would be on the order of half that of the proposal because of the reduction in the number, from two to one, of major spills. The magnitude of effects for Alternative IV, however, would be similar to that for the base case: concentrations of contaminates may locally exceed sublethal but not acute (toxic) levels.

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

Routine activities associated with the Nuiqsut Deferral Alternative that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.2) and are summarized below. The following analysis for the Nuiqsut Deferral Alternative focuses on the differences in the amount of activity estimated for this deferral alternative, as compared with that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in <3 years.

The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and epontic and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., in bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. The one assumed 7,000-bbl oil spill for the Nuiqsut Deferral Alternative is estimated to have sublethal and lethal effects on <3 percent of the epontic community in the sale area.

Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection). Due to the predominance of shorefast ice along the shoreline of the Beaufort Sea, most of the shoreline is thought to support little or no resident flora or fauna down to about 1 m in depth. Subtidal marine plants and invertebrates are not likely to be contacted by an oil spill, except for floating larval forms, which may be contacted anywhere near the surface. The organisms likely to be contacted by floating or dispersed oil include zooplankton (e.g., copepods, euphausiids, mysids, and amphipods), as well as the larval stages of annelids, mollusks, and crustaceans. In general, the percentage of marine invertebrates contacted by floating or dispersed oil is expected to be similar to that expected for plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate populations from the assumed large oil spill is expected to take less than a month.

Because the Nuiqsut Deferral Alternative assumes only one 7,000-bbl oil spill rather than the two assumed for the base case, it is expected to reduce base-case effects on lower trophic-level organisms by about 50 percent. Also, the Nuiqsut Deferral Alternative would delete 243 partial and whole blocks, or about 14 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral area and would eliminate it as an area where a platform oil spill could originate. However, due to the normal pattern of wind and water currents in this area, platform or pipeline oil spills to the east of the deferral area would remain a potential oil-spill source that could affect the deferral area. Hence, in terms of an oil spill, the removal of 14 percent of the sale area associated with the Nuiqsut Deferral Alternative, is not likely to further reduce the amount of toxic hydrocarbons that could reach the deferral-area. Altogether, the Nuiqsut Deferral Alternative is expected to reduce base-case effects on lower trophic-level organisms by about 50 percent.

Conclusion: The assumed 7,000-bbl oil spill is estimated to have lethal and sublethal effects on up to 1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spill also is estimated to have lethal and sublethal effects on <3 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

3. Fishes: Alternative IV, the Nuiqsut Deferral Alternative, would remove blocks from the southcentral portion of the proposed lease-sale area. The deferral probably would alter slightly the projected level of effects on fishes due to seismic activity, drilling, oil spills, and construction, as assessed for the base case (Sec. IV.B.3).

a. Seismic Effects: The base-case assessment concluded that, in general, a very small portion of the regional populations would be affected by seismic activity. An exception would be for some marine fishes, such as the kelp snailfish and leatherfin lumpsucker. Because they are concentrated in the *Stefansson Sound Boulder Patch, those populations might be affected to a greater extent.* The Nuiqsut deferral would delete blocks in Stefansson Sound, reducing the likelihood of seismic effects on boulder-patch fishes. So, with the deferral, there is one fewer exception to the generalization that only a very small portion of the regional populations would be affected by seismic activity.

b. Drilling Effects: The base-case assessment concluded that there would be a very low level of drilling effects on fishes: fishes would be displaced a short distance during installation activities and drilling-fluid discharge but would reutilize their habitat upon completion of the activities. This conclusion about negligible effects would not be reduced further by the deferral.

c. Oil-Spill Effects: The base-case concluded that a spill in nearshore waters would be lethal to a small portion of several anadromous fish populations, decreasing the population levels by perhaps several hundred thousand juvenile fish for a generation. This assessment would be modified slightly under the Nuiqsut deferral, primarily because the blocks that would be deleted are offshore of the Sagavanirktok River Delta, which is a critical overwintering habitat for anadromous fish, as described in Section III.B.2. The Nuiqsut deferral probably would reduce the oil-spill risk to the delta, as indicated by the projected number of oil spills. The deferral assumption is that there might be only one spill of about 7,000 bbl rather than two such spills under the base-case assumptions. While the deferral would reduce the oil-spill risk to the delta that arises from the new leases, there are existing leases for which the risk would not be eliminated. For example, the deferral does not eliminate the oil-spill risk from the Endicott Development Project adjacent to the delta. So, the Nuiqsut deferral reduces by only a very small amount the oil-spill risk to fishes.

d. Effects From Construction Activities: The base case concluded that the effects of sale-specific construction on fishes would be very small, affecting only fish movements in localized areas for a short term; however, the effects of long causeways associated with nearshore State developments probably would be greater, as assessed for the cumulative case. This conclusion is unchanged for the Nuiqsut deferral.

Conclusion: Under Alternative IV, the effects due to seismic, drilling, oil spills, and construction would be only slightly less than the effects for the base case: at worst, the effects would be lethal to a very small portion of some nearshore anadromous fish populations, decreasing the population levels by perhaps several hundred thousand juvenile fish for one generation (<7 years).

4. Marine and Coastal Birds: The Nuiqsut Deferral, Alternative IV, would remove from the proposed lease-sale area 243 whole and partial leasing blocks (about 14% of the sale area) (marine and coastal bird habitats) of an area offshore of Prudhoe Bay east to offshore of the Canning River Delta (Fig. III.D.1). Alternative IV would provide a potential reduction in oil-spill effects on marine and coastal birds and their habitats from about Cape Halkett east to Camden Bay. One spill (7,000 bbl) is assumed under Alternative IV compared with two spills (7,000 bbl each) under the base case. The probability of one or more oil spills ≥1,000 bbl occurring declined from 88 percent under the base case (Alternative I) to 72 percent under Alternative IV.

A comparison of the proposal (Alternative I base case) and Alternative IV combined probabilities (expressed as percent chance) of one or more ≥1000-bbl spills occurring and contacting environmental resources—important habitats of marine and coastal birds—within 180 days is shown in Appendix B, Table B-51. Alternative IV reduces the chance of spill occurrence and contact to Simpson Lagoon (from 6% under the base case to 4% under Alternative IV), to Gwydyr Bay (from 8% under the base case to 5% under Alternative IV), and to Jago Lagoon (from 6% under the base case to 4% under Alternative IV) as shown in Appendix B Table B-51. The chance of spill occurrence and contact with offshore marine habitats of birds from Herschel Island west to Point Barrow (as represented by Ice/Sea Segments IS 12 through IS 4 in Appendix B Table B-51) also is reduced under Alternative IV. However, probabilities of spill occurrence and contact to the Northern Lead System (NLS) during the spring (May-June) are not reduced under Alternative IV, and the above habitats are still expected to be impacted by the assumed oil spill.

Potential oil-spill effects on marine and coastal bird habitats east of Cape Halkett could be reduced under this alternative with the reduction in the risks of oil-spill effects on marine and coastal bird habitats in Simpson Lagoon, Gwydyr Bay, Jago Lagoon, and offshore habitats in the sale area. However, oil-spill effects on marine and coastal birds and these habitats still are expected to occur from the assumed oil spill under Alternative IV. Thus, the overall effect of oil spills on marine and coastal birds still is expected to include the loss of several thousand birds, with recovery taking place within about one generation (2-3 years).

Noise and disturbance effects on marine and coastal birds from air and vessel traffic under Alternative IV are expected to be about the same as under the Alternative I base case (short-term displacement of birds lasting a few minutes to < 1 day), because the same level of development activity is assumed under both alternatives.

Assuming for this alternative (as for the base case) that offshore pipelines would be built to support oil development and production in the eastern and western parts of the proposed sale area, with Bullen Point and Oliktok Point as pipeline landfalls, this alternative would not reduce onshore habitat and disturbance effects on marine and coastal birds from those effects described for the base case.

Conclusion: Under Alternative IV, oil-spill effects on marine and coastal birds and their habitats east and offshore of Cape Halkett to Herschel Island could be reduced. However, the overall levels of effect on marine and coastal birds and their habitats in the sale area, due primarily to the assumed oil spill, noise and disturbance, and habitat alteration, are expected to be the same as for the base case (a loss of several thousand birds with populations expecting to recover within 1 generation).

5. Pinnipeds, Polar Bears and Belukha Whales: The Nuiqsut Deferral, Alternative IV, would remove from the proposed lease-sale area 243 whole and partial leasing blocks (about 14% of the sale area) of an area offshore of Prudhoe Bay east to offshore of the Canning River Delta (Fig. III.D.1). Alternative IV would provide a potential reduction in oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats from Cape Halkett east to Camden Bay. One spill (7,000 bbl) is assumed under Alternative IV compared with two spills (7,000 bbl each) under the base case. The probability of one or more oil spills ≥1,000 bbl occurring declines from 88 percent under the Alternative I base case to 72 percent under Alternative IV.

A comparison of the Alternative I base case and Alternative IV combined probabilities (expressed as percent chance) of one or more ≥1000-bbl spills occurring and contacting environmental resources—important habitats of pinnipeds, polar bears, and belukha whales—within 180 days is shown in Appendix B, Table B-51. Alternative IV reduces the chance of spill occurrence and contact to Simpson Lagoon (from 6% under the base case to 4% under Alternative IV), to Gwydyr Bay (from 8% under the base case to 5% under Alternative IV), and to Jago Lagoon (from 6% under the base case to 4% under Alternative IV) as shown in Appendix B, Table B-51. The chance of spill occurrence and contact with offshore marine habitats of these marine mammals from Herschel Island west to Point Barrow (as represented by Ice/Sea Segments IS 12 through IS 4 in Appendix B Table B-51) also is reduced under Alternative IV. However, probabilities of spill occurrence and contact to the Northern Lead System (NLS) during spring (May-June) are not reduced under Alternative IV, and the above habitats still are expected to be impacted by the assumed oil spill under Alternative IV.

Potential oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats east of Cape Halkett could be reduce under this alternative with the reduction in the risks of oil-spill effects on these marine mammal habitats in Simpson Lagoon, Gwydyr Bay, Jago Lagoon, and offshore habitats in the sale area. However, oil-spill effects on pinnipeds, polar bears, and belukha whales and these habitats still are expected to occur from the assumed oil spill under Alternative IV. Thus, the overall effect of oil spills on pinnipeds, polar bears, and belukha whales still is expected to include the loss of small numbers of seals (200-300 seals), walruses (no more than perhaps several hundred), polar bears, (perhaps 20-30 bears), and belukha whales (< 10), with populations recovering (recovery meaning the replacement of individuals killed as a consequence of the proposal) within one generation or less (such as about 2-5 years).

Noise and disturbance effects on pinnipeds, polar bears, and belukha whales from air and vessel traffic under Alternative IV are expected to be about the same as under the Alternative I base case (short-term displacement of marine mammals lasting less than a few days), because about the same level of air and vessel traffic encounters with these marine mammals is expected under both alternatives, even though the amount of air and vessel traffic is assumed to be reduced under Alternative IV.

Assuming for this alternative (as for the base case) that offshore pipelines would be built to support oil development and production in the eastern and western parts of the proposed sale area, with Bullen Point and Oliktok Point as pipeline landfalls, this alternative would not reduce onshore habitat and disturbance effects on pinnipeds, polar bears, and belukha whales from those effects described for the base case.

Conclusion: Under Alternative IV, oil-spill effects on pinnipeds, polar bears, and belukha whales and their habitats east and offshore of Cape Halkett to Herschel Island could be reduced. However, the overall levels of effect on pinnipeds, polar bears, and belukha whales and their habitats in the sale area, due primarily to the assumed oil spill, noise and disturbance, and habitat alteration, are expected to be about the same as for the base case (a loss of relatively small numbers of marine mammals with populations expecting to recover within 1 generation).

6. Endangered and Threatened Species: The Nuiqsut Deferral Alternative (Alternative IV) would remove about 14 percent of the proposed sale area, deferring the area offshore of Prudhoe Bay east to offshore of the Canning River Delta from petroleum exploration and development/production. Alternative IV would provide a potential reduction in oil-spill effects on endangered and threatened species and their habitats from about Cape Halkett east to Camden Bay. One spill (7,000 bbl) is assumed under Alternative IV compared with two spills (7,000 bbl each) under the base case (Alternative I). The probability of one or more oil spills ≥1,000 bbl occurring declines from 88 percent under the base case to 72 percent under Alternative IV.

a. Effects on the Bowhead Whale: This alternative would defer an area used by bowhead whales for occasional feeding and migration during the late summer and fall and slightly reduce the potential for adverse effects from oil spills, noise, and disturbance as a result of exploration and development and production activities.

Under this deferral alternative, 14 exploration and delineation wells would be drilled as compared with 22 under the base case. The number of platforms (5) and production wells (158) are expected to be less than for the base case. Noise and habitat disturbance from drilling units, postlease geophysical surveys, vessel and aircraft traffic, and production platforms to bowhead whales feeding in and migrating through the sale area would be reduced, because no new leases would be issued within the deferred area. However, leases previously have been granted in and adjacent to the deferred area as a result of previous Federal lease sales, and aircraft and vessel traffic may move into and across the deferred area enroute to these leased blocks. This traffic could disturb low numbers of bowheads for a few minutes once or twice per day and cause bowheads to avoid areas near vessel activities. In addition, noise from seismic surveys within leased blocks outside of the deferred area could be transmitted into the deferred area, although the sound intensity within the deferred area would be at reduced levels and would be unlikely to significantly displace feeding or migrating whales. However, noise from any activities on previously leased blocks within the deferred area would not be diminished by this alternative. In the area remaining to be offered for lease, the effect on bowheads would be as described for the base case, with whales avoiding areas within a few miles of vessels, seismic surveys, drilling units, and production platforms. Exposure of bowhead whales to noise-producing activities is not expected to result in lethal effects, but some individuals could experience temporary, nonlethal effects.

Oil-spill risks to bowhead whales would be reduced as compared with the base case. The OSRA estimated one spill ≥1,000 bbl, with an estimated 72-percent chance of one or more such spills occurring over the production life of the proposed action. The OSRA model estimated a 7- to 32-percent probability (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting Environmental Resource Areas (ERA's) 5-10 (Ice/Sea Segments IS's 5-10), where bowheads may be present during the fall migration, within 30 days over the production life of the proposed action (Table IV.A.2-1). The probability of contact in IS 9, the area of highest probability of contact, is estimated at 32 percent. The greatest reduction in oil-spill risk for this alternative compared with the base case occurs for ERA 8. The OSRA model estimated a 5-percent probability (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting ERA SLSN (Northern Spring Lead System), an area where bowheads may be present during the spring and fall migration, within 30 days over the production life of the proposed action. If spilled oil were to contact a whale-habitat area, resulting effects would be as discussed under the base case (Sec. IV.B.6). Some bowhead whales could experience one or more of the following: skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the consumption of contaminated prey items, and perhaps temporary displacement from some feeding areas. Some individuals might be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small. Overall, exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects.

Conclusion: The level of disturbance in the deferred area would be less with the alternative than without it; however, bowheads would be subject to the same level of disturbance in the area outside of the deferred area as they would be under the base case and would remain subject to some disturbance from activities on previously leased blocks within the deferred area. Oil-spill effects probably would not be reduced substantially under this alternative, although fewer whales would be likely to be exposed to spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills most likely would experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years.

b. Effects on the Arctic Peregrine Falcon: Because arctic peregrines primarily nest inland 32 km (20 mi) or more from the coast, deferral of this area would result in no demonstrable reduction of effects determined under the base case of the proposal (Sec. IV.B.6). These include disturbance (rarely) by distant support aircraft, construction of onshore gathering pipelines, and gravel mining and potential contact with oil either directly or through contact with oiled prey. Neither disturbance nor oiling of peregrines is considered a likely result of the proposed action or this alternative, because activities involving these adverse factors generally are far-removed from primary areas of falcon activity. Exposure of peregrines to oiled prey, likely to be infrequent in any case, is not expected to decrease significantly under this alternative, because the decreased number of projected spills does not result in significantly decreased shoreline contact by oil.

Conclusion: As determined for the base case of the proposal, overall routine and spill-related effects of the Nuiqsut Deferral Alternative on the arctic peregrine falcon are expected to be minimal, with <5 percent of the population exposed to potentially adverse factors. Because exposure of falcons to oiled prey is expected to be insignificant under both the base case and this alternative, reduction of adverse effects also is expected to be insignificant. No mortality is expected to result from this alternative.

c. Effects on the Spectacled Eider: Because spectacled eiders are uncommon in Beaufort coastal areas except during two relatively brief staging and migration periods, and little reduction in probability of oil spill contact (e.g., Table B-53) in areas potentially used by this species results from deferral of the central sale area under this alternative, deferral of the area would result in no significant reduction of the effects determined for this species under the base case of the proposal (Sec. IV.B.6). These include no significant effects from routine activities and relatively low mortality from an oil spill (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur given the present population status of declining numbers on the breeding grounds in recent decades and relatively low reproductive rate.

Conclusion: As determined for the base case of the proposal, overall routine effects of the Nuiqsut Deferral Alternative on the spectacled eider are expected to be minimal, affecting <2 percent of the population. Likewise, no significant reduction of the oil-spill mortality expected under the base case is anticipated, because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur under the current declining population status.

d. Effects on the Steller's Eider: Because the only substantial occurrence of Steller's eiders in Alaska during the nesting season is in the Barrow area (they are rare east of Pt. Barrow) and almost no reduction in spill-contact probability (e.g., Table B-53) in the areas potentially used by this species results from this alternative, deferral of the area would result in no significant reduction of the effects determined under the base case of the proposal (Sec. IV.B.6). These include no significant effects from routine activities and relatively low mortality from an oil spill (<100 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur given the present population status of declining numbers on the breeding ground in recent decades and relatively low reproductive rate.

Conclusion: As determined for the base case of the proposal, overall routine effects of the Nuiqsut Deferral Alternative on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population. Likewise, no significant reduction of the oil-spill mortality expected under the base case is anticipated, because there is no significant change in probability of spill contact in coastal areas used by eiders. No recovery from any substantial mortality is likely to occur if population status is declining as at present.

7. Caribou: The Nuiqsut Deferral, Alternative IV, would remove from the proposed lease-sale area 243 whole and partial leasing blocks (about 14% of the sale area) of an area offshore of Prudhoe Bay east to offshore of the Canning River Delta (Fig. III.D.1). Alternative IV would provide a potential reduction in oil-spill effects on caribou and their coastal (insect-relief) habitats from about Cape Halkett east to Camden Bay. One spill (7,000 bbl) is assumed under Alternative IV compared with two spills (7,000 bbl each) under the base case. The probability of one or more oil spills ≥1,000 bbl occurring declines from 88 percent under the base case (Alternative I) to 72 percent under Alternative IV.

A comparison of the Alternative I base case and Alternative IV combined probabilities (expressed as percent chance) of one or more ≥1000-bbl spills occurring and contacting land segments—important coastal habitats of caribou— within 180 days is shown in Appendix B, Table B-53) Alternative IV shows the highest reduction in the chance of spill occurrence and contact to the shoreline from Point McIntyre east to Flaxman Island (from 7% under the base case to 3% under Alternative IV for LS 34 and from 5% under the base case to 3% under Alternative IV for LS 37). The chance of spill occurrence and contact with some other coastal habitats of caribou from Pitt Point (LS 26) east to Barter Island (LS 41) were slightly reduced under Alternative IV (Appendix B Table B-53). However, probabilities of spill occurrence and contact to the shoreline of the sale area within 180 days was still 30 percent (Appendix B Table B51, contact to Land).

Potential oil-spill effects on caribou coastal habitats east of east from Point McIntyre to Flaxman Island could be reduced under this alternative with the reduction in the risks of oil-spill effects on caribou using insect-relief habitats along this coastal area. However, oil-spill effects on caribou and these habitats are still expected to occur from the assumed oil spill under Alternative IV. Thus, the overall effect of oil spills on caribou still is expected to include the loss of small numbers of caribou with recovery occurring within about 1 year.

Disturbance and displacement effects on caribou from air and road traffic under Alternative IV are expected to be about the same as under the base case of Alternative I (local but long-term displacement of some caribou cows and calves during the calving season, persisting for more than 1 generation); because the same level of onshore development activity (i.e., onshore pipelines and roads) is assumed under both alternatives.

Assuming for this alternative (as for the base case) that onshore pipelines and roads would be built to support oil development and production in the eastern and western parts of the proposed sale area, with Bullen Point and Oliktok Point as pipeline landfalls and the same onshore facilities, this alternative would not reduce onshore habitat effects on caribou from those effects described for the base case.

Conclusion: Under Alternative IV, oil-spill effects on caribou and their habitats from Point McIntyre east to Flaxman Island could be reduced. However, the overall levels of effect on caribou and their habitats in the sale area, due primarily to disturbance-displacement, and habitat alteration are expected to be the same as for the base case (local displacement of some caribou cows and calves during the calving season with effect persisting for >1 generation).

8. Economy of the North Slope Borough: The Nuiqsut Deferral Alternative would decrease the area offered for leasing to industry and could decrease industry interest in Sale 144. However, for the purpose of analyzing potential changes to NSB revenues, expenditures and employment, this alternative is considered to have the same effects as for the base case, as discussed in Section IV.B.8. The effects on the subsistence economy are reduced.

Increased revenues and employment are the most significant economic effects that would be generated by this alternative. Increased property-tax revenues and new employment would be created with the construction, operation, and servicing of facilities associated with OCS activities. These facilities are described in Table IV.A.1-1 and are summarized as follows: during the exploration phase between 1997 and 2004, 5 exploration and 9 delineation wells would be drilled, and during the development and production phase between 2001 and 2027, 158 production wells would be drilled and 5 platforms and 111 km of offshore pipeline would be installed. The number of workers needed to operate the infrastructure is determined by the scale of the infrastructure and not the amount of oil produced. Some temporary employment is generated by assumed oil spills.

Analysis of economic effects resulting from this alternative is limited to effects on the NSB. The information that follows is from the Rural Alaska Model, prepared for MMS by the ISER, and from the NSB 1993/1994 Economic Profile and Census Report (Harcharek, 1995).

a. NSB Revenues and Expenditures: Under existing conditions, total property taxes in the NSB and NSB revenues are in general projected to decline, as discussed in Section III.C.1. This alternative is projected to increase property taxes above the declining existing-condition levels starting in the year 1997, averaging about 2 percent each year through the production period. Also under existing conditions, the two expenditure categories that affect employment—operations and the CIP—are projected to decline. Of these two categories, only expenditures on operations would be affected by the proposed sale's effects on taxable property value.

b. Employment: The gains from this alternative in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. A peak employment estimate of 2,480 jobs is projected for 2006, declining to under 1,000 jobs by 2023. (See Appendix E for a description of the methodology for employment and population forecasts.) All of these jobs would be filled by commuters who would be present at the existing enclave-support facilities approximately half of the days in any year.

This alternative is projected to affect employment of the region's permanent residents in two ways: (1) more residents would obtain petroleum-industry- related jobs as a consequence of Sale 144 exploration and development and production activities, and (2) more residents would obtain NSB-funded jobs as a result of higher NSB expenditures.

While the Nuiqsut Deferral Alternative is projected to generate a large number of petroleum-industry-related jobs in the region, the number of jobs filled by permanent residents of the region is not projected to be large. Total resident employment with this alternative is expected to be about 4-percent greater than existing-condition employment. Overall employment should, therefore, not decline as far by the end of the projection period as it would under existing conditions. The increase in employment opportunities may partially offset declines in other job opportunities and delay expected outmigration.

Employment generated by oil-spill-cleanup activities also would have economic effects. The number of cleanup workers actually used to clean up the assumed oil spill of 7,000 bbl associated with this alternative would depend to a great extent on what procedures were called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities. Activities associated with Sale 144 could generate cleanup work for about 3 percent of the workers associated with the EVOS—or 300 cleanup workers at the peak of the cleanup effort.

c. Effects of Subsistence Disruptions on the NSB Economy: Disruptions to the harvest of subsistence resources could affect the economic well-being of NSB residents in a number of ways. Adverse effects primarily would be felt through the direct loss of subsistence resources. In addition, loss of subsistence resources would increase demand for store-bought goods and result in an inflation of prices.

Subsistence activities are an integral component of the NSB economy as well as the culture. Subsistence is the "body and soul" of Native culture (Nukapigak, 1995). If one or more subsistence resources became unavailable for harvest, the economic well-being of NSB residents would be harmed. There are two components to the economic well-being associated with subsistence resources—the value of subsistence resources as a source of food and the cultural value of the resources. Both of these values can be represented as a direct source of economic well-being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased in the marketplace. This food source is a substitute for income earned in the marketplace that would have to be used to purchase food. Subsistence activities and the value derived from these pursuits, however, go beyond a substitute for food bought in the market. As a way of life, there is a real, measurable economic value gained from NSB residents having access to such activities. A disruption of a subsistence harvest, for example by an oil spill, would result in a real loss of economic well-being to residents. "Our food would be destroyed by an oil spill" (Itta, 1995).

The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. Under the Nuiqsut Deferral Alternative, effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns on Barrow (Atqasuk), Kaktovik, and especially the community of Nuiqsut are expected to affect subsistence resources for a period up to 1 year but make no resource unavailable, undesirable for use, or greatly reduced in number (see Sec. IV.E.10, Subsistence-Harvest Patterns).

Conclusion: For the Nuiqsut Deferral Alternative, the effects on the economy of the NSB are expected to be different from the base case of the proposal in that OCS direct employment will be less. A peak employment of 2,480 is projected for 2006, declining to under 1,000 jobs by 2023.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. Under the Nuiqsut Deferral Alternative, effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns on Barrow (Atqasuk), Kaktovik, and especially the community of Nuiqsut are expected to affect subsistence resources for a period up to 1 year but make no resource unavailable, undesirable for use, or greatly reduced in number.

9. Sociocultural Systems: Alternative IV, Nuiqsut Deferral, would alter the onshore industrial activities and population and employment projections for the sale, because the resource estimate for this alternative is 40 percent lower than for the base case. The number of wells, platforms, and pipeline miles estimated for exploration, development and production, and transportation also would decrease (see Table IV.A.1-1).

In the Nuiqsut Deferral, an estimated one spill ≥1,000 bbl is assumed with a 72-percent chance of occurrence. The OSRA probabilities for this deferral area indicate a 45-percent chance of one or more spills ≥1,000 bbl occurring and contacting Subsistence Resource Area C within 30 days during the winter and open-water seasons and a 5-percent chance within 180 days. This represents a 23-percent reduction from current base-case 30-day probabilities and a 22-percent reduction from current base-case 180-day probabilities (see Appendix B). The probability of spill contact to Subsistence Resource Area D also would be reduced with Alternative IV. Effects on Nuiqsut subsistence-harvest patterns, particularly the bowhead whale hunt, would be reduced from the base case (see Sec. IV.B.10).

Conclusion: Under this alternative, effects on sociocultural systems from industrial activities, changes in population and employment, and effects on subsistence-harvest patterns are expected to produce only short-term disruptions to sociocultural systems in Barrow (Atqasuk) and Kaktovik; in the community of Nuiqsut, effects would be less pronounced and of shorter duration. These disruptions are expected to last up to 1 year but are not expected to cause displacement of ongoing community activities and the traditional practices for harvesting, sharing, and processing subsistence resources.

10. Subsistence-Harvest Patterns: Effects on subsistence from the proposed lease sale would result from oil spills; noise and disturbance; and the placement of exploration, development and production, and support facilities. Under the Nuiqsut Deferral, Alternative IV, the oil-resource estimate is reduced by 40 percent, and the number of wells, platforms, and pipeline miles estimated for exploration, development and production, and transportation also would decrease. Alternative IV removes activity from 243 blocks (559,872 ha or 14% of the sale area) in an area offshore of Prudhoe Bay east to and offshore of the Canning River Delta (Fig. III.D.1).

Many subsistence activities occur locally; but Nuiqsut subsistence whaling originates from Cross Island, with a whaling area encompassing waters from east of the Colville River Delta to offshore and eastward of Cross Island. In the base case, an estimated two spills ≥1,000 bbl are assumed with an 88-percent chance of occurrence. In the Nuiqsut Deferral, an estimated one spill ≥1,000 bbl is assumed with an 72-percent chance of occurrence. The OSRA probabilities for the Nuiqsut Deferral indicate a 45-percent chance of one or more spills ≥1,000 bbl occurring and contacting Subsistence Resource Area C within 30 days during the winter and open-water seasons and a 51-percent chance within 180 days. This represents a 23-percent reduction from current base-case 30-day probabilities and a 22-percent reduction from current base-case 180-day probabilities (see Appendix B). The reduced probability of an oil spill contacting the area from Cape Halkett to Camden Bay would reduce the level of effects from oil spills on Nuiqsut's bowhead whale harvest that are expected for the base case under Alternative I. The percent chance of a spill occurring and contacting Barrow's Subsistence Resource Area B, and Kaktovik's Subsistence Resource Area D is also reduced.

Noise and disturbance would affect some Nuiqsut subsistence activities. While this deferral alternative would not substantially change biological effects to regional populations of subsistence species, it would eliminate nearshore blocks of a major portion of Nuiqsut's bowhead whale subsistence-harvest area and thus offer some mitigation from noise and traffic disturbance to this community's hunters. Overall, a reduction in production platforms (from eight in the base case to five in Alternative IV) and pipeline miles would occur; with the deletion of Pt. McIntyre in this alternative, a reduction in landfalls would occur as well.

Conclusion: Under Alternative IV, effects as a result of oil spills, noise and disturbance, and construction activities on subsistence-harvest patterns in Barrow (Atqasuk), Kaktovik, and especially the community of Nuiqsut are expected to affect subsistence resources for a period up to 1 year but make no resource unavailable, undesirable for use, or greatly reduced in number.

11. Archaeological Resources: Under the Nuiqsut Deferral Alternative, 243 whole and partial leasing blocks (about 14% of the sale area) of an area offshore of Prudhoe Bay east to offshore of the Canning River Delta would be removed from consideration. Of the 14 reported shipwrecks in the proposed sale area one, the *Reindeer,* would be removed from further analysis if the Nuiqsut Deferral Alternative were adopted (Tornfelt and Burwell, 1992).

Conclusion: The effects from the Nuiqsut Deferral Alternative would be the same as for the proposal.

12. Air Quality: The Nuiqsut Deferral Alternative (Alternative IV) would remove about 14 percent of the proposed sale area, deferring the area offshore of Prudhoe Bay east to offshore of the Canning River Delta from petroleum exploration and development/production. This would decrease the level of activity from the base case and, consequently, the effect on air quality is expected to remain low (see Sec. IV.B.12).

Conclusion: The effects of this alternative on air quality are expected to be low, the same level of effects as for the base case.

13. Land Use Plans and Coastal Management Programs: Deferring the 243 blocks in the south-central portion of the proposed lease-sale area (offshore Prudhoe Bay east to offshore the Canning River Delta) would lessen the risk of oil spills occurring and contacting waters of the deferred area; possible effects on coastal habitats in this area would be reduced. There would be a reduction in the probability of an oil spill contacting the subsistence-harvest areas used by Nuiqsut, Barrow and Kaktovik, as well as a reduction of noise and disturbance levels due to the decrease in the number of wells, platforms, and pipeline miles estimated for exploration, development and production in the subsistence-harvest area of Nuiqsut. Pipeline landfalls for this alternative would decline by one from the three forecast for the proposal. The landfalls handling crude-oil production from the eastern and western Beaufort Sea would remain. The landfall forecast for the West Dock would not be necessary. Pollution from artificial-island construction and local, permitted discharges near Nuiqsut would be eliminated.

Conclusion: For Alternative IV, the effects of potential conflicts on land use plans and coastal management programs overall are expected to be almost the same as for the base case of Alternative I: conflicts could occur with specific Statewide standards and NSB Coastal Management Plan policies related to the potential for user conflict between development activities and the subsistence bowhead whale hunt, with the exception that the Nuiqsut Deferral Alternative would reduce the possibility of conflicts with the Nuiqsut subsistence-harvest area by reducing the possibility of spilled oil contacting that area and providing some mitigation from noise-related disturbances affecting the harvest area of Nuiqsut.

F. EFFECTS OF ALTERNATIVE I - THE PROPOSAL, LOW CASE:

Introduction: The low case of the proposed action is not expected to yield recoverable quantities of hydrocarbons. Accordingly, the field-development scenario is expected to be an exploration-only scenario. Exploration drilling is expected to begin in 1997 and cease in 2001. During these years, a total of six exploration and delineation wells may be drilled. In this scenario, only one rig a year would be active. Total drilling muds discharged as a result of drilling these wells would be 3,780 tons. Total cuttings discharged would be 4,920. As part of the siting of each of the six wells, a total of 138 km of the Beaufort Sea would be affected by seismic surveys. During the life of the exploratory drilling, 540 helicopter flights would be launched to support the single working rig. During the same period, there would be 48 support-boat trips in support of offshore bottom-founded rigs. Nearshore drilling would take place on ice islands that would be supported from shore by ice roads. Of the 5 years allocated to exploratory drilling in the low case, it is assumed for purposes of analysis that drilling in two of those years would be conducted on nearshore ice islands. For further information on exploration timeframes, see Appendix A, Table A-1.

1. Water Quality:

For the low case, the only agent likely to affect water quality in the Beaufort Sea Sale area would be deliberate discharges from exploration platforms. Oil spills and construction activities related to development would not occur.

Deliberate Discharges During Exploration: Exploratory vessels would discharge drilling fluids in bulk quantities (Sec. IV.B.1), along with sanitary wastes from wastewater-discharge sources. Discharges of drilling muds and drill cuttings for exploration would occur over a 6-year period. One well per year would be drilled and 570 metric tons (630 English short tons) of drilling mud and 740 metric tons (820 English short tons) of drill cuttings would be discharged each year.

Drilling muds used offshore of Alaska are of relatively low toxicity and are limited to this low level of toxicity in permits for their discharge granted by USEPA. During exploration, only barium concentrations in discharged muds are expected to be always more than a 100-fold greater than concentrations in shelf sediments (Table IV.B.1-1). Concentrations of cadmium, chromium, lead, mercury, and zinc in discharged muds, however, may be more than 100-fold greater than concentrations in nearshore sediments.

Based on the above and additional information presented in Section IV.B.1, exploratory discharges are not likely to exceed applicable water-quality criteria outside of a 100-m (328-ft) radius, or 0.03 km^2 (7 acres) around each discharge site. With only one well drilled per year, no more than 0.03 km^2 (7 acres) at any one time could be temporarily degraded during active discharge of drilling muds and cuttings.

Conclusion: For the low case, effects on water quality would be limited to exploration discharges and would persist for a few hours over a fraction of a square kilometer (km^2 = 0.29 nautical mi^2) [nmi^2]).

2. Lower Trophic-Level Organisms:

In the low case, exploration only is assumed in the sale area. There are no production activities associated with this alternative. Routine activities that may affect lower trophic-level organisms in the Beaufort Sea include seismic surveys and drilling discharges. The effects of these activities on lower trophic-level organisms are discussed in the base-case analysis (Sec. IV.B.2). The following low-case analysis focuses on the differences in the amount of routine activity (the only variable) estimated for the low case as compared with that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for the low case.

a. Effects of Seismic Surveys:

As discussed in the base-case analysis, seismic surveys are expected to have little or no effect on lower trophic-level organisms. The base-case scenario estimates that up to 30 seismic surveys would be required for 8 exploration wells, 14 delineation wells, and 8 production platforms. Because the low case estimates only 6 seismic surveys for 4 exploration and 2 delineation wells, it is expected to have even less of an effect on lower trophic-level organisms. Hence, the low case is expected to have even less of an effect on lower trophic-level organisms (i.e., little or no effect) than the base case.

b. *Effects of Drilling Discharges:* The exploration scenario assumes that four exploration and delineation wells would be drilled under the low case. This would release about 3,780 short tons of drilling muds and 4,920 short tons of drill cuttings into marine waters over a 5-year period. Discharges of this type were found to have no adverse effects on planktonic organisms and mostly sublethal effects on benthic organisms. Any effect on benthic organisms would be limited to areas near and downcurrent of the discharge point. Less than 1 percent of the benthic organisms within the sale area would be affected by discharges associated with the base case, and recovery is expected within 1 year. Because the scenario estimates only 4 exploration wells under the low case (the base-case scenario estimates a maximum of 30), the low case is expected to have even less of an effect than the base case on lower trophic-level organisms. The epontic community is not likely to be affected by the low case.

Conclusion: Drilling discharges and seismic surveys associated with the low case are expected to have even less of an effect on lower trophic-level organisms than that of the base case (mostly sublethal effects on <1% of the benthic organisms in the sale area). Recovery is expected within 1 year.

3. *Fishes:* For the low-case scenario, fishes probably would be affected by geophysical (seismic) operations and drilling. However, a low-case assumption is that no significant oil fields would be found; so no oil spills would occur, and neither pipelines nor causeways would be constructed.

The following assessment of the effects of seismic exploration and drilling on marine fishes is based on the base-case assessment in Section IV.B.3, and particularly the information in the proceedings of the Alaska-based symposium on "Fisheries and Oil Development on the Continental Shelf" (Benner and Middleton, 1991). The assessment also incorporates by reference the assessments of effects on fishes for the low case in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). The conclusions of both assessments were that the effects would be low or very low.

The seismic exploration and drilling activities associated with the low case that occur within the Sale 144 area primarily would affect marine fishes that inhabit the Federal waters outside of bays, lagoons, and river deltas. Anadromous and freshwater fishes, which usually inhabit only freshwater or the nearshore band of relatively warm, brackish water, would not be affected by the anticipated operations beyond the 3-mi Federal/State border.

a. *Drilling Effects:* Activities associated specifically with drilling-unit installation and operation—including the discharge of drilling fluids—have not changed since preparation of the Sale 124 and 126 FEIS's. For the Sale 144 area, six wells are projected to be drilled over a 5-year period (Appendix A, Table A-1). Exploration discharges are expected to equal about 3,780 short tons of drilling muds and 4,920 short tons of drill cuttings. These discharges would be about one-fifth as great as was assumed for the base case, so the overall effects on fishes would be less than those for the base case. Fishes probably would be displaced a short distance during installation of drilling equipment and drilling-fluid discharge but would reutilize their habitat upon completion of the activities. In other words, the effects for the low case on fishes would be nonlethal, local, and temporary.

b. *Seismic Effects:* The following assessment of the specific effects of seismic operations on fishes is based on Section IV.B.3, which analyzes the probable effects of seismic operations for the base-case assumptions. The conclusion in that section is that seismic operations would injure only a few fish, those with air bladders, for one generation in a localized area. For the low-case scenario, the amount of seismic operations that are projected are about half as great as for the base case: 150 km^2 during 1 month of operation (Table IV.A.1-1). This small amount of seismic activity would, at most, injure very few fishes for one generation in localized areas.

Conclusion: The most serious effects of the low case on fishes would be injury to very few fishes for one generation (or <7 years) in localized areas.

4. *Marine and Coastal Birds:* Several million migratory birds of about 150 species occur on marine, coastal, and tundra habitats within or adjacent to the proposed Sale 144 area. Oldsquaw, red phalarope, glaucous gull, and common eider are among the most abundant species present. Important coastal habitats are shown in Fig. III.B.3. The primary adverse effects from low-case OCS exploration activities in the proposed sale area on marine and coastal birds could come from noise and disturbance associated with air and vessel traffic in support of exploration activities. No oil spills are assumed to occur under the low case.

Site-Specific Noise and Disturbance Effects: Primary sources of noise and disturbance to marine and coastal birds would come from air (about 108 flights/year for 2 years) and marine (10 boat trips/drilling season for 5 years) traffic to and from the one exploration platform (operating/year). Air support is assumed to be centered out of Deadhorse-Prudhoe Bay with 1 helicopter round trip per day during the open-water season for the one exploration-drilling platform and a total of about 108 helicopter trips per year (out to the one unit and back to Deadhorse-Prudhoe Bay over a 5-year period). If there are drilling operations during the open-water season, MMS requires the operator to maintain an emergency-standby vessel within the immediate vicinity of the drilling unit. Depending on ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for a floating platform.

The greatest disturbance is likely to come from aircraft traffic flying near barrier-island bird colonies and to a lesser degree from aircraft and boats passing near lagoon concentrations of feeding and molting waterfowl and shorebirds. Aircraft flying between the exploration platform and support facilities at Deadhorse that take a route along the coast adjacent to the sale area during the nesting season are more likely to temporarily disturb thousands of birds than aircraft that fly directly from Deadhorse airport to the offshore platform. Occasionally, these direct offshore flights may briefly disturb foraging flocks of seabirds with little or no lasting effects; however, aircraft disturbance to local feeding or molting concentrations of waterfowl and shorebirds in the lagoon areas during the fall may reduce the ability of migratory birds to acquire the energy (fat-lipid reserves) necessary for successful migration. If such disturbance occurred frequently, migration mortality might increase and winter survival of other affected birds might be reduced; but the amount of air traffic (one or two flights/ day/platform during drilling of the exploration wells) is not likely to more than occasionally disturb more than a few feeding and molting flocks of birds near the coast or near the drill platform. Noise and disturbance displacement effects on birds from aircraft traffic are expected to be very short term (a few minutes to < 1 hour).

The noise associated with drilling operations and the movement of barges and supply vessels (about 10 trips/year) could disturb foraging seabirds near the drilling site. However, the low-frequency sounds emitted from drilling operations have not been shown to continually displace foraging seabirds from active oil-development areas along the California coast or in Cook Inlet. Expected Sale 144 vessel traffic of about 10 trips to and from the one platform per year during the 5 years of exploration could temporarily disturb marine and coastal birds. As the vessels pass near the birds, short-term diving or flight responses may result. Unless industry uses small boats or hovercraft capable of moving through very shallow water and boat operators deliberately pass through the coastal lagoons and river deltas, vessel-traffic disturbance of birds is likely to be very brief (a few minutes to < 1 hour). It is very unlikely that industry operations under the proposed marine-support and transportation scenarios would have any reason for moving boats through the shallow lagoons adjacent to the sale area. However, if industry boat traffic were to pass through the lagoons, disturbance effects on birds would be similar to those of low-flying aircraft. The overall effect of noise and disturbance from aircraft, boat traffic, and drilling activities on marine and coastal birds is expected to be very short-term, with disturbed birds returning to normal behavior, local distribution, and abundance within 1 hour.

Conclusion: For the low case, the overall effects on marine and coastal birds (waterfowl, seabirds, and shorebirds) are expected to be very short term (< 1 hour) and local (within a few km of the disturbance sources).

5. Pinnipeds, Polar Bears, and Belukha Whales: Six species of nonendangered marine mammals—numbering over 100,000 ringed, spotted, and bearded seals; 3,000 to 5,000 polar bears; 250,000 walruses; and about 12,000 belukha whales—commonly occur year-round or seasonally in a portion of or throughout the Beaufort Sea Planning Area and are very likely to be exposed to OCS-exploration activities. Noise and disturbance could adversely affect marine-mammal populations found in the proposed Sale 144 area. No oil spills are assumed to occur under the low case.

a. Site-Specific Noise and Disturbance Effects: The primary sources of noise and disturbance of ringed, bearded, and spotted seals; walruses; polar bears; and belukha whales would come from the air and marine traffic associated with the low case and more specifically from the supply-boat traffic (12 trips/year), icebreakers, and helicopters (about 108 helicopter flights/year) associated with the assumed one or two exploration-drilling units. Aircraft traffic centered out of Deadhorse-Prudhoe Bay, or other locations, traveling to and from the drilling platform could be a primary-disturbance source to spotted seals hauled out on the beaches along the Colville River Delta and to walruses and bearded and ringed seals hauled out on the ice. Seismic boats assumed for the low case also would be primary-noise sources (see Sec. II.B.1.a). Secondary-disturbance sources would be low-frequency noises from drilling operations on the one exploration platform. Exploration drilling would take place from a bottom-founded mobile or floating drilling unit; depending on ice conditions, the floating unit would be supported by one or more vessels with icebreaking capabilities.

Exploration drilling from a drillship in the deeper water tracts may coincide with the belukha whale fall migration through the offshore areas along the pack-ice front. Icebreaker traffic has been demonstrated to disturb the belukha whales within 35 to 50 km (22-31 mi) of the vessel (Finley and Davis, 1986). Other than flight responses, the meaning or importance of behavioral changes correlated with the sound and presence of boats is uncertain. Icebreaker traffic could briefly interrupt marine-mammal migration when the vessels are near marine-mammal concentrations within a lead system; and it temporarily (a few hours to a few days) may interrupt the movements of belukha whales, seals, and walruses or displace some animals 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 low-case activities. Such traffic is not likely to have more than a short-term (a few hours to a few days) displacement effect on pinniped, polar bear, and belukha whale movements or distributions; but the displacement of pinnipeds, polar bears, and belukha whales could affect the availability of these animals to subsistence hunters for that season. Icebreaker activity also may physically alter some ice habitats and destroy some ringed seal lairs in pack-ice areas, perhaps crushing or displacing some ringed seal pups and perhaps displacing a few denning polar bears. Populations of seals and polar bears should recover from such losses within 1 year.

Exploratory drilling during the winter season—when natural leads are often frozen over—would result in formation leads and cracks in the ice on the leeward side of the one drill platform (operating/year); such local changes in ice habitat would attract seals, which in turn could attract polar bears (Stirling, 1988). In a worst-case situation, a few polar bears could be unavoidably killed to protect oil workers when the bears were attracted to the drill platform due to food odors and curiosity. Under the Marine Mammal Protection Act, the oil companies would be required to have a permit to take or harass polar bears. Consultation with the FWS on this matter is expected to result in the use of nonlethal means in most cases to protect the safety of the rig workers from polar bear encounters. The number of bears lost as a result of such encounters is expected to be very low (probably <5 bears).

Some of the air traffic to and from exploration-drilling platform (108 helicopter trips/year) could greatly disturb some hauled-out seals and walruses, causing them to charge in panic into the water. Because of frequent low visibility due to fog, aircraft may not always be able to avoid disturbing walruses and seals hauled out on the ice. Walrus nursery herds that haul out on the ice in the far western part of the planning area are not expected to be exposed to aircraft traffic, because the westernmost lease blocks of the proposal are to the east of the ice front where walrus nursery herds occur during the summer-fall (July through September) season. However, aircraft disturbance of hauled out seals in the sale area could result in injury or death to young seal pups. Although air-traffic disturbance would be very brief, the effect on individual seal pups could be severe. Aircraft disturbance of small groups of spotted and ringed seals hauled out along the coast or disturbance of bearded seals hauled out offshore near the one drill platform is not likely to result in the death or injury of many seals, although increases in physiological stress caused by the disturbance might reduce the longevity of some seals if disturbances were frequent. The overall effect of aircraft disturbance is expected to involve the loss of a few walrus calves and seal pups and to result in temporary displacement and stress on other pinnipeds, with populations expected to recover within <1 year.

b. Effects of Geophysical Seismic Activities: Over a 5-year exploration period, an area of approximately 138 km^2 (85 mi^2) is assumed to be covered by geophysical seismic surveys (a minimum of 23 km^2 [14 mi^2]/lease block) using about two vessels/year in the Beaufort Sea Planning Area during the open-water season.

Ringed seals pupping in shorefast-ice habitats within about 150 m (135 yd) of the on-ice shot lines are likely to be disturbed by on-ice seismic exploration (Burns and Kelly, 1982). However, the number of ringed seal pups that possibly could be killed as a result of this level of disturbance is likely to be less than a few hundred, considering the sparse distribution (1-2 seal dens/nmi^2) of breeding seals in the Beaufort Sea. This is expected to have no more than a short-term (< 1 year) effect on the population (40,000 seals), with recovery taking place within 1 year.

An estimated 23 km^2 (14 mi^2)/well of open-water seismic surveys at several survey sites, using perhaps two seismic boats for 8 days, could disturb pinnipeds, polar bears, and belukha whales during the 1 to 2 weeks of survey activity (Sec. II.B.1.a). Similar to other boat traffic, open-water, active seismic activities are likely to result in startle responses by ringed, bearded, and spotted seals; walruses; polar bears; and belukha whales near the sound source. As with other vessel traffic, this disturbance response is likely to be brief (a few minutes to < 1 hour), and the affected animals are likely to return to normal behavior patterns within a short period of time (a few hours) after a seismic vessel has left the area. Noise and disturbance from seismic boats and other vessels could be a problem if boat traffic moved near marine-mammal-haulout areas or interfered with spotted seal and walrus movements. However, this effect is not likely, given the expected amount of vessel traffic associated with the low case. If the presence of noise from industrial activity occurred very near coastal subsistence areas and reduced or delayed the use of these habitats by marine mammals, the availability of these subsistence resources to villagers could be adversely affected (see Sec. IV.C.10.a, Effects on Subsistence). Overall, noise and disturbance from air and marine traffic associated with the low case are expected to have short-term (< 1 day) and localized (within 1-3 km [0.62-1.9 mi] of the activity) effects on these marine-mammal populations.

c. Effects of Offshore Platform Installation: For the low case, one exploration-drilling platform (unit) per year is assumed to be used in the sale area. Site preparation for a bottom-founded drilling unit could temporarily—for one season—affect marine mammals through noise and disturbance. Some pinnipeds, polar bears, and belukha whales temporarily could be displaced within approximately 1.6 to 4.8 km (1-3 mi) of the platform by noise and disturbance from platform installation and marine-vessel and air-support traffic. Local displacement for less than one season could occur within 1 to 3 mi of the activity site.

Overall Summary: For the low case, noise and disturbance due to air and vessel traffic, seismic shallow-hazard surveys, and drilling-unit installation and operations could have some adverse effects on pinnipeds, polar bears, and belukha whales found in the lease-sale area. Noise associated with seismic activities and air and vessel traffic could cause brief startle, annoyance, and/or flight responses (a few minutes to < 1 hour) of pinnipeds, polar bears, and belukha whales. Helicopter trips and boat traffic to and from the one exploration-drilling platform could disturb small numbers (< 100) of hauled-out ringed, bearded, and spotted seals and walruses, causing them to charge in panic into the water and result perhaps in the injury or death of a small number of seal pups and walrus calves (< 100). Because the walrus-nursery herds and nursing seals and pups are widely distributed along the ice front, aircraft moving to and from the drill platform is likely to temporarily disturb only a small portion of the walrus and seal populations. Thus, aircraft-disturbance effects on walrus and seal abundance and distribution is expected to be short term, with populations recovering within < 1 year.

Vessel traffic supporting the drilling units and seismic vessels operating during the open-water season temporarily could displace or interfere with some marine-mammal movements and distribution for a few hours to a few days. Such short-duration displacement is expected to have a short-term (a few hours to a few days) effect on the local distribution and abundance (within 1-3 km of the activity) of pinnipeds, polar bears, and belukha whales.

Conclusion: The overall effect of the low case is expected to include the loss of small numbers (< 100) of pinnipeds (ringed, bearded, and spotted seals and walruses) and (< 10) of polar bears, and there would be a short-term effect (a few hours to a few days) on the local distribution (1-3 km) of pinnipeds, polar bears, and belukha whales.

6. Endangered and Threatened Species: The endangered bowhead whale, the threatened spectacled eider, the proposed Steller's eider, and the recently delisted arctic peregrine falcon (considered here as a candidate species) may occur year-round or seasonally in the Beaufort Sea Planning Area and may be exposed to OCS exploration activities under the low case of the proposal. OCS activities under the low case may result in noise and disturbance; altered habitat; and contaminants, such as drilling muds and cuttings, and could adversely affect the behavior, distribution, and abundance of individuals or populations occurring in or adjacent to the Sale 144 area.

The low-case scenario assumes that one drilling unit would drill one or two exploration or delineation wells each year between 1997 and 2001 for a total of six wells. Support for operations on ice islands or nearshore gravel islands is expected to be by ice roads. Drilling operations farther offshore would be supported during the open-water season by at least one supply-boat trip/drilling unit/week and one helicopter flight/drilling unit/day. Depending on ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units. The time required to drill and test a well is about 90 days. It is assumed that no production would occur under this alternative and that crude oil would not be released during exploration. More detailed information on logistics and transportation scenarios may be found in Section II.A.

a. Effects on the Bowhead Whale: Bowhead whales may be present in the Sale 144 area generally from early April to mid-June during their spring migration from the Bering Sea to the Canadian Beaufort Sea and from August through October during their fall migration back to the Bering Sea. Noise-producing exploration activities, including aircraft traffic, icebreaking or other vessel traffic, geophysical-seismic surveys, and drilling are the activities most likely to affect bowhead whales. The potential effects on bowhead whales as a result of these activities are discussed in detail under Section IV.B.6, the base case.

Bowheads may exhibit avoidance behavior if approached by vessels at a distance of 1 to 4 km (0.62 to 2.5 mil). They are not affected much by any aircraft overflights at altitudes above 300 m (328 yd). Most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a distance of a few kilometers but rarely show avoidance behavior at distances of more than 7.5 km (4.7 mi). Bowheads have been sighted within 0.2 to 5 km (0.12-3 mi) from drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to noise-producing activities. If drillships are attended by ice- breakers, as is typically the case during the fall in the U.S. Beaufort Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to ice-breakers breaking ice. In general, whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident; and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30 to 60 minutes (in the case of seismic activity).

Occasional brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migrating between the central Bering and eastern Beaufort Seas. However, these disturbance or avoidance factors might become significant if industrial activity were sufficiently intense to cause repeated displacement of specific individuals. Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant seismic exploration or drilling. Behavioral studies have suggested that bowheads habituate to noise from distant ongoing drilling or seismic operations (Richardson, Wells, and Wursig, 1985; Richardson et al., 1985), but there still is some apparent localized avoidance (Davis, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely impact bowhead use of that area (Richardson et al., 1985), but there has been no documented evidence that noise from OCS operations would serve as a barrier to migration.

Drilling muds and cuttings discharged during exploration activities are not expected to cause significant effects either directly through contact or indirectly by affecting prey populations. Any effects would be limited to individuals in the immediate vicinity of the drilling rig due to rapid dilution of such materials or removal from the water column. Drilling muds and cuttings are not known to be harmful to bowhead whales.

Summary: Bowheads may exhibit avoidance behavior if closely approached by vessels or seismic-survey activity but are not affected much by overflights unless aircraft altitudes are below 300 m (328 yd). Bowheads have been sighted near drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to them. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident; and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30 to 60 minutes (in the case of seismic activity). Exposure of bowhead whales to noise-producing activities is not expected to result in lethal effects, but some individuals could experience temporary, nonlethal effects.

Conclusion: Bowheads may exhibit avoidance behavior to vessels and activities related to seismic-survey and drilling activities during exploration. Overall, exposure of bowhead whales to noise-producing activities is not expected to result in lethal effects, but some individuals could experience temporary, nonlethal effects.

b. Effects on the Arctic Peregrine Falcon: The major effect-producing agent associated with the low case that might influence arctic peregrine falcons would be noise from support activities. There would be no adverse effects from oil spills, since it is assumed that economically producible hydrocarbon resources would not be discovered under this scenario. Nesting peregrines could, on rare occasions, be disturbed by aircraft overflights related to the proposed sale that may occur inland from the coast. Nesting sites such as those near Ocean Point on the Colville River, about 40 km (25 mi) inland, and along the coast south of Barrow may be vulnerable to such occasional disturbance. The extent of such disturbance would depend on future locations of support facilities. Aircraft based in Deadhorse or Barrow would not typically fly over these areas. Thus, significant disturbance of peregrine falcons associated with the exploration phase is unlikely. Gravel mining for any artificial islands associated with Sale 144 also is unlikely to affect the peregrine because extraction is expected to occur near the Beaufort Sea coast, and peregrines are not known to nest in this area.

Conclusion: For the low case, effects on the arctic peregrine falcons are expected to be minimal.

c. Effects on the Spectacled Eider: Spectacled eiders staging or migrating in nearshore areas along the Beaufort Sea coast are not expected to experience substantial adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparent low probability that routes traveled and area covered by scattered coastal flocks during two relatively brief staging/migration intervals would be intersected by the flight paths of support aircraft (1-2 round-trip flights/day) between rigs and onshore facilities at Kuparuk Field or Deadhorse. It is likely that only a limited degradation of available foraging habitat would occur, within about 1 to 2 km (0.62-1.2 mi) of the established flight paths from rigs west of Oliktok Point during the limited time males in late June and females with juveniles in late August are traversing the area. However, if helicopters servicing rigs in the western sale area first return to and then follow the coastline to onshore facilities during these periods, disruption of foraging activity potentially could be more widespread. Likewise, because nest sites are scattered over much of the arctic slope, relatively few are expected to be overflown by helicopters from offshore units, and significant disturbance of nesting or brood-rearing eiders is not expected to occur.

Conclusion: Overall routine effects on the spectacled eider are expected to be minimal, affecting <2 percent of the population.

d. Effects on the Steller's Eider: Steller's eiders staging or migrating in nearshore areas along the western Beaufort Sea coast are not expected to experience substantial adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparently low probability that the routes traveled and area covered by scattered coastal flocks of this small Alaskan population during two relatively brief staging/migration intervals would be intersected by the flight paths of support aircraft (1-2 round-trip flights/day) between rigs and onshore facilities at Kuparuk Field or Deadhorse. It is likely that only a limited reduction of available foraging habitat would occur, within about 1 to 2 km (0.62-1.2 mi) of the established flight paths from rigs in the western part of the sale area during the limited time males in late June and females with juveniles in late August are traversing the area. However, if helicopters servicing platforms in the western sale area first return to and then follow the coastline to onshore facilities during these periods, disruption of foraging activity potentially could be more widespread. Also, it is unlikely that the primary Alaskan nesting area, located south and southeast of Barrow, would be overflown by helicopters from offshore units, so significant disturbance of nesting or brood-rearing eiders is not expected to occur.

Conclusion: Overall routine effects on the Steller's eider are expected to be minimal, affecting <2 percent of the Alaska population.

7. Caribou: Among the terrestrial-mammal populations that could be affected by activities associated with the low case are the more than 634,000 caribou of the Western Arctic, Central Arctic, Teshekpuk Lake, and Porcupine caribou herds occurring along the coast adjacent to the Beaufort Sea Planning

Area. The primary potential effects on caribou from OCS exploration activities under the low case would come from helicopter traffic (disturbance) to and from the offshore drilling platform (unit). No oil spills are assumed to occur for the low case.

Disturbance of caribou associated with exploration activities would come primarily from helicopter traffic (about 108 flights/year or 1 trip/day/platform for 5 years during the open-water season) to and from Deadhorse-Prudhoe Bay and the one offshore-exploration platform. Caribou have been shown to exhibit panic or violent flight reactions to aircraft flying at ≤60-m (162-ft) elevations and exhibit strong escape responses (animals trotting or running from aircraft) to aircraft flying at 182 m to 383 m (500-1,000 ft) (Calef, DeBock, and Lortie, 1976). These documented reactions of caribou were from aircraft that circled and repeatedly flew over caribou groups. Aircraft traffic associated with exploration is likely to pass overhead of caribou once during any flight to or from the platform, and the disturbance reactions of caribou are expected to be brief, lasting for a few minutes to no more than 1 hour. The duration of the effect (the time it takes caribou to return to undisturbed behavior) and the amount of stress on individual animals is not likely to have an appreciable effect on the health of affected caribou. Even in a severe case where some caribou calves could be separated from the cows, resulting in the possible loss of the calves, such incidents are likely to be rare or infrequent (calves generally do not become permanently separated from the cow unless aircraft harassment is deliberate and persistent). The area of displacement is expected to be local—within 1 mi of the aircraft-flight path—and represent a very short-term (a few minutes to < 1 hr) effect on the local distribution (within 1.6 km or 1 mi of the aircraft traffic) of caribou.

Conclusion: The effect of the proposed Sale 144 low-case activities on caribou distribution is expected to be very short term (a few minutes to < 1 hour) and local (within 1.6 km or 1 mi of the aircraft traffic).

8. Economy of the North Slope Borough: In the low case, the gains in direct employment from Sale 144 would result from exploration-only activities. During exploration, from 1997 through 2001, four exploration and two delineation wells are expected to be drilled. Fewer than 100 jobs would be created, and most of them would be filled from outside the region. A few jobs would employ NSB residents who would work at the industry enclave, but these jobs would be short term and would have little effect on the economy of the NSB. Because of the low overall employment generated in this case, and because most of this employment would go to commuters from outside the region who would be living and working either offshore or at the industry enclave, the effect on employment in the NSB would be minimal.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. Effects from the low case of the proposal are expected to be short term, localized, and have no apparent effect on the subsistence harvests in Barrow, Atqasuk, Nuiqsut, and Kaktovik. Regional effects on subsistence-harvest patterns would be the same as for the individual communities (see Sec. IV.F.10, Subsistence-Harvest Patterns).

Conclusion: The effects of the low case of the proposal on the economy of the NSB would be minimal.

9. Sociocultural Systems: In the low case, only exploration would occur in the proposed Sale 144 lease-sale area, and it is not known where such exploration might occur. No oil spills are assumed to occur for the low case. 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. Effects could occur in any of the communities near the proposed sale area: Barrow, Atqasuk, Nuiqsut, and Kaktovik.

a. Industrial Activities: In the low case, the communities of Barrow, Nuiqsut, and Kaktovik could be used for some air support, but Deadhorse-Prudhoe Bay would be the primary air-support staging area for helicopter flights of personnel to exploration platforms. One helicopter trip per day per plat- form (four exploration and two delineation wells are assumed in the low-case scenario) is assumed for the low case, or about 108 helicopter flights per platform for 5 years during the open-water season (see Table IV.A.1-1). Industrial activities for the low case could be expected to cause periodic disruption of sociocultural systems but without any displacement of existing institutions.

b. Population and Employment: Sale 144 exploration is projected to affect the population of the NSB with a slight increase in petroleum-industry-related activity. Employment projections as a consequence of Sale 144 activities are provided in Section IV.B.8. Low-case exploration activities from 1997 through 2001 are expected to create fewer than 100 jobs. Of this total, most would be filled from outside the NSB region and would have little effect on total NSB employment. The few residents who would be employed as consequence of Sale 144 would work at the existing enclaves at Deadhorse-Prudhoe Bay and Kuparuk. Increased employment as a result of exploration in the proposed lease-sale area is expected to be low enough that it would have a minimal effect on the population of the NSB.

Increases in population and employment as a result of the low case are expected to be minimal, as none of the communities are expected to experience much of an increase in sale-related employment. Effects of the proposed Sale 144 low-case activities on the sociocultural systems of these communities from increases in population and employment could be expected to cause periodic disruption without the displacement of existing institutions.

c. Effects on Subsistence-Harvest Patterns: Subsistence underpins the Inupiat sociocultural system (see Sec. III.C.3 for a detailed description). Overall effects of the Sale 144 low case on subsistence-harvest patterns are expected to periodically affect subsistence resources but have no apparent effect on subsistence harvests (see Sec. IV.B.10).

Conclusion: The effects of the Sale 144 low case are expected to cause periodic disruption of sociocultural systems without the displacement of existing institutions.

10. Subsistence-Harvest Patterns: The low case assumes only exploration would occur in the proposed Sale 144 lease-sale area. Effects on subsistence-harvest patterns would be expected to occur only as a result of noise and disturbance. Noise and disturbance during exploration would be associated with the (1) surveys that are part of the preliminary activities of the lease-sale phase, (2) well drilling during the exploration phase, and (3) aircraft and marine support.

Animals may avoid areas of high noise and disturbance (see Sec. IV.B.6) and could contribute to short-term effects, such as flight behavior or increased wariness that could make them more difficult to harvest or become unavailable to a particular community.

Industrial activity is not expected to result in distributional changes in the bowhead population. Support vessels and drilling units in the vicinity of subsistence-harvest areas could disturb harvests without disturbing the general bowhead population. Exploration-drilling units and their associated support activities are not likely to affect bowhead whaling in the Sale 144 area because bowhead whaling occurs in the spring, when narrow leads are formed and little open water exists. Exploration-drilling units are not likely to be moved into operation until after the whaling season, when open water has formed. Once in place, however, bottom-founded drilling units would be in place year-round and could be located near bowhead whale-harvest areas.

Noise from bottom-founded exploration-drilling units, support vessels, or icebreakers could disrupt the whaling effort. Although not very likely, a vessel or rig in the pathway of a whale chase could cause that particular harvest to be unsuccessful. Icebreakers moving through the whale-harvest area also could contribute to an unsuccessful harvest if they were not coordinated with the bowhead whale migration (beginning mid-April [see Sec. III.C.3]) and the whale hunting season. Spring 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. During fall whaling in Nuiqsut and Kaktovik, the situation is somewhat different because whaling is done in open water and not in narrow ice leads. Even so, there could be some disturbance to the bowhead harvest in the harvest areas of these communities.

Recent evidence indicates that a whale may react to vessel-engine noise as far as 12 km away from the source, although disruption is likely to be short term and temporary (see Sec. IV.B.6). Such disturbance would most likely be short and temporary enough that, during a normal whaling season (2 months), there would be ample opportunities to harvest other whales. However, during a year when weather and ice conditions were poor, the whalers' ability to harvest any whales would be limited because the noise disruption could occur during the brief period when harvesting whales was possible.

With the exception of Barrow, not many bowheads are harvested because of limitations of IWC quotas. Some years, no more than one or two whales in a village may be harvested. If there were disruptions to the bowhead whale hunt because of noise and disturbance associated with exploration drilling and such disruptions occurred in a year when the weather restricted the whaling season to a few weeks, it is likely that the harvest could be decreased. However, it is most likely that the harvest still would be available, and that it still would be attained. With only four exploration and two delineation wells assumed in the entire sale area and mitigating measures requiring (1) consultation with Native communities on exploratory drilling, (2) seasonal drilling restrictions, and (3) bowhead whale monitoring, the probability of such an event occurring is less likely. Thus, only short-term, localized effects are expected on bowhead whales in Barrow (Atqasuk), Nuiqsut, and Kaktovik with no apparent effects on the bowhead subsistence harvest.

Belukha whales could experience disturbance from industrial activities in the Arctic, but disturbance is expected to be short term and temporary. Because the peak season for harvesting belukha whales occurs during the summer months (open-water period) in all of the communities near the Sale 144 area, a drilling unit, vessel, or icebreaker located near an open-water area used for belukha whaling could disturb a community's whaling. However, disruptions are most likely to be short term and are not expected to affect harvest levels. Because the belukha-hunting season for Barrow and Atqasuk (with Barrow) occurs under two different conditions (in spring ice leads and in summer open water) and hunting is possible at different times over a 6-month period, noise and disturbance could be expected to periodically affect belukha whales but produce no apparent effect on the subsistence hunt.

Noise and disturbance are expected to have insignificant effects on subsistence-fish stocks. Disturbance from seismic activity associated with Sale 144 would occur more than 5 km (3 mi) from subsistence-fishing areas, and boat noise would have only transitory effects on fishes. Effects from noise and disturbance activities associated with Sale 144 are expected to periodically affect fishes but have no apparent effect on the fishes subsistence harvest.

Seals are somewhat susceptible to noise and disturbance from aircraft and vessel traffic. Industrial activity associated with Sale 144 is not expected to result in distributional changes in seal populations. Disturbance from aircraft or vessels could cause short-term, localized effects on seals; but these effects would not affect annual harvest levels, and seals would not become unavailable during the year. Effects on seals in the subsistence-harvest areas of Barrow (Atqasuk), Nuiqsut, and Kaktovik due to noise and disturbance are expected to be periodic but have no apparent effect on subsistence harvests.

Noise and disturbance from aircraft could have localized, short-term effects that would cause some disruption to walrus. Effects on walrus due to noise and disturbance in the Barrow (Atqasuk) and Nuiqsut subsistence- harvest areas are expected to be periodic but have no apparent effect on walrus-subsistence harvests; Kaktovik does not generally harvest walruses.

Noise and disturbance from activities associated with exploration drilling may disturb waterfowl-feeding and waterfowl-nesting activities. Such low-level biological effects would be too brief to have significant effects on bird harvesting by the communities in the Sale 144 area. Effects on waterfowl in the Sale 144 area from noise and traffic disturbance are expected to be periodic but with no apparent effect on subsistence harvests. Polar bears could experience short-term, localized aircraft disturbance that could cause some disruption but have no apparent effect on the subsistence harvests in Barrow, Atqasuk, Nuiqsut, and Kaktovik.

Conclusion: Effects from the proposed Sale 144 lease sale in the low case are expected to be short term, localized, and have no apparent effect on the subsistence harvests in Barrow, Atqasuk, Nuiqsut, and Kaktovik. Regional effects on subsistence-harvest patterns would be the same as for the individual communities.

11. Archaeological Resources: Under the low case of the proposal, effects on archaeological resources would result primarily from any bottom-disturbing activity related to OCS exploration. A survey for archaeological sites has not been conducted to date on the Federal OCS.

Conclusion: Effects from the low case of the proposal should be less than for the base case because less bottom-disturbing activity is projected. The Prehistoric Resource Analysis completed for this sale indicates that there should be no prehistoric archaeological sites within the sale area; therefore, there would be no effects on submerged prehistoric sites. The requirement for review of geophysical survey data prior to any lease activities would ensure to the greatest degree possible that any historic shipwreck within the sale area would be identified and avoided by bottom-disturbing activities resulting from this lease sale; therefore, the expected effect on historic shipwrecks would be low.

12. Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.12, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. The modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum potential effect to the air quality in the Class II area.

Under the low case, there would be exploration only with no oil development. Emissions from the peak-exploration year would be the same as for the base case. Table IV.E.12-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration years. Under the Federal and State of Alaska PSD regulations, a PSD review would be required. The OCD model air-quality analysis for air pollutants emitted for exploration under the low case estimated that the maximum NO_2 concentration, averaged over a year, would be $0.72\ \mu/m^3$ at the shoreline or 4 percent for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.)

Air-pollutant levels reaching the shore are expected to be very low spatially and temporally because of the small amount of emissions from exploration activities and their distance from shore. In addition, there is no development or production under the low case to serve as a source of evaporation or smoke from oil spills. Consequently, the effects of air-pollutant emissions in the low case—other than with respect to standards—are expected to be minimal.

Conclusion: Assuming exploration only in the low case, effects on onshore air quality analyzed are expected to be 4 percent (approximately one-third of those assessed for the Alternative I base case) of the maximum allowable PSD Class II increments. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration and development and production activities and from accidental emissions would not be sufficient to harm vegetation.

13. Land Use Plans and Coastal Management Programs: Most activities that would result from Sale 144 would require some local or State determinations with respect to the NSB LMR's or the (ACMP) as amended by the (NSB CMP). Potential conflicts with the policies of these programs are assessed on the basis of the effects determined in the previous sections (Secs. IV.B.1 through 12).

a. NSB Comprehensive Plan and Land Management Regulations: These regulations apply only to activities that occur within the NSB. In the low case, no development is assumed in order to support the offshore-exploration activities. As a result, no conflict with the land use plan for the NSB is anticipated. Some LMR's would apply by virtue of corresponding with NSB CMP policies that may be applicable. However, the avenue for implementation would be through the review of the Exploration Plan, to which only coastal policies apply.

b. Alaska Coastal Management Program: Section 307(c)(3)(B) requires lessees to certify that each activity that is described in detail in the lessee's exploration and development and production plans that affects any land use or water use in the coastal zone complies with the State's coastal program and will be implemented consistent with it. The State has the responsibility to concur with the certification or

Table IV.F.12-1
Estimated Uncontrolled Emissions for the Beaufort Sea Sale 144
Alternative I Low Case
(in tons per year)

	Regulated Pollutants				
	CO	NO_x	PM-10	SO_2	VOC
Base Case[1,2]					
Peak Exploration Year	312.6	1611.0	62.4	70.6	114.8

Source: USDOI, MMS, 1995.

1 Assumes peak-year emissions from exploration from drilling two exploration/delineation wells from one rig.
2 Assumes exploration only with no development.

object to the lessees' determinations. This analysis of potential conflicts between the activities assumed to occur and the ACMP 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 highly unlikely that all the events that are hypothesized will occur as assumed in this EIS. Changes made by lessees as they explore and develop and produce petroleum products from leases offered in this sale could affect the accuracy of this assessment.

Conflict regarding disruption of the bowhead whale harvest may become apparent if the harvest for any of the communities were disrupted in a year when the whaling season was short due to weather. The Statewide standard for subsistence guarantees opportunities for subsistence use of coastal areas and resources (6 AAC 80.120). Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. The NSB CMP policy 2.4.3(b) states that "offshore drilling and other development within the area of bowhead whale migration during the migration seasons shall not significantly interfere with subsistence activities nor jeopardize the continued availability of whales for subsistence purposes."

Conclusion: For the low case, some conflict with the subsistence policy is possible.

G. EFFECTS OF ALTERNATIVE I - THE PROPOSAL, HIGH CASE - ON:

Introduction: Resource Estimates and Basic Exploration, Development and Production, and Transportation Assumptions for Effects Assessment: The high-case midpoint estimate assumes 3.9 billion barrels (Bbbl) of oil may be found within the boundaries of Alternative I. Table IV.A.1-1 shows the levels of infrastructure and resources that have been assumed for the analyses of the effects of the high case of the proposed action.

The level of activities and the timing of events associated with the high case for Alternative I are shown in Table IV.A.1-1. Exploratory drilling is expected to begin in 1997 and continue through 2009. During these years, a total of 65 exploration and delineation wells would be drilled, with a maximum of four drilling rigs operable in any one exploratory year. Twenty five production platforms are expected to be installed between 2001 and 2010, while pipeline laying is expected to begin in 2004 and conclude in 2009 (5 years longer than in the base case). Drilling of production and service wells is expected to begin in 2001 and continue through 2012, with a total of 850 wells drilled. Production is expected to begin in 2005 and continue through 2030 (some 4 years longer than in the base case).

In comparing the level and extent of activity of the base case with that of the high case, it is apparent that the high-case activity level is approximately three times that of the base case. This difference is consistent with the resource spread between the two cases: 1.2 Bbbl versus 3.9 Bbbl. A review of Table IV.A.1-1 reveals this ratio: i.e., base-case exploration and delineation wells 22, high case 65; base-case number of production platforms 8, high case 24; etc. Tanker loadings from Valdez generated by the proposed action also mirror this trend. For the base-case peak-production years of 2008 and 2009, 135 to 145 tankers trips (loadings) would be generated. For the high case, the peak-production year of 2011 would see 415 to 430 loadings. (For each case, it is assumed that 100,000-deadweight-ton tankers would be used for carriage.)

Overall, the transportation and field-development scenarios of the base and high cases are very similar. Both cases call for pipeline landfalls at Oliktok Point, Point McIntyre, and near Bullen Point. However, the high case hypothesizes an additional landfall at Pitt Point and a new stretch of onshore pipeline that would connect with the Kuparuk pipeline system at Central Production Facility 2 (CPF 2) (see Fig. IV.A.1-1). Additionally in the high case, fully one-third of the production platforms (9) are assumed to be floating concrete structures located in water depths >38 m (125 ft). This number is in contrast with the base case, which forecasts that two-thirds of the production platforms would be located in water depths between 11 and 38 m (35-125 ft) and the balance in waters <11 m (35 ft) deep. The high case assumes the locations of the remaining platforms will be evenly split between locations in waters that are <11 m (35 ft) deep and locations in water depths between 11 and 38 m (35-125 ft).

1. Water Quality: Agents that are most likely to affect water quality in the Beaufort Sea sale area are oil spills, causeways, dredging, and deliberate discharges from platforms. In the context of this analysis, regional effects refer to effects encompassing at least 1,000 km^2 (292 nautical mi^2 [nm^2]); local effects encompass smaller areas, most frequently a few or less square kilometers [$km^2 = 0.29\ nm^2$].

a. Oil Spills: Generic effects of oil spills on water quality are described in Section IV.B.1 of this EIS. Because of unavoidable chronic and accidental discharges of oil, measurable degradation of existing pristine water quality is likely to occur in the sale area. For the size spill assumed in this EIS, 7,000 bbl—37-fold less than the *Exxon Valdez* spill—elevated hydrocarbon concentrations above chronic (sublethal-effect) criteria could persist for perhaps 3 to 10 days in summer, affecting an area of 20 to 100 km^2 (5.8-28 nautical mi^2 [nmi^2]) for each spill (Sec. IV.B.1). Six such spills are assumed to occur in the high case, so that the area with temporarily degraded water quality over the 30 years of development and oil production life could total between 120 and 600 km^2 (34 and 174 nmi^2).

In addition to these large spills, more chronic spillage of smaller volumes (≤1,000 bbl) also is expected (see Sec. IV.A.1.). During drilling of 65 exploration and delineation wells over 13 years, on the order of seven such small spills could occur, but the total spilled would amount to only about 63 bbl. For production, an additional 959 small spills of ≤1,000 bbl each, totaling 10,868 bbl, are projected over the life of the field. Small spills of this magnitude are relatively common in western and northern Alaska.

Regional, long-term degradation of water quality to levels above State and Federal criteria because of hydrocarbon contamination is very unlikely. Each spill of 7,000 bbl could temporarily (for ≤10 days) contaminate water over 100 km^2 (78 nmi^2) with hydrocarbon concentrations above the chronic criterion of 0.015 ppm but less than the acute criterion of 1.5 ppm. The large number of very small spills anticipated over the production life of the field could result in local, chronic hydrocarbon contamination of water within the margins of the oil fields.

b. Shore-Access Structures: No new causeways are projected. Causeways already exist at Oliktok Point and West Dock, two access points in the high case. The third and fourth access points for the high case, the ≤90-m (300-ft) raised gravel structures just west of the ANWR boundary and at Pitt Point, would have to be constructed. The structures would be too short to affect coastal circulation. Turbidity could be increased downcurrent within 3 km (2 nmi) of each access point during construction; however, turbidity would cease with end of construction. The effect on turbidity would be local and persist for only for a few days.

c. Dredging: Dredging would be used primarily for trenching and burying subsea pipelines. Dredging also might be used to prepare foundations for the 25 projected production platforms, but this latter use would be comparatively slight. Pipeline installation would involve greater volumes of dredged materials and greater areal disturbance. The greatest effect on water quality from dredging would be related to turbidity.

For the high case, 225 km (121 nmi) of offshore pipeline could be emplaced over a 6-year period in the planning area and inshore waters (Table IV.A.1-1). With multiple short pipelines serving 25 platforms, about 65 km (35 nmi) of pipe could be placed offshore in a single summer—the same as for the base case, with an onsite dredging rate of about 1.3 km/day (0.7 nmi/day). Trenching and dumping of dredged spoils would disturb 610 ha (1,500 acres) in the sale area and inshore waters, or somewhat less if the spoils were used to backfill the trench.

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. However, turbidity would not be expected to extend farther than 3 km (2 nmi) from the trenching and dumping operations and would cease within 2 to 3 hours after dredging stops. Because dredging occurs at a rate of 1.3 km per day (0.7 nm/day), the extent of the turbidity plumes would be about 3.9 km^2 (=390 ha, 960 acres) at any one time (a 1.3-km by 3-km plume [0.7-nmi by 2-nmi plume]). Over the six 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 contaminants. Beaufort Sea Planning Area sediments do contain elevated levels of hydrocarbons, but these hydrocarbons do not appear to be labile (Sec. III.A.5). However, the increased turbidity from dredging (and dumping) would be likely to exceed a chronic (sublethal) turbidity criterion; e.g., a >10-percent, temporary change in photocompensation depth, within ≤3 km (≤2 nmi) of construction activities. No effect on regional water quality is expected.

d. Deliberate Discharges During Exploration: Exploratory vessels would discharge drilling fluids in bulk quantities (Table IV.A.1-1) along with sanitary wastes from wastewater-discharge sources. Discharge of drilling muds and drill cuttings from exploration would occur over a 13-year period. During the last 9 years of exploration and delineation drilling, concurrent development drilling would be occurring at earlier, successful exploration sites in the sale area.

Discharges during exploration would peak in 2002 and 2003 at eight wells, 4,600 metric tons (5,100 English short tons) of drilling mud, and 6,000 metric tons (6,600 English short tons) of drill cuttings per year. Discharge during these peak exploration years would be twice that of the base case but negligible compared with total discharge during peak overall drilling in 2008 for the high case, with 120 production wells and 5 exploration/delineation wells being completed.

Based on the above and additional information presented in Section IV.B.1, the USEPA has determined that high-case exploratory discharges are not likely to exceed applicable water-quality criteria outside of a 100-m (328-ft) radius, or 0.03 km^2 (7 acres) around each discharge site (Appendix H). In the year of maximum exploratory drilling, four exploratory platforms would be present; and water quality of no more than 0.03 km^2 (7 acres) around each platform, a maximum of 0.12 km^2 (28 acres) at any one time or a total of 1.95 km^2 (482 acres), could be temporarily degraded during active exploration discharge of drilling muds and cuttings. The effect of exploration discharges on water quality would persist for a few hours within the 100-m-(328-ft)-radius mixing zone around each platform, a negligible effect on water quality.

e. Deliberate Discharges During Production: Generic effects of production discharges on water quality are described in Section IV.B.1 of this EIS. Peak discharge of drilling mud and drill cuttings from the 25 production platforms would occur in 2006 and 2008, when 120 wells would be drilled in each of those 2 years. Discharges over 15 years from all 850 production wells would total 116,000 to 524,000 metric tons (128,000 to 577,000 English short tons) of drilling muds and 900,000 metric tons (990,000 English short tons) of drill cuttings. Although these quantities are 3-fold greater than in the base case, these quantities still are small compared with the natural sediment load of the Beaufort Sea Planning Area as described in Section IV.B.1.

With two drilling rigs per platform and assuming that maximum discharge rates are limited by USEPA to the same extent during production as during exploration (see USEPA, 1995), instantaneous discharges would be of the same order of magnitude in production as in exploration. The total quantity of drilling muds discharged in production is estimated to be 3- to-12-fold greater than during exploration (Table IV.A.1-1). Total discharge of drill cuttings during production drilling would be 16-fold greater than the total discharged during exploration. Effects on water quality from discharges of muds and cuttings during production drilling also should be only local and short term—on the order of square kilometers [$km^2 = 0.29\ nm^2$] or less—and would persist over a 15-year period of drilling.

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 $^{o}/_{oo}$. (Seawater has a salinity of 35 $^{o}/_{oo}$.) The USEPA has limited oil and grease concentrations in formation-water discharges to 42 ppm daily maximum and 29 ppm monthly average in the current Arctic General NPDES Permit for offshore oil and gas exploration (USEPA, 1995). Similar restrictions on discharges are anticipated during production (*FR*, 1993).

Over the life of a field, the volume of formation water produced is equal to 20 to 150 percent of the oil-output volume (Collins et al., 1983). As oil is pumped from a field, the ratio of water to oil being produced increases. Toward the very end of the productive life of a field, 10 bbl 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 the field in the high case can be estimated at 780 to 5,850 MMbbl, with up to 150 MMbbl of this amount produced in the last year of field production. Over the life of the field, the mass equivalent of 23,000 to 170,000 bbl 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 a USEPA permit and would be regulated so that water-quality criteria, outside an established mixing zone, are not exceeded. To date, for exploration in the Beaufort Sea, USEPA has prohibited discharge of formation waters into waters <10 m (ca. 5 fathom) deep. Reinjection and injection projects to maintain field pressure have become almost standard operating procedure. Of the 12 active oil fields in Alaska in 1994, 10 had water-injection projects (State of Alaska, AOGCC, 1995). Formation water from the Endicott Reservoir, the first offshore-producing field in the Beaufort Sea, is 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 high enough permeability to allow large volumes of water to be injected at low pressure and (2) can contain the water. Also, injection should not be into a formation that might otherwise be a future potable-water supply.

If formation waters were reinjected or injected into a different formation, no discharge of formation waters would occur and no effect would occur. If formation waters were discharged, the effect on water quality would be local but would last over the life of each field.

f. Gravel-Construction Projects: Several solid-fill islands may be constructed and used for shallow-water development. A solid-fill island constructed on Federal leases likely would require relatively little fill compared with the above projects as long as causeways to shore were not included. Any of these individual construction projects could be completed within one to two summers, and turbidity effects in the vicinity of the construction activity would be short term and local.

g. Solid-Fill, Artificial Island Removal: Solid-fill, artificial islands used for exploration and/or development eventually will be abandoned. In spite of carefully planned abandonment operations, debris, particularly shoreline armoring, seems to inevitably remain on artificial islands. Armor debris gradually erodes from the abandoned solid-fill islands, drifts downwind, and accumulates along the mainland coast. In the immediate years following abandonment, on the order of 1 to 100 polypropylene bags a year could accumulate on nearby shorelines. As in the past. the MMS would require lessees to conduct periodic surveys of adjoining shoreline and recover the armor debris found. Debris accumulation and recovery would continue for several years.

In addition to armor debris, erosion of abandoned, solid-fill islands can result in local but persistent turbidity plumes as the sediments of the islands are reworked by waves and currents for a few to several years. (A causeway would not similarly erode but would more likely enhance deposition of waterborne materials, decreasing turbidity.)

Summary: An estimated six oil spills of ≥1,000 bbl each would temporarily and locally increase water-column hydrocarbon concentrations above chronic criteria for hydrocarbons over a total area of about 600 km^2 (174 nmi^2). The large number of very small spills anticipated over the production life of the field could result in local, chronic contamination within the margins of the oil field.

Deliberate discharges are regulated by USEPA such that any effects on water quality must be extremely local; water-quality criteria must be met at the edge of the mixing zone established by the USEPA-issued discharge permit. Discharge of formation waters—rather than their reinjection into the seafloor—would result in local pollution in the vicinity of each field, with whatever the formation waters contain, over the life of each field.

Conclusion: Contaminants from oil spills may exceed sublethal but not acute (toxic) levels over about 600 km^2 (174 nmi^2) for a few weeks and contaminants from construction, island abandonment, and permitted discharges could exceed sublethal, but not acute (toxic) levels over 1 to a few 100 km^2 (0.3 to ca. 100 nmi^2) for several years.

2. Lower Trophic-Level Organisms: Under the high case, both exploration and production are assumed to occur in the sale area. Routine activities associated with the high case that may affect lower trophic-level organisms in the Beaufort Sea include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of routine and accidental activities on lower trophic-level organisms are discussed in the base-case analysis (Sec. IV.B.2) but are summarized below. The following high-case analysis focuses on the differences in the amount of activity (the only variable) estimated for the high case, as compared with that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for the high case.

a. Effects of Seismic Surveys: The high case estimates that a maximum of 90 seismic surveys would be required for 24 exploration wells, 41 delineation wells, and 25 production platforms. This represents about three times the amount of seismic surveys estimated for the base case (a maximum of 30 seismic surveys). However, as discussed in the base-case analysis, seismic surveys are expected to have little or no effect on lower trophic-level organisms. Thus, the high case is expected to have an effect on lower trophic-level organisms similar to that of the base case (i.e., little or no effect).

b. Effects of Drilling Discharges: The high case estimates a maximum of 24 exploration, 41 delineation, and 850 production wells over a 16-year period. This would release into marine waters a maximum of 40,950 short tons of drilling muds and 53,300 short tons of drill cuttings in the exploratory phase and up to 578,000 short tons of drilling muds and 1,003,000 short tons of drill cuttings in the production phase. Because the high case estimates about three times the drilling activity (915 wells) expected for the base case (295 wells), the high case is expected to have about three times the effect. However, discharges of this type were found to have no adverse effects on planktonic organisms and mostly sublethal effects on benthic organisms. Any effect on benthic organisms would be limited to areas near and downcurrent of the discharge point. It is estimated that <1 percent of the benthic organisms within the sale area would be affected by discharges associated with the high case.

These effects would be mostly sublethal and would affect <1 percent of benthic organisms in the sale area; recovery is expected within 1 year.

c. Effects of Construction: The estimated amount of construction is based on the number of bottom-founded production platforms and the associated pipeline laying. The high case estimates that there would be a maximum of 25 production platforms and 355 mi of pipeline construction, whereas the base case estimates that there would be a maximum of 8 production platforms and 185 mi of pipeline construction. Hence, about three times as much offshore construction is estimated for the high case than for the base case. However, this still would constitute much less than 1 percent of the available benthic habitat within the sale area. In the areas affected by platforms or pipelines, changes in species composition would occur in favor of invertebrates and marine plants requiring a hard substrate for settlement (i.e., platforms and exposed pipelines). Less mobile organisms that rely on soft substrates would be adversely affected by construction and platform placement (sublethal and lethal effects). More mobile adult invertebrates are expected to avoid these areas of disturbance. Plankton communities are expected to experience little to no effect from these activities. Immobile benthic communities affected by platform placement or pipeline construction are expected to recover in <1 year. Much less than 1 percent of the immobile benthic organisms in the sale area would be affected by platform and pipeline construction. Because of the small area affected by the platform and pipeline construction and the widespread distribution of benthic marine organisms in the sale area, the high case is expected to have little effect on lower trophic-level communities in the sale area.

d. Effects of Oil: This section addresses the effects of an accidental oil spill on lower trophic-level organisms associated with the high case. The effects of oil on lower trophic-level organisms are discussed in the base-case analysis. The high case differs from the base case in the estimated combined probability of one or more ≥1,000-bbl oil spills occurring and contacting certain land segments after 10 days (1-3% for the base case, 1-10% for the high case); in the number of land segments contacted (11 for the base case, 20 for the high case); and in the number of assumed 7,000-bbl oil spills (two for the base case, six for the high case). Hence, the effects of the assumed high-case oil spills on lower trophic-level organisms are estimated to be about three times that of the base case and are summarized below.

The effect of petroleum-based hydrocarbons on phytoplankton, zooplankton, epontic, and benthic organisms depends on the species and lifestage, the type and concentration of hydrocarbon, and the duration of exposure. The potential effects of such exposure range from sublethal to lethal. Larval forms are more sensitive to toxic agents than adults and would sustain the greatest adverse effect from spring to fall when they are most abundant. Where flushing times are longer and water circulation is reduced (e.g., in bays, estuaries, and mudflats), the recovery of the affected communities is expected to take longer. The adverse effects of oil on phytoplankton include inhibition of photosynthetic activity and growth, lowered feeding and reproductive activity, community changes, and death. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Zooplankton can be contaminated by oil by direct uptake from the water, uptake from food, and direct ingestion of oil particles. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil, although individual organisms experienced either direct mortality, external contamination, tissue contamination by aromatic constituents, inhibition of feeding, or altered metabolic rates. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported to date.

Based on the assumptions discussed in the text, each of the assumed high-case oil spills is estimated to have sublethal and lethal effects on up to 1 percent (6% for all spills) of the phytoplankton and zooplankton populations in the Beaufort Sea area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton for each spill. Recovery within the affected embayments is expected to take 1 to 2 weeks for each spill. Hence, the overall effect of the high case on plankton is three times that of the base case. Less than 5 percent/spill of the epontic community within the sale area is expected to be sublethally and lethally affected.

The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. Sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection). Due to the predominance of shorefast ice along the shoreline of the Beaufort Sea, most of the shoreline supports little or no resident flora or fauna down to about 1 m in water depth. Subtidal marine plants and invertebrates are not likely to be contacted by an oil spill, except for floating larval forms, which may be contacted anywhere near the surface in the water column. The organisms likely to be contacted by floating or dispersed oil include zooplankton (e.g., copepods, euphausiids, mysids, and amphipods) as well as the larval stages of annelids, mollusks, and crusteaceans. In general, the percentage of marine invertebrates contacted by floating or dispersed oil is expected to be similar to that expected for plankton (a maximum of 1%). Due to their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine larva from each of the six large oil spills is expected to take less than a month per spill. Small oil spills (an estimated total of 10,868 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: The effects of high-case oil spills (6 are assumed) are estimated to be about three times those of the base case (2 are assumed). Each of the assumed high-case oil spills is estimated to have lethal and sublethal effects on <1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spills also are estimated to have lethal and sublethal effects on <5 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take <1 month.

3. Fishes: Compared with the base case, the almost 3-fold increase in oil resources assumed in the high case increases the probability of development and production, with a proportional increase in the amount of drilling activity and construction that would affect fishes. Also, the increase in oil resources would mean a proportional increase in the number of oil spills that would affect fishes.

The following assessments are based in general on the base-case assessment for fishes in Section IV.B.3. The assessment also incorporates by reference the assessment of effects on fishes for the high case in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). The overall conclusions of the previous high-case sections were that the effects on offshore fishes would be low or moderate.

a. Seismic Effects: The following assessment of the specific effects of seismic operations on fishes is based on Section IV.B.3.a., which analyzes the probable effects of seismic operations for the base-case assumptions. The conclusion in that section is that seismic operations would injure only a few fishes for one generation in localized areas. For the high-case scenario, the area and duration of seismic operations would be about three times greater than projected for the base case: about 1,500 km^2 during several months of operation (Table IV.A.1-1). Still, the seismic operations would injure only a few fishes in relatively small areas.

b. Drilling Effects: The following assessments of the specific effects of drilling, including discharge of drilling fluids, are based also on Section IV.B.3.b, which analyzes the probable effects of the base-case scenario. The conclusion of that section is that the effect would be nonlethal, local, and temporary. Under the high-case assumptions, about five times as many exploratory and production wells would be drilled as for the base-case assumptions, with corresponding increases in the amounts of discharged drilling fluids and cuttings. The anticipated types of effects are the same as for the base case with regard to drilling: fishes would be displaced a short distance during installation of drilling equipment and drilling fluid discharge but would reutilize their habitat upon completion of the activities.

c. Oil-Spill Effects: The following assessments of the specific effects of oil spills are based on Section IV.B.3.c, which analyzes the probable effects of the base-case scenario. The assessment also incorporates by reference the assessment of effects on fishes for the high case in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). The conclusions of both those high-case assessments were that oil-spill effects on fishes would be very low or moderate.

The high case for Sale 144 assumes that six is the most likely number of spills of ≥1,000 bbl occurring during the projected production life of the Sale 144 area. The probability that the spills would contact land in the open-water season within 30 days during the production life of the Sale 144 area is <15 percent (Appendix B, Table B-36). The probability of a spill contacting areas where fish overwinter and reproduce—individual land segments adjoining deltas—is slightly less than for the entire coastline. So, there is a low probability of oil spills that would be lethal to a large portion of several anadromous fish populations.

d. Effects from Construction Activities: The following assessments of the effects of construction of offshore platforms and pipelines incorporate by reference the high-case assessments on fishes in the FEIS's for Lease Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively).

An estimated 500 km of pipeline would be laid offshore in conjunction with the high-case activities for Sale 144 (Appendix A, Table A-5). A comparable amount of trenching would be required to lay the pipeline; however, the effects of offshore-pipeline installation on fishes are expected to be localized and of temporary duration.

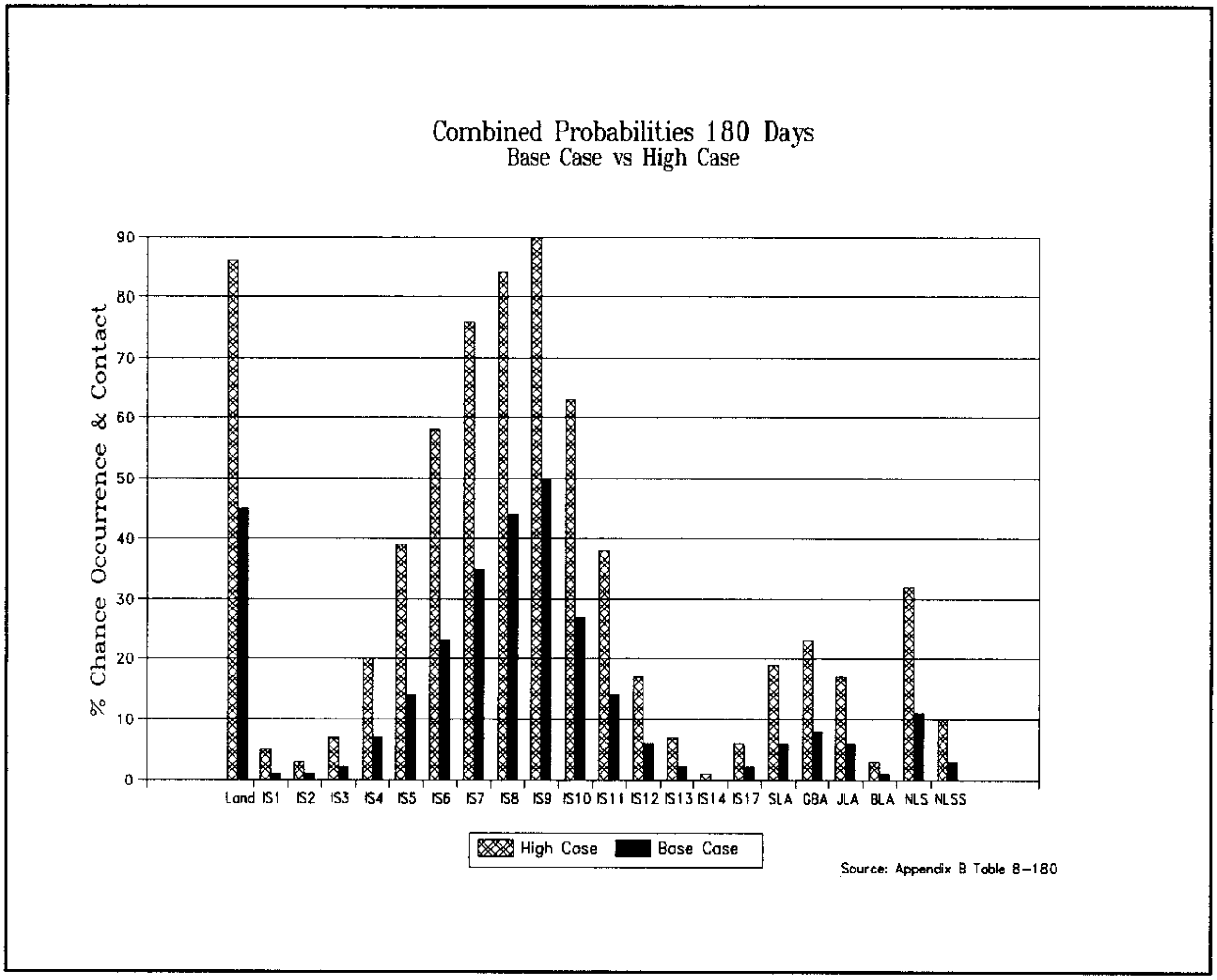
Several short jetties or shore-approach causeways might be built in conjunction with the pipelines (Appendix A, Table A-6). The projected short length of the causeways in the Sale 144 scenario means that the magnitude of hydrographic changes would be relatively low compared with the effects of long causeways that presently exist on the Beaufort Sea coast. The shore approaches for the pipelines might be constructed at existing causeways. The effects of several additional short jetties on fish movements and migrations are likely to be only localized and short term.

Summary: The most serious effects on fishes as a result of the high case would be from oil spills and construction of short jetties. There is a moderate probability of oil spills that would be lethal to a minor portion of several anadromous fish populations. Short jetties, as projected for the high case, would likely have a minor effect on fish movements.

Conclusion: Overall, the six spills and other activities assumed for the high case would, at worst, be lethal to a minor portion of some anadromous fish populations, decreasing population levels for one generation or <7 years.

4. Marine and Coastal Birds: For the analysis of the effects of the high case on marine and coastal birds, it is assumed that 3,900 MMbbl of oil would be produced from 25 platforms and transported to shore through 224 km (140 mi) of offshore pipelines: For the base-case analysis, it is assumed that 1,200 MMbbl of oil would be produced from 8 platforms and transported through 50 km (80 mi) of offshore pipelines. The most likely number of spills of ≥1,000 bbl (average of 7,000 bbl) increases from two for the base case to six for the high case. (For a discussion of the general effects of oil on marine and coastal birds, see Sec. IV.B.4.)

a. Effects of Oil Spills: Six oil spills (7,000 bbl) are assumed to occur under the high case compared with two spills under the base case. The probabilities of spill contact to important marine and coastal concentrations and habitats of birds such as the Northern Lead System (NLS) offshore of Point Barrow, Gwydyr Bay (GBA), and offshore of Camden Bay (Ice/Sea Segment IS9) within 180 days increase from 11, 8, and 50 percent, respectively, under the base case to 32, 23, and 90 percent under the high case (see Fig. IV.G.4-1). These significant increases in spill-occurrence and contact probabilities indicates that a larger portion of one or more of the six oil spills would contact these important habitats and probably affect a much larger number of birds (for one habitat-area-lagoon, for example, this could represent an increase in mortality of a few thousand birds for the base case to several thousand to 100,000 for the high case). An increase in spill-contact probability also indicates that a greater portion of the coastline and surface area of a habitat such as Gwydyr Bay may be covered by the oil slick. The probability of spill occurrence and contact to land within 180 days increases from 45 percent under the base case to 86 percent under the high case (Fig. IV.G.4-1). In the high case, a substantial reduction in local assemblages of sea ducks such as oldsquaw is expected to occur, with perhaps the loss of a total of >100,000 birds of various species, assuming some of the oil spills contacted a lagoon and other coastal areas during fall when birds concentrate along the coast.. For the high case, an increase in spill-contact probabilities to coastal beaches such as those along the coast of Gwydyr Bay (GBA), in Simpson Lagoon (SLA), and within the Point Barrow (Northern Lead System NLS) area, indicates that a greater percentage of the surface area of these habitats would be contaminated if some of the oil spills occurred during the open-water season. Such an increase in habitat contamination would increase the number of seabirds, waterfowl, and shorebirds affected by the spill. A greater number of birds could become oiled and/or ingest oiled vegetation or could ingest contaminated prey and die as a result. The total loss of seabirds, ducks, and shorebirds easily could exceed 100,000 birds, assuming that extensive areas of coastline were contaminated.



IV.G.4-1. Comparison of Base-Case with High-Case Combined Probabilities (expressed as a percent chance) of One of More Oil Spills ≥1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas; Land; Ice/Sea Segments (IS2 through IS13); Lagoons: Simpson Lagoon (SLA), Gwydyr Bay (GBA), Jago Lagoon (JLA), Beaufort Lagoon (BLA); the Northern Lead System (NLS); and Boundary Segments (BS2 and BS3) Within 180 Days Over the Assumed Production Life of Sale 144

Species such as oldsquaw, which have a very abundant regional population, probably would recover from the loss of a few thousand to perhaps 20,000 individuals within one generation (about 1-2 years), while species with depressed regional populations, such as Pacific brant and common and king eiders, are expected to take more than one generation to recover the loss of tens of thousands of birds (perhaps 3-5 years).

A total of 7 small oil spills ≥1 bbl and <1,000 bbl during exploration, and of 913 small oil spills <50 bbl and 39 spills ≥50 bbl but <1,000 bbl during production, also are assumed to occur offshore under the high case (Table IV.A.2-4). These minor spills are expected to have an additive effect on marine and coastal bird losses, perhaps increasing losses by a few thousand birds and increasing habitat contamination by perhaps about 1 percent.

b. Effects of Habitat Alteration: The amount of high-case onshore development is assumed to increase to 344 km (215 mi) of onshore pipelines and associated roads versus 168 km (105 mi) under the base-case onshore development, with additional offshore pipeline landfall at Pitt Point (west of Cape Halkett) and associated onshore pipeline and road to TAPS. However, the effects of habitat alteration from pipeline-road construction and shore-base construction on tundra habitats of marine and coastal birds are expected to be similar to those described under the base case. Some localized changes are expected in the distribution or abundance of shorebirds and waterfowl (such as tundra swans) within the near vicinity (within about 1 mi) of pipeline-road corridors or near other facilities in the Teshekpuk Lake area (important habitat of waterfall such as Pacific black brant). Waterfowl and shorebird populations are expected to recover from this habitat loss and displacement within one generation (about 1-2 years).

c. Effects of Noise and Disturbance: The amount of air traffic associated with exploration and development is assumed to increase from 108 flights per year during exploration and 150 to 456 flights per month during development under the base case to 510 flights per year during exploration and 150 to 456 flights/month during development under the high case. Noise and disturbance of marine and coastal birds are expected to increase somewhat from that described for the base case; however, the level of effect is expected to remain short-term, with localized changes in the distribution of marine and coastal birds associated with air and vessel traffic lasting for only a short period of time (a few minutes to no more than a few days).

Conclusion: The overall effect of the high case on marine and coastal birds is expected to include the loss of tens of thousands of birds (up to perhaps 100,000) from the assumed six oil spills, with recovery taking place within more than one generation (perhaps 3-5 years). Other effects (disturbance and habitat alteration) are expected to be local (within 1 km [0.62 mi]) of the pipelines and other structures) and/or short-term (a few minutes to <1 hour from aircraft). Bird-population recovery from habitat alteration and other nonlethal disturbances is expected within one generation.

5. Pinnipeds, Polar Bears, and Belukha Whales: For the analysis of the effects of the high case on pinnipeds, polar bears, and belukha whales, it is assumed that 3,900 MMbbl of oil would be produced from 25 platforms and transported to shore through 140 mi of offshore pipelines; for the base-case analysis, it is assumed that 1,200 MMbbl of oil would be produced from 8 platforms and transported through 80 mi of offshore pipelines. The most likely number of spills of ≥1,000 bbl (average of 7,000 bbl) increases from two for the base case to six for the high case. (For a discussion of the general effects of oil on pinnipeds, polar bears, and belukha whales, see Sec. IV.B.5.)

a. Effects of Oil Spills: The probabilities of spill occurrence and contact to important seal, walrus, polar bear, and belukha whale-concentration areas and habitats, such as the Northern Lead System (NLS) off Point Barrow, increased from 11 percent under the base case to 32 percent under the high case within 180 days (Fig. IV.G.4-1). This significant increase in spill-contact probabilities indicates that a larger portion of one or more of the six assumed spills would contact this important habitat and might contact a much larger number of ringed and bearded seals (from perhaps a few hundred under the base case to perhaps a few thousand under the high case). A substantial increase in spill-occurrence and contact probabilities to ice-front habitats (as represented by Ice/Sea Segments) of seals, walruses, and polar bears north of Herschel Island IS12) west to Point Barrow (IS4) occurs under the high case compared to the base case (Fig. IV.G.4-1; probabilities of spill occurrence and contact to IS4 through IS12 increase from 6-50% under the base case to 17-90% under the high case). These spill risks indicate that under the high case, a greater portion of the ice/sea habitat in this part of the Beaufort Sea would be contaminated by oil, assuming three or more of the assumed six spills occurred during the winter or ice-cover season. Several thousand walruses as well as seals and perhaps as many as 60 polar bears might be contaminated by oil.

In the high case, assuming extensive oil contact occurs, several hundred to several thousand seals and walruses and some polar bears could be contaminated with oil; and several young seals and walrus calves and a number of polar bears are expected to die as a result of stress associated with hydrocarbon inhalation or ingestion and absorption of hydrocarbons through the skin. Few adult seals or walruses are expected to die from oil-spill contact (see Sec. IV.B.5, general effects of oil pollution on marine mammals). Perhaps as many as 60 polar bears could be lost due to oil ingestion through grooming and eating contaminated prey such as oiled seals. The above losses of young seals, walruses, and polar bears are likely to be replaced by the populations within about one generation (about 4-7 years).

An increase—from 28 percent (base case) to 66 percent (high case)—in oil-spill-occurrence and contact probabilities to landfast-ice habitat (as represented by contact to land in Fig. IV.G.4-1) of denning ringed seals along the Beaufort Sea coast indicates that some increase in spill contamination of under-ice habitat is likely to occur for the high case. The number of ringed seals and ringed seal lairs contaminated with oil would increase (for the high case, perhaps a several hundred seal pups could be lost due to oil contamination and/or abandonment by adult seals). This loss of seal pups is likely to be replaced within about one generation (about 4-5 years).

A total of 7 small oil spills ≥1 bbl and <1,000 bbl during exploration and 913 small oil spills <50 bbl and 39 spills ≥50 bbl but <1,000 bbl during production also are assumed to occur offshore under the high case (Table IV.A.2-4). These minor spills are expected to have an additive effect on seal, walrus, and polar bear losses, perhaps increasing losses by a few polar bears, seals, and walrus pups and increasing habitat contamination by perhaps about 1 percent.

b. Effects of Habitat Alteration: Although the amount of offshore development for the high case is assumed to increase over that for the base case (8 production platforms for the base case versus 25 platforms for the high case), the effects of habitat alteration from platform construction and/or installation and pipeline laying on marine-mammal habitats are expected to be about the same as described for the base case (see Sec. IV.B.5). Some very localized changes would be expected in the distribution of some seals and polar bears within 0.62 to 1.2 km (1-2 mi) of the platforms during construction-installation activities (one season), representing a short-term effect.

c. Effects of Noise and Disturbance: For high-case exploration and development, the amount of air traffic is assumed to increase to levels of 510 flights per year and 150-456 flights per month (from 108 and 64-334 flights per year for base-case exploration and development, respectively). Boat trips are assumed to increase to 23 trips per year in the high case (from up to 16 in the base case). The amount of area surveyed by geophysical activities during development is assumed to increase from 736 km^2 (456 mi^2) under the base case to 2,300 km^2 (1,426 mi^2) under the high case. Noise and disturbance of pinnipeds, polar bears, and belukha whales are expected to increase somewhat from that described for the base case, but the level of effect is expected to remain short term: very temporary (a few minutes to a few days at most) changes in the local distribution of pinnipeds, polar bears, and belukha whales associated with air- and vessel-traffic disturbance under the high case and the increased loss of walrus calves and seal pups, but such losses are expected to be replaced within <1 year.

Conclusion: The overall effect of the high case is expected to include the loss of several hundred to perhaps a few thousand young pinnipeds, several polar bears (30 to 60), and a few belukhas (<20) due to the assumed six oil spills, with recovery taking place within about one generation (4-7 years). Noise and disturbance and habitat effects on seal, walrus, polar bear, and belukha whale behavior and distribution are expected to be short term (a few minutes to a few days) and local (within about 1-3 km of the traffic and platforms).

6. Endangered and Threatened Species: The endangered bowhead whale, the threatened spectacled eider, the proposed Steller's eider, and the recently delisted arctic peregrine falcon (considered here as a candidate species) may occur year-round or seasonally in the Beaufort Sea Planning Area and may be exposed to OCS exploration and development/production activities under the high case of the proposal. The OCS activities under the high case may result in noise and disturbance, altered habitat, and spilled oil or other contaminants, such as drilling muds and cuttings, and could adversely affect the behavior, distribution, and abundance of individuals or populations occurring in or adjacent to the Sale 144 area. It is assumed that crude oil would not be released during exploration.

The high-case scenario assumes that one to four drilling units would drill 1 or 2 exploration wells each year between 1997 and 2009 and 1 to 6 delineation wells each year between 1997 and 2008 for a total of 65 wells. Support for operations on ice islands or nearshore gravel islands is expected to be by ice roads. Drilling operations farther offshore would be supported during the open-water season by at least one supply-boat trip/drilling unit/week and one helicopter flight/drilling unit/day. Depending on ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units. The time required to drill and test a well is about 90 days. It is also assumed that 25 production platforms (with a total of 850 wells) would be in operation for 26 years. More detailed information on logistics and transportation scenarios may be found in Section II.A.2. Analysis of oil-spill risk on species along the southern transportation route, particularly the southern sea otter and the marbled murrelet, can be found in the Cook Inlet Planning Area Oil and Gas Lease Sale 149 DEIS (USDOI, MMS, Alaska OCS Region, 1995), which is incorporated here by reference.

Activities that would occur during development and production are similar to those that would occur during exploration, with the addition of activity associated with oil transport. A spill of crude oil during development or production could affect individual species, as discussed below. In addition, cleanup activities associated with any oil spill may result in disturbance.

The OSRA estimated six spills ≥1,000 bbl, with an estimated 99.5-percent chance of one or more such spills occurring over the production life of the proposed action.

a. Effects on the Bowhead Whale: Bowhead whales may be present in the Sale 144 area generally from early April to mid-June during their spring migration from the Bering Sea to the Canadian Beaufort Sea and from August through October during their fall migration back to the Bering Sea. Noise-producing exploration activities (including aircraft traffic, icebreaking or other vessel traffic, geophysical-seismic surveys, drilling, and pipeline construction) and production operations are the activities most likely to affect bowhead whales. The potential effects on bowhead whales as a result of these activities are discussed in detail under Sec. IV.B.6, the base case.

Bowheads may exhibit avoidance behavior if approached by vessels at a distance of 1 to 4 km (0.62 to 2.5 mi). They are not affected much by any aircraft overflights at altitudes above 300 m (328 yd). Most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a distance of a few kilometers but rarely show avoidance behavior at distances of >7.5 km (>4.7 mi). Bowheads have been sighted within 0.2 to 5 km (0.12-3 mi) from drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to noise-producing activities. If drillships are attended by icebreakers, as is typically the case during the fall in the U.S. Beaufort Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to icebreakers breaking ice. Noise from dredging (trenching) for pipeline construction and the production operations from the eight platforms may cause whales to avoid the immediate vicinity of the activities; however, it is likely that the area of avoidance would be relatively small because whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident; and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30 to 60 minutes (in the case of seismic activity).

Bowhead whale-avoidance reactions under the high case are expected to be qualitatively similar to those discussed under the base case. However, there would be a substantial increase in aircraft, vessel, drilling, and construction activity under the high case; and noise sources also would increase substantially. Bowhead whales would be more likely to encounter these activities and react more frequently. Most of the increased noise and disturbance would occur during the comparatively brief period of exploration and development, when a considerable number of support vessels may be needed for ice management, seismic surveys, and ferrying supplies. Once production platforms are in place, support-vessel traffic likely would be greatly curtailed, and bowhead avoidance likely would be significantly reduced. Despite the increased number of noise sources under the high case, bowhead reactions are expected to entail short diversions of individual swimming paths to avoid closely approaching these sites.

Occasional brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migrating between the central Bering and eastern Beaufort Seas and should not result in serious adverse effects to individual bowheads or to the bowhead population. However, these disturbance or avoidance factors might become significant if industrial activity were sufficiently intense to cause repeated displacement of specific individuals (which we do not believe to be the case at the level of activity projected under the high case). Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant seismic exploration, drilling, and dredging. Behavioral studies have suggested that bowheads habituate to noise from distant ongoing drilling, dredging, or seismic operations (Richardson, Wells, and Wursig, 1985; Richardson et al., 1985), but there still is some apparent localized avoidance (Davis, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely impact bowhead use of that area (Richardson et al., 1985), but there has been no documented evidence that noise from OCS operations would serve as a barrier to migration.

The OSRA model estimated there is a 99.5-percent chance of one or more oil spills ≥1,000 barrels occurring. The OSRA model estimated a 7- to 85-percent probability (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting ERA's 4-11 (Ice/Sea Segments 4-11), areas where bowheads may be present during the fall migration, within 30 days over the production life of the proposed action. The probability of contact in ERA 9—the area of highest probability of contact—is estimated at 85 percent. The OSRA model estimated a 16-percent probability (expressed as a percent chance) of one or more spills ≥1,000 bbl occurring and contacting ERA SLSN (Northern SLS Area), an area where bowheads may be present during the spring and fall migration, within 30 days over the production life of the proposed action.

If an oil spill occurred and contacted bowhead whales, effects would occur qualitatively, as described under the base case. Oil-spill effects are likely to be greater under the high case than under the base case because six spills of ≥1,000 bbl are estimated under the high case as opposed to two spills under the base case. Consequently, the probability that whales may be contacted is greater under the high case than under the base case. The probability of oil actually contacting whales would be considerably less than the probability of its contact with bowhead habitat. If an uncontrolled, uncontained spill were to occur, a few bowheads could experience one or more of the following: skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the consumption of oil-contaminated prey items, and perhaps temporary displacement from some feeding areas. Some individuals may be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small.

Summary: Bowhead whale behavior, such as avoidance, under the high case is expected to be qualitatively similar with that discussed under the base case. There would be a substantial increase in aircraft, vessel, drilling, and construction activity; and whales would be likely to encounter these activities more frequently. Bowheads may exhibit avoidance behavior if closely approached by vessels or seismic-survey activity but are not affected much by any overflights unless aircraft altitudes are below 300 m (328 yd). Bowheads have been sighted near drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to them. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident; and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30 to 60 minutes (in the case of seismic activity). Overall, exposure of bowhead whales to noise-producing activities is not expected to result in lethal effects, but some individuals could experience temporary, nonlethal effects.

Since more oil spills are assumed to occur under the high case than under the base case, the probability is greater that whales may be contacted by spilled oil; and oil-spill effects are likely to be greater. However, the probability of oil actually contacting whales would be considerably less than the probability of contact with bowhead habitat. Some individuals may be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small. Overall, exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects.

Conclusion: Bowheads may exhibit avoidance behavior to vessels and activities related to seismic surveys, drilling, and construction during exploration and development and production. Some bowhead whales could be exposed to spilled oil, resulting in temporary, nonlethal effects, although some mortality may result if there were a prolonged exposure to freshly spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills would most likely experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years.

b. Effects on the Arctic Peregrine Falcon: If oil were released and contacted coastal areas near peregrine-nest sites or feeding areas, peregrine falcons may be affected through direct contact by adults (when hunting or via prey caught in the vicinity of the spills) or indirectly through disruption or a reduction in prey organisms (seabirds and shorebirds). The probability of such an event would be related to the probability of spilled oil being present in the vicinity of peregrine-nesting and/or -feeding areas. There is a very low probability that arctic peregrine falcons would contact spilled oil. Peregrines may occur in coastal areas such as the Colville or Canning River Deltas in the fall or near coastal nest sites south of Barrow. The combined probability (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting potential foraging areas within 30 days (LS's 20-45) ranges from 1 to 13 percent (Appendix B, Table B-36). If a spill occurred, the conditional probability of contact in these areas (expressed as a percent chance) from Launch Areas and Pipeline Segments, with few exceptions, is ≤5 percent (Appendix B, Tables B-12 and B-13); nearly all are <3 percent. The actual risk (probability) of spill contact for peregrines in these areas probably is even less than suggested by the OSRA values. Because of this species' transient occurrence in the areas likely to be contacted and the fact that they do not typically contact the water surface, it is very unlikely that peregrines would be significantly affected by oil spills. Indirect oiling from oiled prey could occur but is expected to result in little mortality. If oil spills affected prey populations, short-term, localized reductions in food availability for peregrines could occur.

Nesting peregrines could, on rare occasions, be disturbed by aircraft overflights related to the proposed sale that may occur inland from the coast. Nesting sites such as those near Ocean Point on the Colville River, about 40 km (25 mi) inland, and along the coast south of Barrow may be vulnerable to such occasional disturbance. The extent of such disturbance would depend on future locations of support facilities. Aircraft based in Deadhorse or Barrow typically would not fly over this area. Thus, significant disturbance of peregrine falcons associated with the exploration phase is unlikely. Significant population-level-disturbance effects associated with the development and production phase would be unlikely as well. It appears that the onshore-gathering pipelines projected for the production phase would be routed coastward of all peregrine falcon-nesting sites and thus should not adversely affect the species. Gravel mining for any artificial islands associated with Sale 144 also is unlikely to affect the peregrine, because extraction is expected to occur near the Beaufort Sea coast where peregrines are not known to nest. Less than 10 percent of the population nesting adjacent to the arctic slope is expected to be exposed to disturbance factors and spilled oil.

Conclusion: The overall effects on peregrine falcons from oil spills and disturbance are expected to be minimal, with <10 percent of the population exposed to potentially adverse factors resulting in only a few mortalities.

c. Effects on the Spectacled Eider: Spectacled eiders staging or migrating in nearshore areas along the Beaufort Sea coast are not expected to experience substantial adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparent low probability that routes traveled and area covered by scattered coastal flocks during two relatively brief staging/migration intervals would be intersected by the flight paths of support aircraft (1-4 round-trip flights/day) between rigs and onshore facilities at Kuparuk Field or Deadhorse. It is likely that only a limited degradation of available foraging habitat would occur, within about 1 to 2 km (0.62-1.2 mi) of the established flight paths from platforms west of Oliktok Point during the limited time males in late June and females with juveniles in late August are traversing the area. However, if helicopters servicing rigs in the western part of the sale area first return to and then follow the coastline to onshore facilities during these periods, disruption of foraging activity potentially could be more widespread. Likewise, because nest sites are scattered over much of the arctic slope, relatively few are expected to be overflown by helicopters from offshore units, and significant disturbance of nesting or brood-rearing eiders is not expected to occur. However, disturbance of some individuals over the life of the project is expected to be unavoidable, and any disturbance could be considered a "take" under the Endangered Species Act. Less than 10 percent of the population is expected to be affected by routine activities.

Exposure of spectacled eiders to oil is expected to result in the general effects noted in Section IV.B.4 (i.e., not expected to survive moderate to heavy contact). A highly variable proportion of the eider population could be vulnerable to an oil spill contacting the Beaufort coastline west of Oliktok Point, because although the staging/migrating individuals are scattered in relatively few flocks along the coast during two brief intervals, such flocks typically contain substantial numbers of individuals. Because most spring migrant spectacled eiders arrive at the nesting areas via overland routes, few are expected to occupy leads offshore where they would be vulnerable to any oil entering such habitat. Eiders are not present in the area from October to May. The combined probability (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting areas occupied during staging/migration periods within 30 days (Elson Lagoon-C2; Land Segments 20-32) ranges from <0.5 to 5 percent (Appendix B, Tables B-36, B-37). If a spill occurred, the conditional probability of contact in these areas within 30 days (expressed as a percent chance) from Launch Areas L1 to L8 and Pipeline Segments P1-P4 and P13 is ≤6 percent (Appendix B, Tables B-6, B-7, B-12, B-13); most values are <3 percent. Thus, relatively low spectacled eider mortality is expected from oil spills associated with the proposed action (<200 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Summary: Spectacled eiders nesting at inland sites, or staging/migrating along the Beaufort Sea coast, are not expected to experience significant adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparent low probability that scattered nest sites, or routes traveled and area covered by scattered coastal flocks during two relatively brief staging/migration intervals, would be overflown by support-aircraft flights between offshore units and onshore facilities. Disturbance of some individuals over the life of the project is expected to be unavoidable, and any disturbance could be considered a "take" under the Endangered Species Act. Relatively low spectacled eider mortality is expected from an oil spill (<200 individuals); however, unless mortality is near the lower end of this range, recovery from spill-related losses is not expected to occur if population is declining as at present.

Conclusion: Overall routine effects on the spectacled eider are expected to be minimal, affecting <10 percent of the population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur if population status is declining as at present.

d. Effects on the Steller's Eider: Steller's eiders staging or migrating in nearshore areas along the western Beaufort Sea coast are not expected to experience substantial adverse effects from potentially disturbing routine activities (primarily helicopter flights) because of the apparently low probability that the routes traveled and area covered by scattered coastal flocks of this small Alaskan population during two relatively brief staging/migration intervals would be intersected by the flight paths of support aircraft (1-4 round-trip flights/day) between rigs and onshore facilities at Kuparuk Field or Deadhorse. It is likely that only a limited reduction of available foraging habitat would occur, within about 1 to 2 km (0.62-1.2 mi) of the established flight paths from rigs in the western sale area during the limited time males in late June and females with juveniles in late August are traversing the area. However, if helicopters servicing rigs in the western sale area first return to and then follow the coastline to onshore facilities during these periods, disruption of foraging activity potentially could be more widespread. Also, it is unlikely that the primary Alaskan nesting area, located south and southeast of Barrow, would be overflown by helicopters from offshore units, so significant disturbance of nesting or brood-rearing eiders is not expected to occur. Less than 10 percent of the Alaskan population is expected to be affected by routine activities. Any disturbance that does occur could be considered a "take" under the Endangered Species Act.

Exposure of Steller's eiders to oil is expected to result in the general effects noted in Section IV.B.4 (i.e., not expected to survive moderate to heavy contact). A highly variable proportion of the eider population could be vulnerable to any oil spill contacting the Beaufort coastline adjacent to the extreme western portion of the proposed sale area, because the staging/migrating individuals generally are scattered in relatively few flocks along the coast during two brief intervals. Because most spring migrant spectacled eiders arrive at the nesting areas via overland routes, few are expected to occupy leads offshore where they would be vulnerable to any oil entering such habitat. Eiders are not present in the area from October to May. The combined probability (expressed as a percent chance) of one or more ≥1,000-bbl spills occurring and contacting areas occupied during migration periods within 30 days (Elson Lagoon-C2; LS's 20-32) ranges from <0.5 to 5 percent (Appendix B, Tables B-36, B-37). If a spill occurred, the conditional probability of contact in these areas within 30 days (expressed as a percent chance) from Launch Areas L1-L8 and Pipeline Segments P1-P4 and P13 is ≤ 6 percent (Appendix B, Tables B-6, B-7, B-12, and B-13); most values are <3 percent. Thus, relatively low Steller's eider mortality is expected from an oil spill (<200 individuals); however, unless mortality is near the lower end of this range (e.g., ≤ 25), recovery of the Alaska population from spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Summary: Because potentially disturbing routine activities (primarily helicopter flights) associated with this sale generally would be far removed from most of the Steller's eiders staging or migrating along the western Beaufort Sea coast or breeding in the primary nesting area south of Barrow, the population is not expected to experience any significant effects from such activities. Any disturbance of individuals could be considered a "take" under the Endangered Species Act. Relatively low Steller's eider mortality would be expected from an oil spill (<100 individuals); however, unless mortality is quite low, recovery of the Alaska population from spill-related losses is not expected to occur if population status is declining as at present.

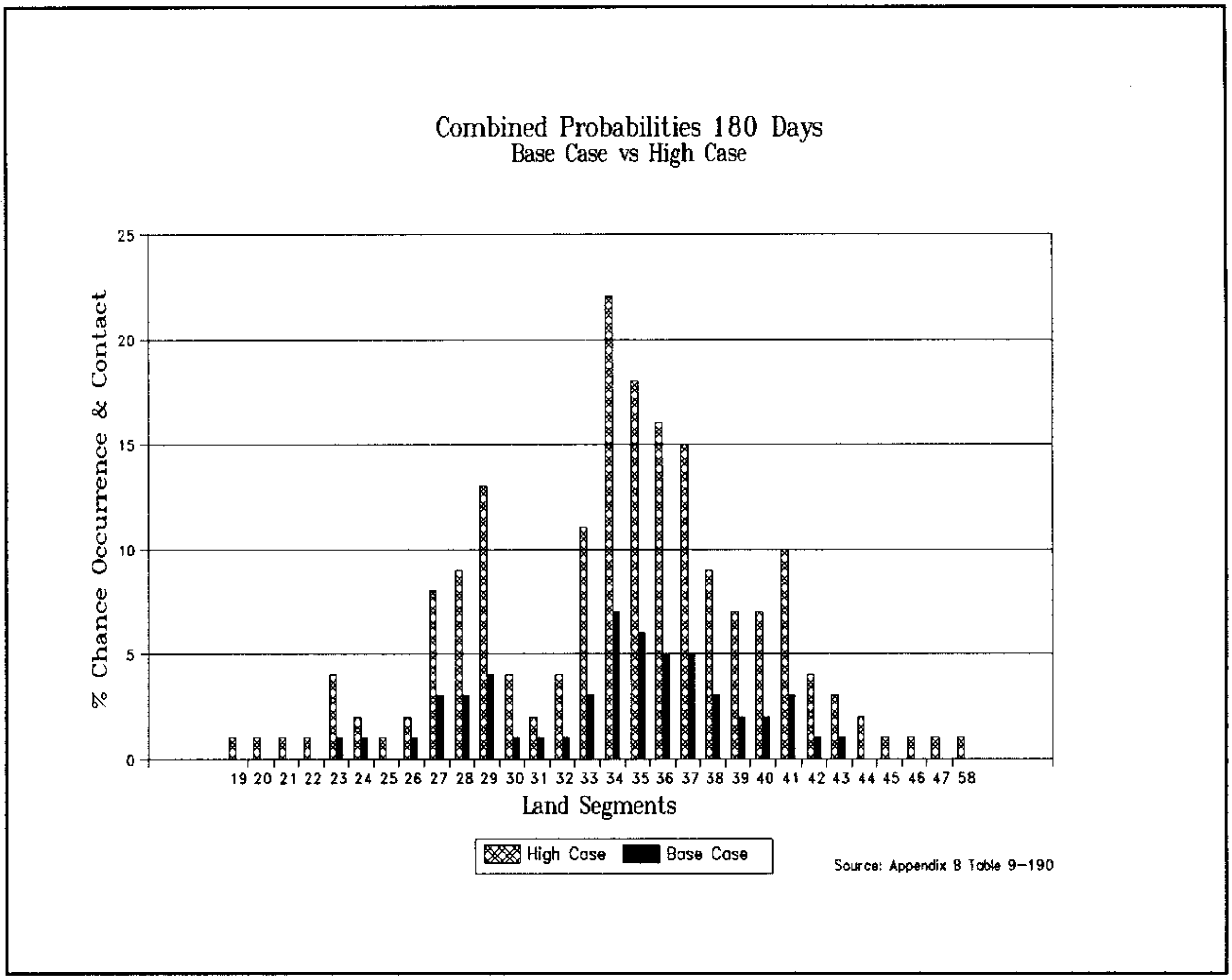
Conclusion: Overall routine effects on the Steller's eider are expected to be minimal, affecting <10 percent of the Alaska population; however, recovery from any substantial mortality resulting from an oil spill is not expected to occur if population status is declining as at present.

7. Caribou: For the high case, an additional fourth offshore pipeline landfall is assumed to be located at Pitt Point (west of Cape Halkett) (Fig. III.B.6). The amount of onshore pipeline and road construction would increase to 344 km (215 mi) for the high case over 168 km (105 mi) that are assumed under the base case. The number of production platforms would increase to 25 (from 8 under the base case). There would be an increase in helicopter traffic during exploration to about 510 flights/year versus 108/year under the base case and an increase during development of 150 to 456 flights per month versus 64 to 334 per month under the base case (air traffic to and from the support facilities at Prudhoe Bay and perhaps at Camp Lonely in the Pitt Point area and at Barter Island). This increase in traffic could increase the frequency of disturbance of some caribou along the flight paths, but such disturbance events would have short-term (minutes to perhaps an hour) effects on caribou behavior and insignificant effects on caribou abundance or distribution.

Onshore pipelines and access roads from a point about 32 km (20 mi) east of Bullen Point, Pitt Point, Oliktok Point, and Point McIntyre to existing facilities and to TAPS would result in motor-vehicle-traffic (as much as several hundred vehicles/day) disturbance of some portion (several thousand caribou) of two caribou herds on the North Slope—the TLH and the CAH. These caribou would be temporarily disturbed by this traffic and displaced from their summer range within a few miles of the pipeline corridors. The additional pipeline landfall at Pitt Point located west of Cape Halkett (Fig. III.B.6) and the associated onshore pipeline and road corridor are expected to cross a portion of the TLH and CAH calving ranges and displace some cows and calves within about 1 to 2 km (0.62-1.2 mi) of the corridor. This reduction in distribution is expected to subside within one generation (about 2 years) after pipeline and road construction is complete. However, a very local reduction in habitat use by some cows and calves within about 1-2 km (0.62-1.2 mi) of the pipeline corridors might persist over the life of the project. Caribou are likely to successfully cross all four pipeline corridors within a short period of time (a few minutes to a few days) during breaks in the traffic flow, even during construction activities (high periods of traffic), with little or no restriction of caribou movements. Caribou abundance and productivity are not expected to be affected under the high case.

The number of assumed oil spills ≥1,000 bbl increases to six (versus two spills under the base case). The assumed six oil spills (7,000 bbl) would substantially increase the probabilities of spill occurrence and contact to coastline habitats from Barter Island (LS 41) west to Oliktok Point (LS 33) (an increase from >2% to 7% under the base case to 7% to 22% under the high case as shown in Fig. IV.G.7-1). Also, the potential for oil-spill occurrence and contact (probabilities ≥1%) to coastline habitats of caribou from Herschel Island (LS 48) west to Point Barrow (LS 19) within 180 days increases under the high case over that of the base case (Fig. IV.G.7-1 probabilities of oil-spill occurrence and contact are ≥1% to 22% under the high case compared with ≤1%-7% under the base case).

Assuming that two or more of the six spills (7,000 bbl) expected under the high case occurred during the open-water season, caribou of the WAH, TLH, CAH, and PCH that frequent coastal habitats from Elson Lagoon (LS 21) east to Demarcation Bay (LS 45) could be directly exposed to and contaminated by the spills along the beaches and in



IV.G.7-1. Comparison of Base-Case with High-Case Combined Probabilities (expressed as a percent chance) of One of More Oil Spills ≥ 1,000 Barrels Occurring and Contacting Certain Land Segments Within 180 Days Over the Assumed Production Life of Sale 144 shallow waters during periods of insect-pest-escape activities (Fig. IV.B.7-1, LS's 21 though 45). However, even in a severe situation, a comparatively small number of animals (several hundred to perhaps a few thousand) are likely to be directly exposed to the oil spill and die as a result of toxic-hydrocarbon inhalation and absorption and possible ingestion of oiled vegetation. This loss probably would be small for any of the four caribou herds, with these losses replaced within less than one generation (about 1 year).

Conclusion: For the high case, the overall effect on caribou behavior and distribution is expected to be long term (> 1 generation) but local (within about 1-2 km [0.62-1.2 mi] of the road-pipeline corridors), and mortality (as many as < 1,000 animals) due to oil spills is expected to be replaced within 1 year.

8. *Economy of the North Slope Borough:* Increased revenues and employment are the most significant economic effects that would be generated by the high case of the proposal. Increased property-tax revenues and new employment would be created with the construction, operation, and servicing of facilities associated with OCS activities. These facilities are described in Table IV.A.1-1 and are summarized as follows: during the exploration phase between 1997 and 2009, 24 exploration and 41 delineation wells would be drilled; and during the development and production phase between 2001 and 2030, 850 production wells would be drilled, 25 platforms and 355 miles of pipeline would be installed. The number of workers needed to operate the infrastructure is determined by the scale of the infrastructure and not the amount of oil produced. Some temporary employment is generated by assumed oil spills. The effects on the subsistence economy are increased.

Analysis of economic effects resulting from proposed Sale 144 is limited to effects on the NSB. The information that follows is from the Rural Alaska Model, prepared for MMS by the ISER, and from the NSB 1993/1994 Economic Profile and Census Report (Harcharek, 1995).

a. NSB Revenues and Expenditures: Under existing conditions, total property taxes in the NSB and NSB revenues are in general projected to decline, as discussed in Section III.C.1. These revenues will be determined by several different factors; and, therefore, the revenue projections should be considered with the understanding that many uncertainties exist about these factors. The high case is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 8 percent each year through the production period. Also under existing conditions, the two expenditure categories that affect employment—operations and the CIP—are projected to decline. Of these two categories, only expenditures on operations would be affected by the proposed sale's effects on taxable property value. Those CIP expenditures that have generated many high-paying jobs for residents would not be affected.

b. Employment: The gains from Sale 144 in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. The peak employment estimate of 8,221 jobs is projected for 2011, declining to under 5,000 jobs by 2025. (See Appendix E for a description of the methodology for employment and population forecasts.) All of these jobs would be filled by commuters who would be present at the existing enclave-support facilities 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 from the enclaves to permanent residences outside of Alaska, especially during the exploration phase. Because economic effects in other parts of Alaska would be insignificant, only employment increases in the North Slope region are discussed.

The high case is projected to affect employment of the region's permanent residents in two ways: (1) more residents would obtain petroleum-industry-related jobs as a consequence of Sale 144 exploration and development and production activities and (2) more residents would obtain NSB-funded jobs as a result of higher NSB expenditures, as discussed above.

While the high case is projected to generate a large number of industry jobs in the region, the number of jobs filled by permanent residents of the region is not projected to be large. Total high-case resident employment is expected to be about 11 percent greater than existing-condition employment. Overall employment should therefore, not decline as far by the end of the production period as it would under existing conditions. The increase in employment opportunities may partially offset declines in other job opportunities and delay expected outmigration.

Appendix E presents a comparison of total resident employment and total resident Native employment (a subset of total resident employment) for the no-sale case and for the high case. It is assumed that all of the direct petroleum-industry-related employment of residents is filled by Natives. However, most of the sale-induced employment is not with the petroleum industry. As petroleum-industry-related employment in the region declines, there probably would be less effort made to recruit and retain Native workers.

Employment generated by oil-spill-cleanup activities also would have economic effects. The most relevant historical experience of a spill in Alaskan waters was the EVOS of 1989, which spilled 258,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Similar effects on the NSB would be mitigated due to the likelihood that cleanup activities, including administrative personnel and spill-cleanup workers, would reside in existing enclave-support facilities.

The number of workers actually used to clean up the assumed six oil spills of 7,000 bbl associated with the high case would depend to a great extent on what procedures were called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities. Activities associated with the high case could generate cleanup work for about 3 percent of the workers associated with the EVOS—or 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

c. Effects of Subsistence Disruptions on the NSB Economy:

Disruptions to the harvest of subsistence resources could affect the economic well-being of NSB residents in a number of ways. Adverse effects would be felt primarily through the direct loss of subsistence resources. In addition, loss of subsistence resources would increase demand for store-brought goods and result in an inflation of prices.

Subsistence activities are an integral component of the NSB economy as well as the culture. Subsistence is the "body and soul" of Native culture (I. Nukapigak, 1995). If one or more subsistence resources became unavailable for harvest, the economic well-being of NSB residents would be harmed. There are two components to the economic well-being associated with subsistence resources—the value of subsistence resources as a source of food and the cultural value of the resources. Both of these values can be represented as a direct source of economic well-being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased in the marketplace. This food source is a substitute for income earned in the marketplace that would have to be used to purchase food. Subsistence activities and the value derived from these pursuits, however, go beyond a substitute for food bought in the market. As a way of life, there is a real, measurable economic value gained from NSB residents having access to such activities. As explained below, disruption of a subsistence harvest would result in a real loss of economic well-being to residents.

The interaction between the "Western" market-oriented economy and subsistence activities is a complex relationship that does not fit neatly into standard economic theory. Much of the reason for this is because the unit of analysis in standard economic theory is the household, whereas the extended-kinship network is important for economic decision making in the Inupiat culture of the NSB. The kinship-sharing network that is characteristic of Inupiat culture distorts the standard economic outlook on an economy. For example, jobs in the market economy often are held in order to support subsistence activities. Earnings from these jobs frequently are not earned by the principal harvester of subsistence resources but rather are contributed to the harvester's subsistence effort by the market-wage earner. Likewise, subsistence resources are contributed to those engaged in market-oriented activities. This, however, is only one possible combination of the relationship between the market economy and subsistence activities. Market-wage earners also may directly engage in subsistence activities. Furthermore, the sharing of resources among the kinship network is not a simple trade of equally valuable goods. Rather, it is based on tradition and status among the individuals within the network.

Because of this extensive subsistence-user/-kinship network, a disruption to a subsistence resource caused by, for example, an oil spill could have ramifications that extend beyond the immediate family of the subsistence harvester to households that, by all appearances, principally engage only in market-economy activities. "Our food would be devastated by an oil spill" (E. Itta, 1995). For example, an MMS survey-research project on the North Slope found that for six North Slope communities (Barrow, Wainwright, Nuiqsut, Point Hope, Anaktuvuk Pass, and Kaktovik), about 70 percent of all households (regardless of ethnicity) obtained the majority of meat and fish in their diet from subsistence activities. A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely could not be compensated for by the market economy through purchases of Western foods. There is considerable evidence that Western foods are not considered equivalent to Native foods (Krause et al., 1983). Even if an equal portion of Western foods were substituted for the lost subsistence foods, there still would be a loss in well-being and, in turn, a loss in income because the substitute foods would be an inferior product. This aspect of the loss does not begin to address the lost value associated with having to forego participating in subsistence activities and, in general, the lost value associated with not being able to participate in the Native culture. This is not to deny the possibility of local residents earning additional income through cleanup jobs; however, cleanup opportunities are not expected to fully compensate for the lost value resulting from being denied use of subsistence resources.

The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. The effects of the high case on subsistence-harvest patterns in Barrow are expected to cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. In Nuiqsut and Kaktovik, high-case effects would cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. High-case effects are expected to cause a significant portion of subsistence waterfowl to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years (see Sec. IV.G.10, Subsistence-Harvest Patterns).

Conclusion: The high case of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1997 and averaging about 8 percent each year through the production period. A peak employment estimate of 8,221 jobs is projected for 2011, declining to under 5,000 jobs by 2025. The number of jobs filled by permanent residents of the region is projected to be about 11 percent greater than existing-condition employment. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. The effects of the high case on subsistence-harvest patterns in Barrow are expected to cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. In Nuiqsut and Kaktovik, high-case effects would cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. High-case effects are expected to cause a significant portion of subsistence waterfowl to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years.

9. Sociocultural Systems: In the high case, it is assumed that exploration and development and production would occur in the proposed lease-sale area. For production, 25 platforms are assumed (17 more than in the base case), and an additional pipeline landfall would be constructed at Pitt Point, as well as landfalls constructed at Oliktok Point and Point McIntyre in the base case. Development and production would be supported by facilities at the Prudhoe Bay and Kuparuk units, which would continue to be the primary support-base infrastructure for major construction and operation activities. Portions of Barrow's and Atqasuk's terrestrial subsistence-harvest areas would be crossed by the assumed pipeline route from the landfall at Pitt Point.

a. Effect Agents: 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. The communities in the proposed sale area that could experience sociocultural effects in the high case are Barrow, Atqasuk, Nuiqsut, and Kaktovik, as in the base case.

(1) Industrial Activities: During the exploration phase in the high case, Prudhoe Bay would be used for primary air support in the Beaufort Sea. Kaktovik has been used in the past for some transportation of freight and personnel to exploration platforms and would most likely continue to be used for future exploration in the eastern Beaufort Sea.

In addition to the production and transportation facilities assumed for the base case (eight production platforms; pipelines; and pipeline landfalls at Oliktok Point, Point McIntyre, and a point about 20 mi east of Bullen Point), development and production for the high case would include 17 additional production platforms. With onshore facilities in place, construction activities would be associated with landfall facilities and pipelines to the production platforms. Air support for high-case development and production would be from Deadhorse-Prudhoe Bay and Kuparuk.

(2) Population and Employment: As in the base case, the high case for Sale 144 is projected to affect the population of the NSB through two types of effects on employment in the region: (1) more petroleum-industry-related jobs as a consequence of Sale 144 exploration and development and production activities and (2) more NSB-funded jobs as a result of higher NSB operating revenues and expenditures (see Sec. IV.B.8). Employment projections in the high case as a consequence of Sale 144 are provided in Section IV.B.8 and Appendix B. Peak high-case employment would be reached in 2010 with a total of 8,221 jobs projected. Native employment would peak the same year at 581 jobs, and resident population would peak in 2011 at 823 jobs. All of these jobs would be filled by commuters who would work and live at enclave sites. Most workers are expected to permanently reside outside of the North Slope and commute to permanent residences in other regions of Alaska and the lower 48.

In the high case as in the base case, the effect on the population of the NSB from increased employment opportunities would partially offset expected declines in other job opportunities, although total high-case resident employment is expected to be <11 percent greater than existing conditions between 1997 and 2010. The Native proportion of the population is not expected to change much: from 74 percent in 1994 to 77 percent in 2010. Native employment is expected to improve slightly as a consequence of Sale 144.

In the high case, an estimated six spills of 7,000 bbl each have a 99.5-percent chance of occurring and contacting the sale area. Based on the history of the *Exxon Valdez* spill in 1989, cleanup for spills from the Sale 144 high case could generate up to 3,000 cleanup jobs at peak effort and suddenly and significantly inflate the local economies of NSB communities involved (Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990e).

b. Effects on Subsistence-Harvest Patterns: Subsistence is important to the Inupiat sociocultural system (see Sec. III.C.3). Effects expected on subsistence-harvest patterns in the Sale 144 area, particularly in the high case and especially as a result of effects on the bowhead whale harvest, would render the bowheads unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years in Barrow, Atqasuk, Nuiqsut, and Kaktovik.

c. Effects on Barrow, Atqasuk, Nuiqsut and Kaktovik: This section discusses the effect of the high case on the communities whose sociocultural systems could be affected by Sale 144. Nuiqsut and Kaktovik are small, relatively homogenous communities that would not absorb the presence of non-Natives as would a community such as Barrow. Interactions with non-Natives, increased non-Native population, and Natives 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 disruptions of subsistence-harvest patterns, especially of the bowhead whale, 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 break- down 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 entrepreneurialism. Kaktovik and Nuiqsut also may experience an increase in social problems due to the roads connecting Nuiqsut to Pitt Point or Oliktok Point and reaching toward

Kaktovik by connecting to Bullen Point, enabling easier access to drugs and alcohol and affecting the social health of the community. Effects on the sociocultural systems, 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 Nuiqsut and Kaktovik. Barrow is a much larger community that is more heterogeneous than others on the North Slope, and it could withstand some degree of increased population and employment opportunities.

Effects on sociocultural systems in Barrow, Nuiqsut, and Kaktovik described above would be long term. There could be a tendency for chronic disruption of sociocultural systems for a period of 1 to 2 years but without tendencies toward displacement of existing institutions.

Atqasuk is too distant from onshore industrial activities to be directly affected by this lease sale and is not expected to experience direct, sale-related increases in population and employment. Atqasuk may experience some indirect rises in population and increases in employment, but they are not expected to be significant. Disruptions in Atqasuk would be short term and would not have a tendency toward displacement of existing sociocultural institutions.

Conclusion: For the high case, the effects on sociocultural systems are expected to cause chronic disruption for a period of 1 to 2 years but without a tendency toward the displacement of existing institutions.

10. Subsistence-Harvest Patterns: In the high case, landfalls would be constructed at Pitt Point, Oliktok Point, Point McIntyre, and a point about 20 mi east of Bullen Point for development and production. Development would be staged from support-base facilities at Deadhorse-Prudhoe Bay and Kuparuk units that would continue to be the primary support-base infrastructure for major construction and operation activities. Twenty-five production platforms would be constructed in the high case (17 more than the base case), and produced oil would be transported to shore through 140 km (87 mi) of offshore pipeline. The most likely number of spills ≥1,000 bbl increases from two in the base case to six for the high case.

a. Effects from Oil Spills: In the high case, six oil spills (7,000 bbl) are assumed to occur. Base-case probabilities of spill contact to important subsistence resources would change in SRA's B, C, and D from 4, 68, and 63 percent, respectively, to 13, 97, and 96 percent, respectively, under the high case. The probability also increases in the Nuiqsut's SRAC (a 29% increase in the probability of oil occurring and contacting subsistence resources during the winter and open-water seasons). In Barrow's SRAB, there would be an increase in probabilities from 4 to 13 percent during the winter and open-water seasons. In Kaktovik's SRAD, the probability of an oil spill occurring and contacting subsistence resources would increase 33 percent. During the winter, such contact could affect sealing and polar bear hunting. During the spring season, sealing, whaling, and bird hunting could be affected. In fall, contact would affect whaling and ocean-fish netting. A spill during the open-water season could affect sealing, belukha whaling, walrus hunting, and bird hunting.

In the high case, effects on subsistence-harvest patterns from oil spills would be greater than in the base case. 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 in all communities other than Barrow could mean a reduction to zero whales—an elimination of the harvest. Even if an oil spill did not affect the entire population of bowhead whales and only a number of individuals in a localized area were oiled or if oil were in the area but did not affect the whales, the bowheads still could be rendered inedible or perceived as such and consequently would not be harvested that year. Effects on bowhead whales would render them unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. The walrus harvest also occurs within a short 2-week period. If an oil spill occurred during or shortly before the walrus harvest season, it is likely that no walruses would be harvested that year. Effects from the high case would render walruses unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. This effect most likely would occur only in Barrow, as Nuiqsut and Kaktovik do not harvest many walruses.

The overall effect of the high case on marine and coastal birds is expected to include the loss of tens of thousands of birds (up to perhaps 100,000) from the assumed six oil spills, with recovery taking place within more than one generation (perhaps 3-5 years). Oil-spill contact to habitat in Gwydyr Bay, Simpson Lagoon, and the Northern Lead System near Point Barrow is expected to cause substantial losses to seabirds, waterfowl, and shorebirds. Assuming that extensive areas of coastline were contaminated, in excess of 100,000 birds could be lost. Species with abundant populations, such as oldsquaw, could be expected to recover in one generation; but species experiencing depressed regional populations, such as Pacific brant and common and king eiders, would take perhaps 3 to 5 years to recover. Effects from disturbance, habitat alteration, and construction are expected to be very local and short term.

b. Effects from Noise and Disturbance: With the additional platforms, effects from noise and disturbance would be intensified and the probability of effects occurring would be increased in the high case; however, they are not expected to increase effects levels. As in the base case, effects from noise and disturbance in Barrow, Atqasuk, Nuiqsut, and Kaktovik could periodically affect the bowhead whale population but with no apparent effects on the subsistence whale harvest.

c. Effects from Construction Activities: Effects on subsistence harvests from construction activities and development and production would be somewhat greater in the high case than those expected in the base case (see Sec. IV.B.10) because there would be an additional landfall constructed at Pitt Point and an additional 177 km (110 mi) of onshore pipeline connecting Pitt Point to the existing Kuparuk field-gathering facilities to the east. There also would be an additional 97 km (60 mi) of pipelines from the platforms to the landfall; these activities are only expected to intensify the effects but not increase effects levels. In Barrow, Atqasuk, Nuiqsut, and Kaktovik, subsistence resources such as bowhead whales and walrus could be periodically affected but with no apparent effects on subsistence harvests.

Effects in Barrow, Atqasuk, Nuiqsut, and Kaktovik would be altered in the high case. As a result of oil spills, subsistence-harvest patterns in Nuiqsut and Kaktovik could experience effects that would cause one or more important subsistence resources (the bowhead whale) to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. Barrow's (and Atqasuk's) subsistence-harvest patterns could experience effects on bowhead whales from oil spills that would cause them to be unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year.

Conclusion: The effects of the Sale 144 high case on subsistence-harvest patterns in Barrow are expected to cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year. In Nuiqsut and Kaktovik, high-case effects would cause bowheads to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years. High-case effects are expected to cause a significant portion of subsistence waterfowl to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years.

11. Archaeological Resources: Under the high case of the proposal, effects on archaeological resources would result primarily from any bottom-disturbing activity related to OCS exploration. In the event of an oil spill, the majority of effects would result from human activity related to cleanup activities. Because there has not been a complete and systematic inventory and evaluation of the archaeological resources in the coastal region of the sale area, the potential for significant effects, should an oil spill occur, cannot be determined.

Conclusion: The effects from the high case of the proposal would likely be the same as from the base case of the proposal. There should be no effects on submerged prehistoric sites as a result of Sale 144 because it is unlikely that there are preserved prehistoric sites within the sale area. The expected effect on historic shipwrecks should be low because of the requirement for review of geophysical data prior to any lease activities. Although oil-spill effects on onshore archaeological resources are uncertain, data from the EVOS indicate that few onshore archaeological resources (<3%) are likely to be significantly affected by an oil spill.

12. Air Quality: A discussion of air-quality regulations and procedures can be found in Section IV.B.12, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. The modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum-potential effect to the air quality of a Class II area adjacent to the proposed sale area.

For the high case, peak-year emissions from exploration would be from drilling three exploration wells and six delineation well from four rigs. Peak-year emissions from development would include platform and pipeline installation and the drilling of 120 production wells from 15 rigs. Peak-year production emissions would result from operations (producing 315 MMbbl of oil), transportation of oil from 8 platforms, and transporting the oil by pipeline. Table IV.G.12-1 lists estimated uncontrolled-pollutant emissions for the peak exploration and development and production years. Under the Federal and State of Alaska PSD regulations, because the estimated annual uncontrolled NO_x emissions for the peak-development year would exceed 250 tons per year, the lessee would be required to control NO_x emissions through application of BACT to emissions sources to reduce NO_x emissions (Table IV.G.12-2). The OCD model air-quality analysis performed for air pollutants emitted for exploration and development and production in the high case showed that maximum NO_2 concentration, averaged over a year, would be 1.45, 0.81, and 0.22 μ/m, respectively, at the shoreline and 6, 3, and 1 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_x had the highest concentrations, which were well within PSD increments and air-quality standards.) Emissions may also result from additional onshore processing and transportation facilities. For a more detailed discussion of the potential effects of air pollution, other than those effects addressed by standards, see Section IV.B.12.

Accidental emissions could result from gas blowouts, evaporation of spilled oil, and burning of spilled oil. For the high case, the probability of experiencing one or more blowouts in drilling the possible maximum of 915 exploration, delineation, and production wells would be 14 to 17 percent. The emissions from a given gas blowout would be quickly diffused and would seldom last longer than a day. For additional information on gas blowouts, see Section IV.B.12.

Oil spills are another accidental source of gaseous emissions. Section IV.A.2, Oil-Spill-Risk Analysis, discusses the probabilities for and size of oil spills associated with the high case.

The burning of spilled oil in the high case would not differ appreciably from the base case. For any given fire, it is expected that any smoke reaching the shore would be dispersed, of short term, and limited to a local area, resulting in a low effect.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Effects on onshore air quality from high-case air emissions are expected to be 6 percent of the maximum allowable PSD Class II increments. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration and development and production activities or from accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

13. Land Use Plans and Coastal Management Programs: Increased oil production in the high case is assumed to require 16 additional production platforms, one additional pipeline-landfall site, and 170 additional mi of pipeline (60 mi offshore and 110 mi onshore). The most likely number of oil spills of ≥1,000 bbl increases from two to six. The increase in the number of oil spills and the increased acreage affected by oil spills exacerbates some of the conflicts identified in the base case of the proposal. As a result, the potential conflicts with the NSB Land Management Regulations and the ACMP that are identified in the base case are relevant to the high case. These conflicts (see Sec. IV.B.13) are summarized here and modified as appropriate to include new levels of effects identified in the other high-case analyses (Secs. IV.F.1 through 12).

a. North Slope Borough Comprehensive Plan and Land Management Regulations: Major land use decisions concerning onshore facilities are comparable with those of the base case. The Offshore Development policy related to vessel traffic during the bowhead whale migration (NSBMC 19.70.040.E) and the policies related to the Transportation Corridor remain relevant. Applicable areawide policies are cited along with the identical NSB CMP policy in the following section.

Table IV.G.12-1
Estimated Uncontrolled Emissions for the Beaufort Sea Sale 144
Alternative I High Case
(in tons per year)

	Regulated Pollutants				
	CO	NO_x	PM-10	SO_2	VOC
High Case[1]					
Peak Exploration Year	1250.4	6444.0	249.6	282.4	459.2
Peak Development Year	1313.1	6819.0	414.1	289.2	357.0
Peak Production Year	1190.0	3232.5	152.5	70.0	115.0

Source: MMS, Alaska OCS Region, 1995.

1 Assumes peak-year emissions from exploration from drilling eight exploration/delineation wells from two rigs. Peak-year emissions from development would include platform and pipeline installation and the drilling of 81 production wells from 9 rigs. Peak-year production emissions would result from operations (producing 315 MMbbl of oil) and transportion.

Table IV.G.12-2
Comparison of Modeled Air-Pollutant Concentrations with Regulatory Limitations
(in micrograms per cubic meter)

Averaging Time	Maximum Modeled Concentration Over Land[1]	PSD Increments[2] Class II
High-Case Exploration NO_2 (annual)[3]	1.56	25
High-Case Development NO_2 (annual)	1.18	25
High-Case Production NO_2 (annual)	.32	25

Source: USDOI, MMS, 1995.

1 Offshore and Coastal Dispersion Model.
2 Increment above ambient concentration allowed in a designated PSD area. Ambient baseline concentration for PSD not established for this area.
3 Modeling was done on other pollutants and these results were lower than shown for NO_X.

b. Alaska Coastal Management Program: As noted previously, this analysis includes only a summary of the potential conflicts identified in Section IV.B.13(b), augmented as necessary to include changes in levels of effects in other high-case analyses.

(1) Energy Facilities (6 AAC 80.070): Conflicts noted in the base case with respect to the landfall located at a point about 20 mi east of Bullen Point still would be evident in the high case. User conflicts between whalers and those installing the pipeline would be in conflict with the second factor of the energy-facility policy, which requires facilities to be compatible with existing and subsequent uses.

(2) Subsistence (6 AAC 80.120): As noted previously, the major conflicts between the proposal and subsistence policies relate to issues of access to subsistence resources and availability of bowhead whales. Policies of particular relevance related to access include NSB CMP policy 2.4.3(d) (NSBMC 19.70.050.D), which requires that development not preclude reasonable subsistence-user access to a subsistence resource; NSB CMP 2.4.5.l[b] (NSBMC 19.70.050.J.2), which is a best-effort policy addressing reduced or restricted access to protect user access for subsistence purposes; and NSB CMP 2.4.3(a) (NSBMC 19.70.050.A), which relates to "extensive adverse impacts to a subsistence resource" that "are likely and cannot be avoided or mitigated." The conflicts are the same as those for the base case, but the potential for conflict in the high case is intensified.

In the high case, the probability of oil spills of $\geq$1,000 bbl is increased from two to six. The resulting effects on birds could be high due to the increased probability of contact with spilled oil. The decrease in the bird populations would deplete the resource below the subsistence needs of the local residents, resulting in the resource being unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 3 to 5 years (Sec. IV.F.10).

(3) Habitats (6 AAC 80.130): The only specific environment in which effect levels rise in the high case is for lagoons and bays. An increase in spill-contact probabilities to coastal beaches, such as along the coast of Gwydyr Bay, in Simpson Lagoon, and within the Point Barrow area, indicates that a greater percentage of the surface area of these habitats would be contaminated if some of the oil spills occurred during the open-water season. This, in turn, would increase the effects on seabirds, waterfowl, and shorebirds. Of particular concern is the Pacific brant, and common and king eiders, which could take more than one to two generations to recover. Because an oil spill is an accidental discharge into the environment, it cannot be planned for. The effects of habitat alteration from pipeline-road construction and shore-base construction on tundra habitats of marine and coastal birds are expected to be similar to those described under the base case. At the time for establishing pipeline routes, avoidance of important wetland habitats will be one of the important siting criteria (6 AAC 80.130 [c][3]).

Effects of habitat alteration are expected to be the same as for the base case. No substantial conflicts with habitat policies are anticipated.

(4) Air, Land, and Water Quality (6 AAC 80.140): Levels of effect for water quality (Sec. IV.G.1) would increase as a result of the one new landfall at Pitt Point, which could have long-term effects on salinity, temperature, ice cover, and turbidity. Changes in salinity, temperature, and turbidity would exceed chronic criteria over an area of up to 50 km^2 as long as the landfall existed. The landfall-induced changes could exceed the State standards with chronic, local effect on water quality over the life of the fields served by the landfall and be in conflict with the ACMP 6 AAC 80.140. The level of effect on air quality (Sec. IV.C.12) would remain the same as for the base case. The level of conflict identified in the base case is comparable in the high case. Likewise, effects from the disposal of formation waters remain the same as in the base case.

(5) Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): The only potential conflict noted in the base case for this standard was with NSB CMP policies 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). These policies protect sites valuable for cultural uses. The potential for conflict with these policies remains the same in the high case.

Summary: Potential conflict between activities assumed for the high case and the NSB Land Management Regulations and the Statewide standards and the NSB district policies of the ACMP is comparable to the base case, with the exception of the addition of possible conflict with the water quality standard of the ACMP and the potential for conflict with the habitat policies. Effects of oil spills are expected to limit their habitat value for seabirds, waterfowl, and shorebirds. Pacific brant and common and king eiders, in particular, may take one to two generations to recover.

- The first area where conflict with ACMP Statewide standards and district policies may arise is the potential for user conflicts between development activities at the landfall site at a point about 20 mi east of Bullen Point and the subsistence bowhead whale hunt. The Statewide standard for subsistence guarantees opportunities for subsistence use of coastal areas and resources (6 AAC 80.120). Conflict also is possible with two policies of the NSB. The first NSB policy relates to subsistence: NSB CMP 2.4.5.1[b] (NSBMC 19.070.050.J.2) requires development that restricts subsistence-user access to a subsistence resource meet three criteria: (1) there is a significant public need, (2) all feasible and prudent alternatives have been rigorously explored and objectively evaluated and cannot comply with the policy, and (3) all feasible and prudent steps have been taken to avoid the adverse effect the policy was intended to prevent. The second NSB CMP policy relates to both subsistence and cultural resource areas: NSB CMP 2.4.5.2(h) (NSDMC 19.70.050.K.8) requires development to be located, designed, and maintained so as not to interfere with the use of a site that is important for significant cultural uses or essential for transportation to subsistence-use areas; again, subject to the three criteria identified above.

- The second area where conflict with district policies may arise is the potential for adverse effects to subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to "extensive adverse impacts to a subsistence resource" that "are likely and cannot be avoided or mitigated." In such an instance, "development shall not deplete subsistence resources below the subsistence needs of local residents of the Borough." Policy 2.4.5.1(a) (NSBMC 19.70.050.J.1) relates to "development that will likely result in significantly decreased productivity of subsistence resources or their ecosystems." An oil spill during Nuiqsut's and Kaktovik's spring bowhead whale hunt could cause the whale harvest to be discontinued because bowheads could become unavailable or undesirable for use for a period of up to 1 year (Sec. IV.B.10). If an oil spill occurred and contacted the Barrow, Nuiqsut, or Kaktovik bird-hunting areas, birds would become unavailable for a period up to 1 year. However, it is not likely that the entire subsistence-bird harvest would be affected (Sec. IV.B.10).

- Conflict with the water quality standard of the ACMP is possible as a result of the one new landfall at Pitt Point. The landfall induced changes could exceed the State standards with chronic, local effect on water quality over the life of the fields served by the landfall and be in conflict with ACMP 6AAC 80.140.

- The high-case scenario may conflict with Statewide habitat policies (6 AAC 80.130). An increase in spill-contact probabilities to coastal beaches, such as along the coast of Gwydyr Bay, in Simpson Lagoon, and within the Point Barrow area, indicates that a greater percentage of the surface area of these habitats would be contaminated if some of the oil spills occurred during the open-water season. Effects of oil spills are expected to limit their habitat value for seabirds, waterfowl, and shorebirds. Pacific brant and common and king eiders, in particular, may take on to two generations to recover.

Conclusion: For the high case of Alternative I, conflicts could occur with specific Statewide standards and NSB CMP policies related to the potential for user conflicts between development activities and the subsistence bowhead whale hunt. Conflicts are also possible with the NSB Coastal Management Program policy related to adverse effects on subsistence resources if spilled oil contacted subsistence hunting areas. In addition, the scenario may potentially conflict with Statewide standards related to water quality and habitats.

H. EFFECTS OF THE CUMULATIVE CASE:

Introduction: The analysis for the cumulative case is based on the potential effects associated with (1) exploitation of known or estimated resources from onshore and offshore State and/or Federal leases, (2) major potential and ongoing resource-development projects, (3) major potential and ongoing construction projects, and (4) other facilities whose activities may affect the proposed sale area. This section focuses on those oil and gas projects that can be hypothesized to have some reasonable chance of occurrence during the life of the proposed action. The discussion in this section is not assumed to be definitive. Each of the analysts contributing to this EIS also may focus on other issues that they feel to be particularly germane to their resource topics.

In analyzing the cumulative case for Sale 144, the authors consider potential effects on (1) the physical and biological resources, sociocultural systems, and various programs from activities associated with petroleum exploration, development and production, and transportation in the Beaufort Sea Planning Area and the major projects discussed in Section IV.A.6 and (2) migratory species from activities over their range, including the transportation of oil from Valdez, Alaska, to the west coast (U.S.) and from industrial and other activities along the Alaska coast and along the Pacific Coast of Canada and the United States. Migratory species include those species or species groups that migrate to and from Alaska and migratory as well as other species in other areas that might be affected by the transportation of Sale 144 oil—especially oil spilled along pipeline and tanker-transportation routes.

Tanker transport of oil potentially could affect migratory as well as other species in the event of an oil spill. As noted in Section IV.A, any economically recoverable oil that might be discovered in the Sale 144 area would be transported through offshore pipelines to various landfalls along the Beaufort Sea coast (see Sec. IV.A.1) and then transported overland via TAPS to Valdez for transshipment to the U.S. west coast. Should all of this oil be shipped out of State, it would, in the base case, generate approximately 38 trips per year from Valdez, assuming the use of a 100,000-deadweight ton tanker.

Oil exploitation associated with Sale 144 would increase the level of activities affecting environments and resources. The level of activities associated with potential exploitation of Sale 144 oil has been estimated in Section II.A and IV.A, and the proportion contributed by these activities to the overall level of activities associated with the present and proposed projects is further discussed in Section IV.A.6. The amount of oil that might be produced as a result of Sale 144 (Alternative I base case) is estimated to range from 300 MMbbl to 2.1 Bbbl; the analyses of the potential effects of Sale 144 was based on an assumed amount of oil equal to 1.2 Bbbl.

1. Water Quality: Agents that are most likely to affect water quality in the coastal Arctic Ocean are oil spills, shore-access structures, dredging, deliberate discharges from platforms, and gravel-construction and -removal projects.

a. Oil Spills: The oil-spill-trajectory analyses indicate that trajectories in the Beaufort Sea generally move westward or northwestward. In the cumulative case, about 3 large spills ≥1,000 bbl and about 450 smaller spills could occur in the Beaufort Sea over the life of the fields. The smaller spills would total about 5,200 bbl, the equivalent of less than one average spill of ≥1,000 bbl. Large spills (at least 1,000 bbl) are estimated to total 21,000 bbl. For the size spill assumed in this EIS, 7,000 bbl, elevated hydrocarbon concentrations above chronic (sublethal-effect) criteria could persist for perhaps 3 to 10 days, affecting an area of 20 to 100 km^2 (5.8-29 nautical mi^2) (Sec. IV.B.1). Because 3 such spills are assumed to occur in the cumulative case, the area with temporarily degraded water quality at some time over the 30 years of development and oil-production life could total between 60 to 300 km^2 (17 to 87 nautical mi^2 [nmi^2]).

b. Shore-Access Structures: Long shore-access structures such as causeways can locally affect turbidity through enhanced sedimentation of suspended loads, through redirection of the flow of watermasses carrying the suspended loads, and by lengthening the period of ice cover within about a 5-km (3-nmi) distance (Hale et al., 1989). Turbidity levels are more likely to be decreased rather than increased by these changes.

(1) Temperature and Salinity: The redirection of water flow also changes local temperature and salinity regimes, and these changes can exceed those allowed by State and Federal chronic standards and criteria. Relevant State standards (to protect marine wildlife and human consumption of raw seafood; State of Alaska, DEC, 1995) for marine-water temperatures are no more than a 1-°C (1.8-°F) increase in the weekly average water temperature, with maximum rate of change not to exceed 0.5 °C (0.9 °F) per hour. Normal daily temperature cycles are not to be altered in amplitude or frequency. The parallel State standard for dissolved inorganic substances (salinity) is a maximum allowable variation above natural salinity of 1 to 4 parts per thousand (‰), depending on ambient salinity.

Federal marine criteria for water temperature are similar to the State standards, with the additional caveat that summer thermal maxima should not be artificially exceeded (USEPA, 1986). There is no Federal marine criterion for salinity. The rationale for State salinity standards was derived from the analysis of the National Technical Advisory Committee to the Secretary of the Interior (1968).

The above standards and criteria for temperature and salinity are designed to protect against chronic or secondary effects rather than against direct toxicity. Much greater temperature or salinity increases than permitted in these standards and criteria would be required to cause direct mortality.

(2) Existing Shore-Access Structures: Four causeways currently exist: at both sides of Prudhoe Bay, at Oliktok Point, and at the Endicott Development. The Alaska Department of Environmental Conservation has listed the area near the Endicott Causeway—the most massive and longest causeway—on its 303(d) list of impaired water bodies because of temperature and salinity exceedances. Additional long causeways such as that at Endicott are not anticipated in the U.S. Beaufort Sea because of (1) the cost of construction (including that for breeches), (2) difficulties in getting causeways approved by regulatory agencies because of concern over causeway effects, and (3) improvement of long-reach drilling techniques that allow nearshore structures to be drilled from land. One short 800-m (0.4-nmi) additional causeway has been proposed near Bullen Point for barge and service access for development and production of the Badami prospect in State waters.

(3) Additional Shore-Access Points for this Proposal: Three shore-access points are hypothesized in the base case. Two of these hypothesized access points are at already existing Oliktok Point and West Dock. Tie-in of an offshore pipeline to these offshore points would be best accomplished through a subsea, buried pipeline to avoid damage to pipeline from both ice gouging and existing ship/barge operations. Such subsea tie-in would have no effect on ambient salinity and temperature regimes. The third access point for the base case, the ≤90-m (300-ft) raised gravel structure just west of the ANWR boundary, would have to be constructed. This structure would be too short to affect coastal circulation. Turbidity could be increased within 3 km (2 nmi) of the access point during construction; however, turbidity would cease with the end of construction. The effect on turbidity would be local and persist for only a few days. If a discovery were made offshore of the Endicott Causeway, any pipeline tie-in to the Endicott Causeway pipeline would be expected to have a subsea, buried approach to the causeway to avoid ice gouging. Thus, even a direct tie-in to the Endicott Causeway would not exacerbate the restricted circulation causing impairment of local water quality near this causeway. In any case, the Endicott Causeway is not a hypothesized shore-access route for the base case.

The effect of these causeways on the water quality of the Beaufort Sea is limited to about a 5-km (3-nmi) distance offshore of each causeway, but the total area affected—including both current and projected causeways—could be >1,000 km^2 (290 nmi^2). The chronic State marine standards (for growth and propagation and for harvesting for consumption of aquatic life) could be exceeded for water temperature, salinity, and turbidity in the vicinity of most of the causeways for the life of the fields. The State already has listed the area near the Endicott Causeway as an impaired water body. This cumulative effect of all shore-access structures would be due almost entirely to existing causeways and is large enough to be considered a regional effect on water quality.

c. Dredging: The only dredging activity that is expected to significantly affect water quality in the planning area is pipeline trenching for Federal leases. Pipelines from development in State waters would be short and in waters that already are naturally turbid over much of the summer. Only a few square kilometers (1 km^2 = 0.29 nmi^2) of water on any single day would have increased turbidity above chronic criteria as a result of dredging, and the turbidity at any location would rapidly disappear when the dredge moves or stops excavation.

d. ***Deliberate Discharges:*** Discharges of muds and cuttings resulting from continued exploration and additional development would be several times greater than those for proposed Sale 144 alone. Residual, elevated concentrations of USEPA priority metals (arsenic, chromium, lead, and zinc) have been found to persist within sediments below mixing zones for at least 2 to 4 years after exploration at shallow (<5-m) water sites in low-energy State Beaufort waters (Snyder-Conn et al., 1990). Additional muds and cuttings would be discharged in State waters from leases in past or proposed State sales. However, discharges from both State and Federal leases during both exploration and development are regulated by USEPA and are no longer allowed to occur in <5-m water depth. Discharges of muds and cuttings would continue for at most only a few years as production wells are drilled. Cumulative effects of muds and cuttings discharges are expected only within mixing zones, i.e., within about 0.03 km^2 (7 acres) of each platform. If formation waters were discharged, the degradation of water quality would be local but would persist over the life of each field.

e. ***Gravel-Construction Projects:*** The proposed Badami causeway and potential construction of multiple solid-fill islands are the largest gravel-construction projects anticipated. Any of these individual construction projects could be completed within one to two summers, and turbidity effects in the vicinity of the construction activity would be short term and local.

f. ***Solid-Fill, Artificial-Island Removal:*** Fifteen solid-fill islands, mostly in State waters, have been constructed during past oil and gas exploration of the Beaufort Sea. Others are likely to be constructed as the result of this proposed sale, or to support development of existing Federal leases and existing and future State leases. Solid-fill, artificial islands used for exploration and/or development will eventually will be abandoned. In spite of carefully planned abandonment operations, debris, particularly shoreline armoring, seems to inevitably remain on artificial islands. Armor debris gradually erodes from the abandoned solid-fill islands, drifts downwind, and accumulates along the mainland coast. In the immediate years following abandonment, on the order of 1 to 100 polypropylene bags a year could accumulate on nearby shorelines. As in the past, the MMS would require Federal lessees to conduct periodic surveys of adjoining shoreline and recover the armor debris found. Because of the international ban on offshore discharge or dumping of plastics under MARPOL Annex V, State lessees also would be required to recover such debris. Generally, the Coast Guard has taken the lead in enforcing this plastics ban in U.S. coastal waters. In any case, debris accumulation and recovery would continue for several years.

In addition to armor debris, erosion of abandoned, solid-fill islands can result in local but persistent turbidity plumes as the sediments of the islands are reworked by waves and currents for a few to several years. (A causeway would not similarly erode but would more likely enhance deposition of waterborne materials, decreasing turbidity.)

g. ***Overall Cumulative Effects:*** The three large spills projected—half resulting from the proposed sale—would temporarily contaminate waters over up to 300 km^2 (87 nmi^2), to levels above chronic criteria but below acute criteria. Causeways predating the proposed sale have caused chronic degradation of salinity, water temperature, and turbidity over a larger area, reaching a regional effect on water quality. Gravel-island removal and formation-water discharges, mostly from existing State and Federal leases would cause local degradation of water criteria beyond chronic criteria on a local basis, in the vicinity of specific fields and persisting a few years beyond the life of the field in the case of abandonment. Other activities— dredging, construction projects, and deliberate discharges—would at most degrade water quality over a few square kilometers [km^2 = 0.29 nmi^2] at any one point in time. The proposed sale could be the most significant contributor to this degradation; however, degradation would cease within hours of cessation of the activity.

Conclusion: Cumulative effects on water quality—about half attributable to the proposed sale—are expected to result in exceeding sublethal but not acute (toxic) levels of contaminants over up to 300 km^2 (87 nmi^2) for a few weeks, with smaller areas affected up to several years. Cumulative effects of existing causeways could result in chronic degradation of water quality on a regional basis—over >1,000 km^2 (290 nmi^2)—over the lives of the fields.

2. ***Lower Trophic-Level Organisms:*** In addition to the base-case of the proposal, other activities associated with the cumulative case that may affect lower trophic-level organisms in the Beaufort Sea include State oil and gas lease sales; State oil and gas fields, and oil-field-related construction activities.

Routine activities associated with these projects that could affect lower trophic-level organisms are the same as discussed for the base case in Section IV.B.2—seismic surveys, drilling discharges, and construction and dredging—although they would be more numerous than for the base case alone because of the additional State activities. Because of the prevalent use of airguns in Alaskan OCS waters and the apparent lack of effect on plankton and benthic organisms, seismic surveys associated with the cumulative case are expected to have little or no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area and none of its plankton. Affected benthic organisms are expected to experience mostly sublethal effects, but some would be killed. Recovery from drilling discharges is expected to occur within 1 year. Dredging and construction associated with the cumulative case are expected to have little or no effect on plankton communities. It is estimated that <1 percent of the immobile benthic organisms would be affected (mostly sublethal effects). Benthic invertebrates and plants needing a hard substrate for settlement are expected to colonize platforms in State and Federal waters within 1 or 2 years. Immobile benthic communities affected by pipeline construction are expected to recover in <3 years.

The effect of accidental activities (oil spills) associated with the cumulative case on lower trophic-level organisms also are the same as those discussed for the base case and are summarized below. For purposes of analysis, this section assumes that three oil spills of 7,000 bbl occur. Two of these spills are assumed to be due to the cumulative proposal; and one is assumed to be due to State oil and gas lease sales, State oil and gas fields, and oil-field-related construction activities. This is one more 7,000-bbl oil spills than are estimated for the base case. Hence, it is estimated that the effect of this additional spill on lower trophic-level organisms would be slightly greater than that expected for the base case (sublethal to lethal effects on <1% of plankton population in the sale area). The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., in bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hour) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity.

Epontic (under-ice) communities are transient in the nearshore areas of the Beaufort Sea. Oil spilled onto the surface of the ice would reduce the amount of light reaching epontic algae, resulting in lowered productivity. If oil were spilled under the ice and trapped directly beneath it, those epontic organisms that were not highly mobile are expected to be lethally affected. Oil trapped in this way is expected to become encapsulated within the ice with increasing time. If oil on, in, or under the ice is released during breakup, effects of this nature could occur in other nearby epontic communities. However, <5 percent/spill of the epontic community in the sale area is expected to be affected in this way.

Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection). Because of the predominance of shorefast ice along the shoreline of the Beaufort Sea, most of the shoreline is thought to support little or no resident flora or fauna down to about 1 m in depth. Subtidal marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, except for floating larval forms, which may be contacted anywhere near the surface. The organisms likely to be contacted by floating or dispersed oil include zooplankton (e.g., copepods, euphausiids, mysids, and amphipods), as well as the larval stages of annelids, mollusks, and crusteaceans. In general, the percentage of marine invertebrates contacted by floating or dispersed oil is expected to be similar to that expected for plankton (a maximum of 1%/spill). Because of their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate populations from each of the large oil spills is expected to take less than a month. Small oil spills (an estimated total of 5,222 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: The effects of cumulative-case oil spills (3 are assumed) are estimated to be about twice that of the base case (2 are assumed). Two of these spills are assumed to be due to the cumulative proposal, and one is assumed to be due to State oil and gas lease sales; State oil and gas fields, oil transportation, and noncrude carriers. Each of the assumed 7,000-bbl oil spills is estimated to have lethal and sublethal effects on up to 1 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. Each of the assumed spills also is estimated to have lethal and sublethal effects on <5 percent of the epontic community and up to 1 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take less than a month.

3. Fishes: Fishes could be affected by several related activities occurring primarily in two areas: by the exploration and production of oil in the arctic region, including the Chukchi Sea, and by the tankering of oil through Prince William Sound and the Gulf of Alaska.

a. Arctic Region: Fishes in the arctic region would be affected by drilling, seismic operations, oil spills, and construction in the Beaufort Sea.

(1) Drilling Effect: For the cumulative case, drilling associated with continued exploration and additional development would be several times greater than that proposed solely for Sale 144. Additional drilling, including the discharge of muds and cuttings, also would occur in State waters and on North Slope lands in past or proposed State sales. The effects on fishes of very high levels of drilling and discharges are discussed in Section IV.F.3.b on the high-case assumptions. The conclusion for the high case are that fishes would be displaced a short distance during installation of drilling equipment and drilling-fluid discharge but would reutilize their habitat upon completion of the activities, i.e., a very low level of effect. Under the cumulative case, the drilling and discharges would occur in the Beaufort and Chukchi seas, including the nearshore areas. Discharges in shallow, ice-covered waters presently are restricted, reducing the likelihood that fishes would be exposed to discharges for relatively long periods of time in areas where there is little circulation. For the cumulative case, the effect also would be local and temporary.

(2) Seismic Effects: For the cumulative case, the duration and extent of seismic operations might be similar to the very high levels assumed for the high case (Sec. IV.G.3.a). The conclusion for the high case is that seismic operations would injure only a few fishes for one generation in localized areas, i.e., a very low level of effect. This level of effect would be slightly greater for the cumulative case, because seismic operations also would occur in shallow nearshore areas and within river deltas during winter. So, the conclusion for the cumulative case is slightly greater than for the high case.

(3) Oil Spills: Because the cumulative-case resource estimates are higher and development and production activities are expected to be greater than for the proposed action, oil spills also are more likely. Because the probability of oil spills increases, effects from spills are more likely.

From a cumulative perspective, the probability of spills contacting land in the Beaufort Sea probably is slightly greater than for the high-case assumption; for the high case, the probability that spills would contact land in the open-water season within 30 days during the production life of the Sale 144 area is <15 percent (Appendix B, Table B-36). The spills might occur closer to the coast in State waters, which would increase the probability of contact with land. Some of the risk is from spills within sensitive fish habitats, such as the Colville River Delta. The conclusion for the high case (Sec. IV.G.3.c) is that there is a low probability of oil spills that would be lethal to a major portion of several anadromous fish populations.

Spills from onshore pipelines are likely to have a high effect on fishes by affecting overwintering and rearing habitat, as described in the Section IV.C.4.d of the FEIS for Chukchi Sea Lease Sale 126. A high effect would result if the Sagavanirktok or Colville rivers were contaminated. The probability of a spill contacting these rivers is indicated by the spill rate for the existing Trans-Alaska Pipeline. There have been 188 small spills as of 1990, which means there is a high probability of a spill contacting the Sagavanirktok River during the 24-year life of the Sale 144 resources. These probabilities also indicate a high potential for effects on fishes.

The conclusion for the cumulative case, which includes low risks in some areas but high risks in others, is similar overall: lethal to a major portion of several anadromous fish populations.

(4) Construction Activities: This section incorporates by reference the information on cumulative effects of construction activities on fishes in the FEIS's for Sales 124 and 126 (USDOI, MMS, 1990 and 1991, respectively). In the base case, no long causeways were projected to be built; only four short jetties or causeways were projected to bring offshore pipelines safely ashore (Sec. II.B.2.a). Neither the locations nor the dimensions of the jetties can be specific at this stage; the assumptions for this analysis, as summarized in Section IV.A.1.b(4)(a), are that there might be pipeline landfalls at Oliktok Point, using the Kuparuk Field infrastructure; at Point McIntyre/West Dock, using the Prudhoe Bay infrastructure; and at an eastern point. For the cumulative case, which includes State leases in the Colville River delta and nearshore leases that have been developed with long causeways, construction would include additional long causeways and possibly facilities in the Colville River Delta.

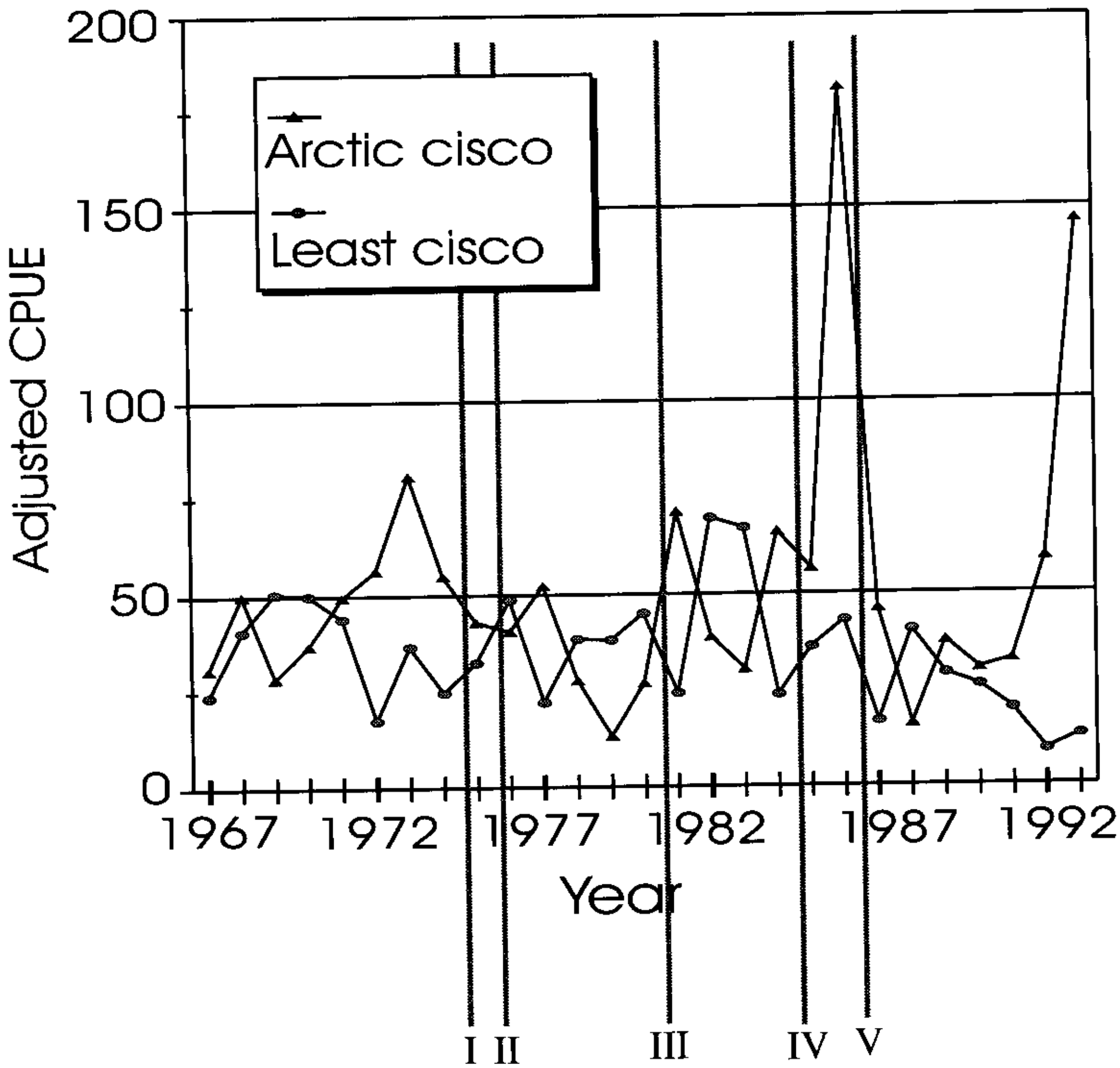
The construction of long, solid-filled causeways in the nearshore Beaufort Sea has affected fish habitat. At the present time, two long causeways—the West Dock and Endicott causeway—have been built in the Prudhoe Bay-Sagavanirktok River area. The two existing causeways and their effects on nearshore-water characteristics are summarized by Segar (1990), Norton (1989), and Colonell and Gallaway (1990). The West Dock causeway, which extends into 12-ft water depths and has had one relatively small 50-ft breach, has altered the surrounding physical ocean- ographic regime. The Endicott causeway, which extends into 6-ft water depths and has had one 200-ft and one 500-ft breach, has altered the surrounding regime to a smaller extent. The difference in effects probably is related to—aside from the sizes of the breaches and water depths at the ends of the causeways—the siting of the causeways; Endicott is situated between two mouths of the Sagavanirktok River, which allows warm, fresh river water to flow seaward on both sides of the causeway.

Alteration of the nearshore physical oceanographic regime has affected the distribution and migration of some anadromous fishes. For example, the oceanographic discontinuities created by West Dock have affected the local distributions of arctic and least cisco but apparently have not blocked alongshore spawning migrations (USDOD, U.S. Army COE, 1988). Another independent analysis of the local distribution of arctic cisco and least cisco around West Dock has been prepared by Fechhelm et al. (1989). They concluded that weather conditions probably determine whether or not there are localized effects. During about one-quarter of the summers, there appears to have been weather conditions that would affect the local distribution of anadromous fishes (Wilson, 1995b).

The effect of causeways on recruitment and overall population levels also has been followed closely. As described in Section III.B., the catch-per-unit effort (CPUE) of arctic and least cisco has fluctuated widely, but there have not been trends, nor relationships to the timing of causeway construction (Fig. IV.H.3). The arctic cisco data indicate unusually high recruitment during years with predominately east winds (Fechhelm and Griffiths, 1990; Moulton, Field, and Kovalsky, 1991). Because the maturation time and lifespan of arctic cisco is about 7 years, the unusually large 1979 and 1985 recruitments probably are responsible for the high CPUE in 1986 and 1993. With regard to least cisco, there has been less variation, but there also is no obvious long-term trend or relationship with the timing of causeway construction. Preliminary 1994 data indicate a reversal of the downward trend in the Colville River least cisco population after 1991 (Wilson, 1995a).

With regard to broad whitefish, one part of the population experienced a dramatic decline and rebound during the past decade—the fishes that overwinter in the Sagavanirktok River and feed during summer in Prudhoe Bay (see Fig. III.B.2-3). The reason for the changes still are not obvious (Wilson, 1995b). The population decline occurred several years after construction of the West Dock was completed, and the decline began before construction of the Endicott Causeway in the Sagavanirktok River delta; so it is probably not related to causeways per se. However, the decline might be related to bridge construction across the lower Sagavanirktok River where the fishes overwinter in restricted habitats, or to winter- construction use of river water. The changes might also be part of natural population cycles that are characteristic of this species in other North Slope rivers.

In conclusion, typical effects on fishes from existing and future causeways would be changes in local distributions during about one-quarter of the years, i.e., a low level of effect. However, other types of construction associated with the cumulative case probably would occur within rivers and overwintering habitats, increasing the likelihood of population effects. For example, pipelines would be constructed across the North Slope and facilities probably would be constructed within the Colville River delta. This construction probably would have more direct effect on freshwater and anadromous populations, disrupting the overwintering habitats and killing small portions of several generations.



I = Winter 1974 - 75, Construction of West Dock "first" section

II = Early 1976, Construction of West Dock "second" section

III = Summer 1981, Construction of West Dock Waterflood Extension

IV = Early 1985, Endicott causeway construction with short temporary breaches

V = 1986, Enlargement of Endicott causeway breaches

Source: After Figure III.B.2-2.

Figure IV.H.3. Colville River Fishery Catch-per-unit-of-Effort (CPUE) and Causeway Construction

b. ***Prince William Sound/Gulf of Alaska:*** This analysis considers effects on the abundant fishes in Prince William Sound and the Gulf of Alaska. They are being considered here because the transportation scenario involves the tankering of oil from Valdez at the terminus of the TAPS through Prince William Sound and the Gulf of Alaska. This assessment incorporates by reference the specific information in Sections IV.I.3(1) and (2) of the FEIS for Sale 124. It focuses on two vulnerable species: Pacific salmon and Pacific herring. Those sections conclude that the effect of the cumulative case on Gulf of Alaska/Prince William Sound fishes would be moderate.

Other information that is incorporated by reference includes the assessments on fishes in the recently prepared DEIS for Oil and Gas Lease Sale 149 in Cook Inlet (USDOI, MMS, 1995). The assessment of cumulative effects (Sec. IV.B.10.c) includes information on the effects on fishes of the 1989 Prince William Sound oil spill and of regional commercial fisheries. The section concludes that commercial fishing is the most likely activity to dramatically affect fish abundance. It also concludes that the effects on fisheries resources due to oil spills associated with the Sale 149 cumulative case generally would be low and not as great as for other types of perturbations.

Conclusion: Overall, the effect of the cumulative case on fishes in the Sale 144 area, is expected to be lethal to small portions of several generations. Because of the development of nearshore prospects, in State waters, using long causeways. Relative to the entire cumulative effect, the projected activities for proposed Sale 144 are expected to be lethal to a very small portion of fish populations containing several generations, as analyzed for the base case.

4. ***Marine and Coastal Birds:*** The additive effects of other ongoing and future development occurring within and beyond the arctic region and OCS planning areas in Alaska within the summer and winter ranges of migratory seabirds, waterfowl, and shorebirds and the cumulative effects on bald eagles are discussed in this section. Migratory seabirds that occur in the Beaufort Sea Planning Area potentially are affected by commercial fishing on their winter ranges in the Bering Sea and in the North Pacific. Migratory waterfowl and shorebirds are affected by onshore development on their winter ranges along the west coast of North America and along the Central Flyway, including development on wetlands in the midwest and southern U.S. Bald eagles and other marine and coastal birds are affected by oil transportation in Prince William Sound. The following development activities could have actual or potential habitat-alteration-destruction, environmental-contamination, and/or direct-mortality effects on migratory waterfowl, seabirds, and shorebirds that summer in the Arctic and seabirds and bald eagles occurring along oil tanker routes for arctic oil development.

a. ***Oil Spills:*** Two oil spills, each 7,000 bbl, are assumed to occur under the base case of the proposal and three spills under the cumulative case. Cumulative oil development includes existing State of Alaska oil-development activities along the Beaufort Sea coast, including barge traffic during the open-water season, and increases the risk of oil-spill occurrence and contact to the seabird-feeding area offshore of Point Barrow and to the Simpson Lagoon, Gwydyr Bay, Jago Lagoon, and Beaufort Lagoon Coastal-Concentration Areas (Fig. III.B.3). Expected effects would be greater than those from the base case of the proposal.

The assumed three oil spills from offshore oil activities associated with Federal and State leases could have the most noticeable effects on birds. Perhaps thousands or tens of thousands of birds, particularly oldsquaw, common eiders, and several species of seabirds, could be killed as a result of oil spills over the life of these projects. The species likely to suffer high mortality rates from oil spills include oldsquaw, common eider, and other sea ducks. Oil spills are likely to have short-term ($\leq$1-generation) effects on very common species such as oldsquaw, because recruitment of birds from unaffected parts of the regional populations is likely to replace lost individuals within one generation. If a spill contaminated coastal saltmarshes, Pacific brant also may suffer high losses. The cumulative loss of Pacific brant from potential spills contacting coastal wetlands could have a long-term ($>$1-generation) effect on the regional population of this species if an oil spill heavily contaminated coastal saltmarsh habitats. If an oil spill severely contaminated the Sag River Delta, snow geese could suffer high mortalities.

Potential future oil-spill effects from tanker transportation of arctic (both offshore and onshore development) oil through Prince William Sound from the TAPS terminal at Valdez could have serious cumulative effects on Gulf of Alaska and Prince William Sound marine and coastal bird populations. The 1989 *Exxon Valdez* (EVOS) tanker spill (11 million gal or 258,000 bbl of oil) probably killed at least 300,000 birds (local nesting seabirds plus overwintering waterfowl, shorebirds, and local raptor-bald eagle populations). Three years after the spill, oil still persisted in sheltered coastal intertidal habitats, such as mussel beds, and continued to affect harlequin ducks and other species. The actual level of effect of the spill on various marine and coastal bird populations has not been determined. The level of effect-recovery time for many Prince William Sound and Kenai Peninsula bird populations was difficult or impossible to determine because little or no information was available on preoil-spill population levels for affected species such as murrelets and auklets. If another large (> 100,000 bbl) tanker spill occurred in Prince William Sound, a similar long-term (> 1-generation) effect on bird populations could occur depending on the season and size of the oil spill and species of birds to suffer the greatest loss.

The direct mortality of seabirds and waterfowl and the mortality of bald eagles from oil spills associated with oil-tanker traffic and other marine-vessel fuel spills (including fishing vessels and barge traffic) in the Bering Sea, Gulf of Alaska, and along the Pacific coast is well known. The recent tanker spill in Prince William Sound has killed tens of thousands to perhaps >300,000 seabirds and sea ducks and perhaps several hundred bald eagles. Large tanker spills (≥100,000 bbl) and smaller oil spills (such as 10,000 bbl) from large fish- processing vessels can kill very large numbers of seabirds (≥100,000), depending on the location and season. Such spills can have long-term (>1 to several generations) effects on migratory seabird populations occurring in the Arctic and along arctic oil-tanker-transportation routes in the Gulf of Alaska and in the northern Pacific (see Fig. IV.A.6-1).

A total of 453 small oil spills ≥1 bbl and <1,000 bbl also are assumed to occur offshore under the cumulative case. These minor spills are expected to have an additive effect on marine and coastal bird losses, perhaps increasing losses by a few thousand birds and increasing habitat contamination by perhaps 1 to 2 percent.

A total of about 9,761 small spills <50 bbl and 56 spills ≥50 bbl but <1,000 bbl of either crude oil or petroleum products also are assumed to occur onshore in association with cumulative North Slope and Trans Alaska Pipeline development facilities including the base case of the proposal (Table IV.A.2-4). These minor spills are expected to have additive effects on marine and coastal bird losses, perhaps increasing losses by a few hundred birds and increasing contamination of terrestrial habitats along pipeline and road corridors by 2 to 5 percent.

b. Offshore Construction: About 40 exploration units (gravel islands, mobile bottom-founded drilling platforms, drillships, and ice islands) have been used in the Beaufort Sea (USDOI, MMS, 1990:Table IV.A.4-1), and a total of several million cubic yards of gravel and dredge material have been used in the construction of gravel islands in Federal OCS waters, in State of Alaska waters, and in Canadian waters. The deposition of fill material and dredging activity has had a short-term (1-2 year) effect on some benthic organisms in local areas at or near island sites and dredge sites. This local loss of some benthic species probably has had nonmeasurable effects on the availability of food organisms to marine and coastal birds that prey on a variety of fishes and invertebrates.

c. Onshore Construction and Development: The construction of hundreds of miles of roads and pipelines associated with oil fields in the Prudhoe Bay-Kuparuk area and future oil fields in the NPR-A, and ANWR has or would destroy some small percentage (perhaps ≤5%) of the available tundra-nesting habitat on the Arctic Slope. The Prudhoe Bay-Kuparuk development encompasses over 1,000 km^2 of tundra habitats, of which a small percentage was altered or destroyed as a result of the construction of roads, pipelines, and gravel pads and the excavation of gravel quarries. The loss of bird habitat from any one of the development projects represents a very small (≥5%) effect on the availability of various tundra-habitat types used by nesting and feeding birds on the North Slope (see Fig. III.B.3). However, the cumulative loss of tundra habitats from all the listed projects, possible NPR-A oil exploration and development in the Teshekpuk Lake waterfowl-concentration area, and possible ANWR oil development is likely to represent a greater loss of tundra habitat on the North Slope and may have a long-term local (within >1 km [>0.62 mi]) or about 100 m of roads and other facilities) effect on the nesting distribution or density of some species for more than one generation (or over the life of the oil fields).

Agricultural development, the filling in of wetlands and cultivation of prairie grasslands, and urbanization and industrial development (construction of subdivisions, shopping centers, airports, and factory complexes) on the winter ranges and breeding habitats of North Slope waterfowl populations of the Pacific and Central Flyways has resulted in a very substantial loss of wetlands habitats (>600,000 acres or more lost per year in the contiguous U.S.) in California, where only 10 percent of the original wetlands remain; in the prairie pothole region of western

Canada and the U.S. midwest, where about 50 percent have been lost; and in the Mississippi bottomlands, where >75 percent have been lost (USDOI, FWS, 1986). The OCS oil development offshore in the Gulf of Mexico has contributed about 8 to 17 percent of the total loss of wetlands along the Louisiana coast from the construction of navigation channels, pipeline canals, and other facilities (Van Horn, Melancon, and Sun, 1988). North Slope and Alaskan waterfowl populations, particularly pintail ducks, mallards, and probably white-fronted geese, have been affected by these habitat losses. The North American population of pintails declined by >50 percent in the 1970's and 1980's, from 6.3 million in the 1970's to 2.9 million in 1985 (USDOI, FWS, 1986). Waterfowl populations are not expected to completely recover from such losses for several generations (≥10 years). Agricultural and industrial activities on land adjacent to some of the remaining wetlands (including protected wetlands such as wildlife refuges) have resulted in the contamination of these wetlands with high concentrations of toxins such as selenium, which has resulted in the deaths and reproductive failure of waterfowl populations and the long-term (several generations) contamination or poisoning of winter-range habitat. Such contamination reduces the winter survival of Alaskan waterfowl and shorebirds that use these habitats. The effect is expected to last a number of generations.

d. Noise and Disturbance: Considerable amounts of air and vessel traffic have been associated with petroleum exploration in the Beaufort Sea (e.g., up to 1,200 helicopter trips per year associated with offshore development). Such high levels of traffic probably would result in some unrestricted low-elevation flights over concentrations of nesting, feeding, and/or molting birds. This disturbance is expected to have short-term (<1-generation) effects on some flocks of birds. Considerable amounts of ground-vehicle and air traffic have been associated with onshore oil exploration and development on the North Slope. Several hundred gravel-truck passages per day were associated with the onshore construction of causeways, drill pads, roads, etc., in the expanding oil development around Prudhoe Bay. Most ground-vehicle activity associated with exploration occurs during winter with little effect on birds. However, frequent summer road traffic associated with oil development, particularly during construction periods (e.g., construction associated with the Endicott oil field), can greatly disturb molting waterfowl such as snow geese when they attempt to cross the roads. Although such disturbance events are likely to subside after construction is complete and not signifi- cantly affect bird populations, some individuals of the species' population may continue to be disturbed by lower traffic levels throughout the life of the field.

During development of the Lisburne field, geese and swans appeared to be tolerant of vehicular traffic on roads during most of the seasons; but during brood rearing, their tolerance of vehicle traffic decreased and they moved farther away from roads, especially roads with heavy traffic (>8 vehicles/hr) (Murphy et al., 1988). The Lisburne development activities had no apparent effect on bird use of overall habitats in the area; however, some common species of shorebirds, such as semipalmated sandpiper and dunlin, occurred in decreased densities (up to 40% for some species, birds and nests) adjacent to (within about 100 m [328 ft] roads as compared with locations away from roads (Troy, 1988; 1993). However, postbreeding densities of these shorebirds tend to increase near roads compared with away from roads (Troy, 1993).

Noise and disturbance from air, vessel, and ground-vehicle traffic from any one exploration and development project are likely to have a short-term (<1 year) effect on marine and coastal birds. However, cumulative aircraft and ground-vehicle disturbance of snow geese, Pacific brant, and other species associated with possible NPR-A and ANWR oil development may cause these species to avoid local (within about 1 km (0.62 mi) of roads and other facilities) parts of their nesting, feeding, or molting habitats on the arctic slope for less than one to two generations during the height of construction activities and reduce habitat use near (within about 100 m [328 ft]) roads and other facilities over the life of the oil fields during the nesting season.

e. Habitat Loss from Agriculture and Other Development: North Slope and Alaskan waterfowl populations—particularly pintail ducks and mallards and probably white-fronted geese—have been affected by these habitat losses on their winter ranges (see discussion above under Onshore Construction and Development). These waterfowl populations are not expected to recover from such losses for a number of generations (≥5-10 years). Although there will continue to be abundant nesting habitat for the above geese and duck populations in Alaska, with high recruitment of young birds, the reduction in the amount of winter range and habitat carrying capacity may limit or prevent the full recovery of these waterfowl populations. Even reducing hunting pressure on these waterfowl populations is not likely to allow complete recovery because of loss of winter-range habitats.

f. Increased Hunting Pressure: The hunting of waterfowl—particularly cackling Canada geese, white-fronted geese, emperor geese, and Pacific brant—on both the summer (Yukon-Kuskokwim Delta) and winter range (California) and along the Pacific Flyway (British Columbia, Washington, and Oregon) has increased as these areas have become more populated and the interest in hunting waterfowl has increased. Hunting pressure has undoubtedly contributed to the declines in these geese populations over the past 25 to 30 years. However, current cooperative management of waterfowl hunting by the Yukon-Kuskokwim Delta villages and FWS has greatly reduced the loss of geese recruitment on the summer range. The excessive mortality of waterfowl due to hunting is likely to be a short-term (< 1 generation) effect in the future if cooperative management of hunting in Alaska continues and enforcement of sports-hunting regulations along the Pacific Flyway remains diligent.

g. Environmental Contamination from Industrial Development and Recreational Sources: Migratory waterfowl and shorebirds that occur in the Arctic can be affected by environmental contaminates (lead, selenium, insecticides, and other toxic organochlorine pollutants) on their winter range. Agricultural and industrial activities in California adjacent to some remaining wetlands (wildlife refuges) have resulted in the contamination of the wetlands with high concentrations of selenium and other toxic substances that have resulted in the deaths of several thousand waterfowl and the long-term (several-generation) contamination or poisoning of winter-range habitat. Such contamination reduces the winter survival of migratory waterfowl and shorebird populations that use this habitat. The effect is expected to last for generations (at least 10 years).

The use of lead shot in the hunting of migratory waterfowl has been a contributing factor in the reduction of waterfowl populations (nesting success) through the ingestion of spent lead shot by the birds in wetland areas. Ingested lead shot is readily absorbed/digested by female ducks during the egg-laying period when they are calcium deficient (lead is taken up to replace the calcium in the bird). Further restriction and the eventual elimination of lead shot in waterfowl hunting should eventually alleviate or eliminate the poisoning problem.

h. Commercial Fishing in the North Pacific: Seabird mortalities due to marine oil spills are additive to the losses of seabirds that occur from the high seas (foreign) driftnet fishery in the North Pacific, Bering Sea, and Gulf of Alaska, where an estimated ≥500,000 birds are incidentally killed each year. Such losses occur over a large geographic area in the North Pacific and probably do not seriously reduce the number of seabirds that nest at a particular colony. However, an increase in the intensity of the fishing effort could increase the take of seabirds. The growing exploitation of bottomfish, such as the pollock fishery in the Bering Sea and Gulf of Alaska, could significantly reduce the availability of prey to some seabird populations if pollock stocks were greatly overharvested in the future. The present level of pollock harvest in the Bering Sea and Gulf of Alaska apparently has contributed to the recent drastic decline of northern sea lion populations in the southern Bering Sea and the Gulf of Alaska.

Overall Cumulative Effects: Direct or indirect loss of several thousand birds from oil spills, including losses from a ≥100,000-bbl spill, is expected to have a short-term effect (< 1 generation, perhaps 1-2 years) on very abundant species, such as oldsquaw and common eider. The oil-spill effect on less abundant species' populations, such as Pacific brant, could take one to two generations for recovery if coastal habitats were heavily contaminated by the spill. Habitat alteration from deposition of fill material and dredging associated with offshore exploration and production platforms and pipelines throughout development in the Beaufort Sea are likely to have short-term (< 1 generation) effects on marine and coastal birds because the local loss of a small number of benthic-prey organisms is likely to have little or no effect on the availability of food organisms to birds that feed on a variety of abundant fish and invertebrates. Cumulative habitat alteration and destruction from onshore-facility activities (such as gravel mining and road, pipeline, and drill-pad construction) are likely to have a short-term (< 1 generation) effect on the distribution or abundance of some waterfowl species through the loss of about ≤5 percent of the available nesting, feeding, and/or molting habitats on the North Slope. High levels of noise and disturbance from aircraft, vessel, and ground-vehicle traffic associated with cumulative oil development on NPR-A (Teshekpuk Lake area), Prudhoe Bay, Duck Island (Endicott), and ANWR are likely to cause a portion of some species' populations (such as snow geese and Pacific brant) to avoid parts of their feeding and molting habitats on the arctic slope for perhaps one generation (2-3 years) during construction activities and long-term (several generations) and local (within 100 m [328 ft] of roads) during the nesting season.

Interregional cumulative effects on migratory waterfowl populations occurring in the Arctic have been and are expected to be long term (a number of generations or at least 10 years) The primary contributing factors to this effect are the loss of wetlands and other habitats on the winter range of regional populations of geese and ducks and the contamination of some of the remaining wetlands by pollutants (insecticides, selenium, toxic compounds, and toxic trace elements) from adjacent agriculture and industrial development in the Pacific Coast states and in the central and southern states. The effect of hunting overharvest of waterfowl on the summer range and fall flyway generally has been short term (< 1 generation). The cumulative effect on migratory seabirds is expected to be long term (one to several generations) The primary contributing factors to this effect are oil spills (tanker, crude oil, and fuel oil) from marine-vessel traffic and mortality from commercial-fishing nets. The contribution of the proposal to cumulative effects on migratory waterfowl and seabirds from oil spills, additional noise and disturbance, and habitat alteration is expected to be generally short term (< 1 generation) effects representing about < 50 percent of the total estimated mortality and < 1 percent of the habitat loss.

Conclusion: Cumulative effects from activities within the arctic region combined with other activities within the range of migratory birds are expected to be long term (several generations or at least 10 years) on migratory waterfowl, migratory seabirds, and shorebirds and (probably < 1 generation) on bald eagles. The contribution of the proposal to the cumulative effects is expected to be generally short-term (≥ 1 generation) effects representing about < 50 percent of the total estimated mortality and < 1 percent of the habitat loss.

5. Pinnipeds, Polar Bears, and Belukha Whales: The cumulative effects of other ongoing and planned projects, as well as those for the base case, on ice seals (ringed, bearded, and spotted seals) and harbor seals, walruses, sea otters, polar bears, and belukha whales are discussed in this section. Although the probability of any or all planned and ongoing projects reaching developmental stages generally is unknown, this analysis assumes that all the OCS projects (see Sec. IV.A.6) do reach developmental stages. These projects could affect marine mammals as a result of oil spills, noise and disturbance, and habitat alteration.

The additive effects of ongoing and future development occurring within the Beaufort, Chukchi, and Bering Seas in the summer and winter ranges of migratory fur seals, harbor seals, ice seals (ringed, spotted, and bearded seals), walruses, and belukha whales occurring in the Arctic or occurring along oil-tanker transportation routes in the Gulf of Alaska are discussed in this section. The development activities listed below could have actual or potential adverse effects on the abundance or distribution of fur seals, harbor seals, ice seals, walruses, and belukha whales.

a. Effects of Oil Spills:

(1) Arctic Region Planning Areas (Beaufort Sea, Chukchi Sea, and Hope Basin): Cumulative oil-spill risks to marine-mammal habitats would increase substantially over the spill risks from the base case (3 spills are assumed under the cumulative case vs. two spills under the base case), particularly during the winter season. The spill risk to flaw-zone (Ice/Sea Segments) habitats from Camden Bay west to Point Barrow (Ice/Sea Segments 3 through 9, Fig. IV.B.4-1) could be attributed to oil activities associated with Federal OCS Sale 124 and with Duck Island (Endicott) development. Spills that occurred during the open-water season (summer) or that occurred during the winter and persisted in the Sale 144 area after meltout pose the highest risk to marine-mammal flaw-zone habitats offshore of Point Barrow eastward to Camden Bay (Ice/Sea Segments 3 through 9, Appendix B, Table B-51). During the winter season, nonbreeding ringed seals, bearded seals, and polar bears could be exposed to cumulative oil spills that contact the ice-flaw-zone habitat and the Northern Lead System (NLS) off Point Barrow. During the summer or open-water season, breeding ringed seals, large numbers of bearded seals, migrant ringed and spotted seals, walruses, and belukha whales in the far western Beaufort Sea could be exposed to spills that occur to the east during winter and contact the flaw-zone habitat.

The most noticeable effects of potential oil spills from offshore oil activities associated with Federal (Beaufort Sea, Chukchi Sea, and Hope Basin OCS leases) and State leases would be through contamination of pinnipeds—perhaps several thousand—and small numbers of polar bears. These species are likely to suffer low (< 30 polar bears) to moderate (< 1,000 seals) mortality rates as a result of this contamination; death may occur for several hundred to a thousand very young seal pups, < 100 polar bears, < 1,000 walrus calves, and highly stressed adult pinnipeds. These losses from an estimated three oil spills are likely to be replaced within one generation or less (5-7 years);

belukha whales are likely to suffer low mortality (<30 whales) due to these three oil spill with population recovery expected within 1 year.

(2) Arctic Oil Transportation Through Prince William Sound and Gulf of Alaska: Potential future oil-spill effects from tanker transportation of arctic oil from the TAPS terminal at Valdez through Prince William Sound could have serious cumulative effects on Prince William Sound and Gulf of Alaska nonendangered marine mammals, especially sea otters. There also could be local effects on the survival of young harbor seals and perhaps northern sea lions if the spill occurred during the pupping season, as did the 1989 *Exxon Valdez* tanker oil spill (11 million gal or 258,000 bbl of crude oil). Indications from scientific studies of the effects of the spill suggest that the local sea otter populations or a portion of the sea otter populations in Prince William Sound, Kenai Peninsula, and the Kodiak-Katmai Bay area were substantially reduced. The Prince William Sound sea otter population may have been reduced by at least 2,650 otters out of an estimated 6,500 otters in the western Prince William Sound area affected by the spill (Garrott, Eberhardt, and Burn, 1993). The Kenai Peninsula and Kodiak-Katmai Bay sea otter populations probably suffered smaller but similar losses (a few hundred otters) due to weathering and dispersion of the spill. It is likely that local assemblages or populations of sea otters in heavily contaminated coastal areas of Prince William Sound will take more than one to two generations or ≥5 years to recover from the spill. The oil spill also adversely affected the survival of harbor seal pups at pupping areas contaminated by oil and was estimated to have killed about 300 harbor seals within the spill area (Frost et al., 1994).

The following effects could occur if one or more large tanker spills (>30,000 bbl) occurred in Prince William Sound: a long-term (1-2 generations), local (portion of a region) effect on sea otter populations and perhaps a short-term (less than or within one generation) effect on the harbor seal population. Transportation of arctic offshore and onshore oil through TAPS and by tankering through Prince William Sound is likely to have a longer term (≥5 years) effect on sea otters and a short-term (<3- year) effect on harbor seals.

b. Effects of Noise and Disturbance: In the Beaufort and Chukchi Seas, cumulative noise and disturbance effects on breeding ringed seals from on-ice seismic surveys are expected to have a short-term (≤1 year) effect on ringed seals, because only a small percentage of the population (perhaps 1-3%) is likely to be disturbed; and even fewer pups are likely to be lost due to adult abandonment of maternity lairs (see Effects of Geophysical Seismic Activities under the base case, Sec. IV.B.5). Noise and disturbance of belukha whales during spring migration from icebreaker and vessel traffic in the Beaufort and Chukchi Seas could possibly have a seasonal effect on the local movement of whales if spring migration of a portion of the whale population were delayed due to frequent vessel traffic in the ice-lead system. Cumulative noise and disturbance effects on other nonendangered marine mammals occurring in the Beaufort Sea from >450 helicopter trips per month and perhaps >200 vessel trips per month are expected to be short term (a few minutes to <1 hour) because the disturbance reactions of pinnipeds, polar bears, and belukha whales would be brief—with the affected animals returning to normal behavior patterns and distribution within a short period of time after the boat or aircraft has left the area—and no long-term development is likely to occur. Disturbance reactions are not likely to be additive. A short-term (one-generation) disturbance effect on polar bears is expected (see Effects of Airborne Noise under the base case, Sec. IV.B.5) if some coastal denning areas in Alaska and some maternity dens on the sea ice were abandoned because of noise and human presence near denning areas. However, existing requirements under the MMPA are expected to prevent excessive disturbance of the bears.

Some polar bears could be killed as a result of human-bear encounters near industrial sites and settlements associated with cumulative oil development. In the Northwest Territories, 15 percent (33 of 265) of the number of polar bears killed as a result of conflicts with humans occurred near industrial sites from 1976 to 1986 (Stenhouse, Lee, and Poole, 1988). Some of these losses are unavoidable and represent a small source of mortality on the polar bear population that would be replaced by recruitment within 1 year. Four bears were unavoidably killed after being attracted to offshore platforms in the Canadian Beaufort Sea over a 5-year period of intensive oil exploration (Stirling, 1988). The incidental loss of polar bears due to cumulative oil and gas development in the Arctic is unlikely to significantly increase the mortality rate of the polar bear population due to subsistence harvest and natural causes.

Migratory populations of belukha whales; walruses; and spotted, ringed, and bearded seals occurring in the Arctic have been exposed to oil-exploration activities (seismic surveying, drilling, air and vessel traffic, dredging, and gravel-dumping operations) in the Beaufort Sea and exposed to some of these activities in the Bering and Chukchi Seas. The exposure of the marine-mammal populations to the above activities and to other marine-vessel traffic (oil-field sealift-barge traffic to the North Slope and increased icebreaker activity in support of Chukchi Sea oil exploration) may increase in the future. These industrial activities are likely to have some short-term (< 1 generation) effects on the distribution of migratory seals, walruses, and belukha whales during the seasonal drilling season. If and when oil development occurs, some local changes (within a few km of the activity) in the distribution of some portions of the seal, walrus, or belukha whale populations could occur. However, some habituation of seals, walruses, and belukha whales to marine and air traffic, to industrial noise, and to human presence is likely to occur; and the displacement associated with cumulative industrial activities or coincidental to such activities is not likely to result in a significant reduction in the overall abundance, productivity, or distribution of ice seals, walruses, and belukha whales in northern Alaskan OCS areas.

c. Effects of Habitat Alteration: About 40 exploration-drilling units have been installed or constructed in the Beaufort Sea as a result of past Federal, State, and Canadian oil and gas leases. Several million cubic yards of gravel and dredge-fill material have altered a few square kilometers of benthic habitat in the Beaufort Sea. The cumulative effects of habitat alterations associated with platform construction or installation, dredging, pipeline burial, and causeways are expected to have local (within 1 km) effects on some benthic organisms and some fish species and are likely to have a short-term (< 1 year or season) and local (1-3 km or 0.62-1.9 mi) effect on the availability of marine-mammal-food sources.

Exploration-drilling units and future production platforms throughout the Beaufort and Chukchi Seas and Hope Basin are expected to have local effects on ice movements and fast-ice formation around the structures. The local changes in ice movements and ice formation are likely to have a short-term (< 1 year) effect on pinniped distribution during platform installation and construction activities. Natural variation in ice conditions and resulting changes in pinniped, polar bear, and belukha whale distribution are likely to reverse or overcome any local reduction in the distribution of these species associated with cumulative exploration and production platforms.

d. Effects of Other Activities:

(1) Effects of Commercial Fishing on Migratory Fur Seals, Harbor Seals, Ice Seals, Walruses, and Belukha Whales: In the Bering Sea, the actual and potential effects of commercial fishing on fur seals, ice seals, walruses, and belukha whales include the following: (1) direct mortality from entanglement in fishing gear and from other interactions (shooting of marine mammals raiding fishing nets); (2) competition for prey/commercial-fish species that could reduce the availability of prey for marine mammals; and (3) displacement of marine mammals due to noise and disturbance from boats and aircraft associated with intense fishing activities. In Bristol Bay, the entanglement of belukha whales in the salmon gillnet fishery is an additive source of mortality for some pods of belukhas. In the Bering Sea, migratory spotted seals are likely to experience some mortality through entanglement interactions with the herring fishing operations along the coast. In the southern Bering Sea and Gulf of Alaska, entanglement of migratory fur seals in discarded fishing gear, as well as incidental catches of sea lions in bottomfishing trawl operations, are likely to be contributing factors in the 20- to 30-year decline of northern fur seal and sea lion populations.

Competition for fish (particularly pollock) is known to occur between migratory marine mammals and commercial fishing. The rapid increase in the bottom fishery in the Gulf of Alaska and southern Bering Sea is suspected to be one of the primary causes for the > 80-percent decline of northern sea lions in the past 30 years and a possible factor in the decline of harbor seals. Other migratory pinnipeds have been less affected because they generally prey on smaller fish (smaller age-classes of pollock and other small fish) than those harvested in commercial fishing. At present, migratory ice seals (spotted, ringed, and bearded seals), walruses, and belukha whales occurring in the Arctic during the summer and occurring in the Bering Sea during the winter have experienced only low losses in numbers due to direct mortality or food competition from commercial fishing in the northern Bering Sea, which involves a much smaller number of operations (probably a few hundred boats) than operations occurring in the southern Bering Sea and Bristol Bay (thousands of boats and spotter aircraft). These arctic marine-mammal populations are not exposed to such intense fishing activities during the winter months when they migrate to the southern Bering Sea. However, the amount of commercial-fishing activity has increased greatly in the northern Bering Sea, and migratory marine mammals are exposed to an increasing amount of vessels and air traffic associated with expanding commercial-fishing operations. There is no question that temporary displacement (minutes to hours to 2-3 days) of seals, walruses, and belukha whales occurs as a result of vessel and air traffic associated with commercial fishing in Bristol Bay and in Norton Sound.

Longer displacement (several days to a few months) of some portions of migratory marine-mammal populations probably is occurring in areas of intense commercial-fishing activity. Up to 33 percent of the walrus herd that seasonally hauls out on Round Island in Bristol Bay apparently had been displaced from the area as a result of the bottom-trawl-fishing operations occurring near Round Island during the summer season (Lowry, 1989, pers. comm.). This seasonal displacement of about 6,000 walruses to other haulout sites is not likely to have a significant adverse effect on the productivity and abundance of the walrus population but could represent a long-term, seasonal (several-year) effect on the distribution of a portion of the population if this reduction in habitat use persisted for several years.

The overall effect of commercial fishing on migratory fur seals, harbor seals, ice seals, walruses, and belukha whales includes direct mortality from entanglement in fishing gear, shooting, competition for prey/ commercial-fish species, and disturbance/displacement from air and vessel traffic associated with commercial fishing. Increases in the number of fishing vessels and related air traffic and increases in fish-harvest rates could result in long-term (several-generations) displacement of some of the other marine-mammal populations (walruses and spotted seals) occurring in the Bering Sea and in the Arctic. Such increases also could cause an increase in the direct mortality of some seals and belukha whales that interact with fishing operations in the Bering Sea and result in an increase in competition for prey/commercial-fish species that could result in a long-term (several-generations) effect on the productivity and abundance of part of the seal and belukha whale populations. The intense commercial bottom-trawl fishery for pollock and other bottomfish apparently has had a long-term effect on regional northern sea lion populations in the southern Bering Sea and in the Gulf of Alaska.

(2) Effects of Hunting/Harvest on the Pacific Walrus

Population: The annual harvest of Pacific walruses had more than doubled from the 1970's (3,000-4,000 animals) to the 1980's (6,000 to >10,000 animals), with a total catch by both Soviet and American hunters at 10,000 to 15,000 per year or 4 to 6 percent of the population (Fay, Kelly, and Sease, 1989). During this same timeframe, scientific data on the productivity of the population indicated that herd productivity and calf survival declined sharply. As a result of the population reaching the carrying capacity of the environment, the increased harvest is occurring at the same time that the population is experiencing a natural decline in productivity (Fay, Kelly, and Sease, 1989).

Harvest/exploitation rates of >10,000 walruses per year have caused the population to decline by about 50 percent according to Fay, Kelly, and Sease (1989), representing a long-term (several-year) effect on the walrus population in the past. A cooperative reduction in harvest rates by Soviet and American hunters would prevent such a population decline. However, some continued decline in the walrus population might continue into the next decade before any reversal or recovery of the population would begin (Fay, Kelly, and Sease, 1989). Optimistically, the international hunting of Pacific walruses still would have a short-term (<1 generation) effect on the walrus population. International subsistence hunting of other pinnipeds and belukha whales is believed to have no more than a short-term effect on migratory seals and belukha whales.

Overall Cumulative Effects: In the OCS Arctic Region Planning Areas (Beaufort Sea, Chukchi Sea, and Hope Basin), the cumulative effects on pinnipeds, polar bears, and belukha whales are expected to be short term (<1 genera- tion). In Prince William Sound, the cumulative effects are expected to be long term (>5 years) on sea otters and short term (<1 generation) on harbor seals. For migratory marine mammals, cumulative effects are expected to be long term (>1 generation to perhaps 3 generations) on northern fur seals and walruses and short term (<1 generation) on ice seals (ringed, spotted, and bearded seals).

Conclusion: Cumulative effects (loss of several thousand seals and sea otters; loss of <100 polar bears, and belukha whales; and loss of several hundred to several thousand walruses due to oil spills, commercial fishing, hunting, and other cumulative activities) are expected to be short term (<1 generation) on ice seals (ringed, bearded, and spotted seals), harbor seals, polar bears, and belukha whales and longer term (>1 generation to perhaps 3 generations) on northern fur seals, walruses, and sea otters. The contribution of the proposal is expected to include about 50 percent of the oil-spill mortality of ice seals, polar bears, walruses, and belukha whales; and <50 percent of the sea otter, fur seal, and harbor seal mortality.

6. *Endangered and Threatened Species:* In addition to previous Federal and State offshore lease sales, some State or private activities may occur in the future. State or private actions reasonably certain to occur within or near the proposed sale area would include State of Alaska oil and gas lease sales, possibly some Canadian Beaufort Sea oil and gas activities in the future, and subsistence-harvest activities. Five additional State oil and gas lease sales are scheduled on lands north of the Brooks Range in the next 5 years, three of which will be in State waters of the Beaufort Sea: Sales 86, 83, and 89 (April 1997, March 1999, and December 1999, respectively). If these sales occur, additional effects similar to those described below for previous State lease sales could occur.

For the total number of oil spills from Federal and State lease activity for the cumulative case, the OSRA estimated three spills ≥1,000 bbl, with an estimated 96-percent chance of one or more such spills occurring within the Beaufort Sea over the production life of the proposed action.

Analysis of oil-spill risk on species along transportation routes south of the proposed sale area particularly the southern sea otter and the marbled murrelet, can be found in the Cook Inlet Planning Area Oil and Gas Lease Sale 149 DEIS (USDOI, MMS, Alaska OCS Region, 1995), which is incorporated here by reference. The DEIS discusses potential effects of an oil spill on these species as a result of tankers transporting oil from the Cook Inlet sale area to lower-48 ports. Potential effects include oil contamination of their insulative capabilities resulting in hypothermia, inflammation/lesion of sensitive tissues following oil contact, tissue or organ damage from ingested oil, and emphysema from inhaled vapors. Potential indirect effects from an oil spill include a reduction in available food resources due to mortality or unpalatability of prey organisms. Mortality of southern sea otters resulting from any spill of oil (estimated probability of occurrence is 6% in the potentially affected area) tankered from the Sale 149 area to southern California is expected to be moderate (an estimated 23 individuals) with an estimated 1-year-recovery time (< 1 generation), although conditions prevailing at the time of a spill could cause much greater mortality to occur. Mortality of marbled murrelets resulting from any spill of oil (estimated probability of occurrence is 6% in the potentially affected area) tankered from the Sale 149 area to northern California is expected to be high (estimated 30-144 individuals, 2-9% of the California population), with an estimated 3- to 15-year (2-8 generations) recovery time. Oil tankered from Sale 149 is expected to contribute only a minor increment of oil-spill risk to these species over the current potential cumulative risk.

a. Effects on the Bowhead Whale: Some effects on bowhead whales may occur from previous and proposed State offshore lease sales. Generally, bowhead whales remain far enough offshore so as to be found mainly in Federal waters; however, in some areas (e.g., the Beaufort Sea southeast and north of Kaktovik and near Point Barrow), the whales may occur in State waters. Exploration and development and production activities occurring on leases from previous or proposed State sales may result in noise effects on whales as described under the base case. These effects could include local avoidance of aircraft and vessels, seismic surveys, dredging, exploratory drilling, construction activities, and production operations that occur within several miles of the whales. Also, whales may react briefly by diving in response to low-flying helicopters. Current State leases with production are well removed from the normal fall-migration route of the bowhead whale. It is unlikely that there would be any major changes in the overall fall bowhead migration route resulting from noise associated with previous or future State lease sales. Should an oil spill occur, effects on whales could include those discussed under the base case, including inhalation of hydrocarbon vapors, a loss of prey organisms, ingestion of spilled oil or oil-contaminated prey, baleen fouling with a reduction in feeding efficiency, and skin and/or sensory-organ damage.

On their summer-feeding grounds in the Canadian Beaufort Sea, bowhead whales may be subject to some disturbance from activities associated with offshore oil and gas exploration and development and production at some time in the future. Apparently, the Canadian government has released a request for industry interest in the Canadian Beaufort Sea. The main area of industry interest to date has centered around the Mackenzie Delta and offshore of the Tuktoyaktuk Peninsula, although there has been little industry activity there in recent years. This area comprises a minor portion of the bowhead's summer range. Possible disturbance to bowhead whales from helicopters, vessels, seismic surveys, and drilling would be as previously described. Bowhead whales would be exposed to the risk of oil spills from exploration, development and production, and transportation of oil from the Canadian Beaufort Sea. Oil-spill effects on the bowhead whales would be as previously described.

It is expected that there would be few effects on bowhead whales during their fall migration through the Beaufort and Chukchi Seas to overwintering areas in the Bering Sea as a result of previous Federal offshore lease sales. Noise effects on bowheads under the cumulative case could be expected to result from activities associated with previous Federal offshore lease sales, including drilling exploration and delineation wells, support-vessel and helicopter activity, and shallow-hazards seismic surveys within the Beaufort Sea Planning Area. There are three potentially producible prospects from previous Federal lease sales. Two of the prospects, the Kuvlum and Hammerhead Units, are within the normal fall-migration route of the bowhead whale. Should development of these units proceed, production platforms would be installed and pipelines would be constructed. Some minor disturbance to bowhead whales on their fall migration might occur in the vicinity of these activities. Support traffic (helicopters and vessels) likely would travel between Deadhorse and any exploration units or production platforms in the planning area. Bowheads may dive if helicopters passed low overhead, and they would seek to avoid close approach by vessels. Behavioral studies have suggested that bowhead whales habituate to noise from distant ongoing drilling, dredging, or seismic operations (Richardson, Wells, and Wursig, 1985; Richardson et al., 1985), but there still is some apparent localized avoidance (Davis, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely affect bowhead use of that area (Richardson et al., 1985), and there has been no documented evidence that noise from OCS operations would serve as a barrier to migration.

In the event a spill occurred during the fall bowhead migration through the Beaufort and Chukchi Seas, effects as previously described for the proposed action could occur. These effects generally would be minor and transient unless whales were confined to an area of freshly spilled oil. After bowheads move westward past Point Barrow, they tend to fan out and cross the Chukchi Sea in a broad front. Consequently, this dispersion also reduces the risk of many whales contacting a fresh spill. Of course, if the spill occurred over a prolonged period of time, more individuals could be contacted. A low number of individuals could be killed as a result of prolonged contact with freshly spilled oil, particularly if spills were to occur within ice-lead systems. The probability of an oil spill adversely affecting fall-migrating bowheads in the Hope Basin is very low, as most bowheads appear to migrate south within Soviet waters along the coast of the Chukchi Peninsula. If oil is spilled into the spring-lead system, effects may occur as described for the proposed action.

Proposed Federal Sale 148 in the Chukchi Sea has been postponed, although a Chukchi Sea/Hope Basin Sale will be considered in the 1997-2002 5-Year Program. Currently, there are no plans for future oil and gas exploration activities in the Bering Sea. Bowheads may encounter from one to several exploratory operations or production platforms in the future along their fall migration route through the Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas. Bowheads likely would make small changes in swimming speed and direction to avoid closely approaching these operations.

A non-OCS activity that affects the bowhead whale is the annual subsistence harvest by Alaska Natives. Bowheads are taken in the northern Bering Sea and in the Chukchi Sea on their spring migration and in the Beaufort Sea on their fall migration. A quota of 54 strikes or 41 whales landed per year was authorized by the International Whaling Commission for 1992, 1993, and 1994. A quota of 266 strikes or 204 bowheads landed has been authorized for 1995 through 1998. It is likely that many more will experience disturbance due to subsistence-whaling activities. This level of harvest was allowed under the supposition that it still would allow for slow growth in the bowhead population. It was assumed that in future years, the bowhead whale population will continue to be monitored and that harvest quotas will be set in order to maintain a healthy bowhead population level.

Whenever vessels are nearby, whales likely would try to avoid being closely approached by motorized hunting boats; however, once the whales migrate out of the Beaufort Sea, there probably would be few whales interacting with hunters during the fall season, and none during the winter. As the bowheads migrate northward through northern Bering, Chukchi, and Alaskan Beaufort Seas during the spring, they are subject to being taken by subsistence whalers. A few whales also may be approached by Natives hunting seals and walruses. These whales likely would attempt to avoid being closely approached.

Summary: Under the cumulative case, bowhead whale behavior, such as avoidance, is expected to be qualitatively similar to that discussed under the base case. There would be an increase in aircraft, vessel, drilling, and construction activity, although bowhead whales generally would not encounter activities in State waters. However, whales could encounter these activities more frequently. Bowheads may exhibit avoidance behavior if closely approached by vessels or seismic-survey activity but are not affected much by any overflights unless aircraft altitudes are below 300 m (328 yd). Whales also likely would try to avoid being closely approached by motorized hunting boats. Bowheads have been sighted near drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to them. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident; and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30 to 60 minutes (in the case of seismic activity). Overall, exposure of bowhead whales to noise-producing activities from oil and gas exploration and development and production operations is not expected to result in lethal effects, but some individuals could experience temporary, nonlethal effects.

Because more oil spills are assumed to occur under the cumulative case than under the base case, the probability is greater that whales may be contacted by spilled oil, and oil-spill effects are likely to be greater. However, the probability of oil actually contacting whales would be considerably less than the probability of contact with bowhead habitat. Some individuals may be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small. Overall, exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering within 1 to 3 years. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects.

Conclusion: Bowheads may exhibit avoidance behavior to vessels and activities related to seismic surveys, drilling, and construction during exploration and development and production. Some bowhead whales could be exposed to spilled oil, resulting in temporary, nonlethal effects, although some mortality might result if there were a prolonged exposure to freshly spilled oil. Overall, bowhead whales exposed to noise-producing activities and oil spills associated with the proposal and other future and existing projects within the arctic-region area—combined with the other activities within the range of the migrating bowhead whale—most likely would experience temporary, nonlethal effects. However, exposure to oil spills could result in lethal effects to a few individuals, with the population recovering to prespill population levels within 1 to 3 years. The contribution of the proposal to the cumulative effects is expected to be of short duration and to result in primarily temporary, nonlethal effects.

b. Effects on the Arctic Peregrine Falcon: Adverse effects on peregrines primarily result from intake of pesticides and other toxic contaminants, habitat destruction, and disturbance of nest sites. The ban of DDT use in the United States has greatly reduced the bioaccumulation and reproductive failure of the peregrine falcon; however, the continued use of toxic pesticides (including DDT) in Central and South America results in a persistence of the contamination in the peregrine. Large-scale habitat destruction in these countries (clearing of forests for agriculture), as well as habitat disruption along migration routes and disturbance near nest sites and in foraging areas, probably also have slowed recovery of the peregrine population. Oil spills are considered a minor threat to peregrines because they are not likely to contact oil directly. However, peregrines could contact oil while feeding on oiled seabirds, waterfowl, or shorebirds and also could be affected by a reduction in prey availability if these species were oiled in large numbers.

Both disturbance and oiling of peregrines (as described for the base case of the proposed action) are considered unlikely results of the proposed action and other Federal lease sales because situations involving these adverse factors generally are far-removed from primary areas of falcon activity and thus should have only occasional, brief, adverse effects. Disturbance associated with onshore activities has the greatest potential for adverse effects. Although the cumulative effect of all OCS lease sales throughout the arctic range of the peregrine falcon is expected to have a greater effect than the proposed action, the overall effect on the population is expected to be minimal.

Conclusion: The cumulative effect of all projects and activities within the range occupied by nesting, migrating, or wintering arctic peregrine falcons is expected to be minimal and short-term, with mortality and sublethal effects on <10 percent of the population, requiring no more than one generation (3 years) for recovery to original status. The contribution of activities associated with proposed Sale 144 to the cumulative effect is not expected to represent >10 to 15 percent of the cumulative effect on the arctic peregrine falcon population.

c. Effects on the Spectacled Eider: In addition to Proposed OCS Lease Sale 144, other projects or activities that could contribute to cumulative effects on spectacled eiders include past and projected Federal and State oil and gas lease sales, current and projected State oil production, subsistence harvests, commercial fishing, marine shipping, and recreational activities. These projects could result in disturbance of nest sites and areas occupied during brood-rearing, molting, staging, and migration, as well as habitat degradation and oil or other toxic pollution effects. Disease, predation, fluctuations in prey availability, and severe weather, as well as the unknown factors that have caused the spectacled eider population in Alaska to decline 90+ percent in the past several decades, presumably would contribute to the cumulative effect or affect the intensity with which other factors operate.

Because potentially disturbing routine activities associated with Federal OCS sales would be far removed from most spectacled eiders nesting or staging/migrating along the western Beaufort Sea coast, the population is not expected to experience significantly greater effects from increases in such activities. On the arctic slope, an estimated 15 percent of available nesting habitat has been developed as oil-production fields; however, <5 percent of the tundra wetlands within the developed area has been destroyed (58 *FR* 27478). Future State onshore development could result in increased eider disturbance and habitat degradation, but the extent of such development will depend on economic factors. Relatively low spectacled eider mortality is expected from oil spills (<200 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25) recovery from cumulative spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate. Subsistence harvest is estimated to remove at least 500 spectacled eiders from the Alaskan population annually (58 *FR* 27477). Effects of the other factors (e.g., fishing-net entanglement, bioaccumulation of toxins in the food chain) on the spectacled eider population currently are unknown.

Conclusion: Routine OCS cumulative effects on the Alaskan spectacled eider population are expected to be minimal, affecting <5 percent of the population; however, recovery from any substantial oil-spill mortality is not expected to occur if population status is declining as at present. Likewise, recovery from substantial overall cumulative effect is not expected to occur if population status is declining as at present. A relatively low level of cumulative mortality still may require more than six generations for recovery, although any estimate of severity is confounded by the uncertainty regarding the population decline. The contribution of activities associated with proposed Sale 144 to the cumulative effect is not expected to represent >5 to 10 percent of the cumulative effect on the spectacled eider population.

d. Effects on the Steller's Eider: In addition to proposed OCS Lease Sale 144, other projects or activities that could contribute to cumulative effects on Steller's eiders include past and projected Federal and State oil and gas lease sales, current and projected State oil production, subsistence harvests, commercial fishing, marine shipping, and recreational activities. These projects could result in disturbance of nest sites and areas occupied during brood-rearing, molting, staging, and migration, as well as habitat degradation and oil or other toxic pollution effects. Disease, predation, fluctuations in prey availability, and severe weather, as well as the unknown factors that have caused the Steller's eider population to decline >50 percent in the past several decades, presumably would contribute to the cumulative effect or affect the intensity with which other factors operate.

Because potentially disturbing routine activities associated with Federal OCS sales would be far removed from most Steller's eiders nesting primarily south of Barrow or staging/migrating along the western Beaufort Sea coast, the population is not expected to experience significantly greater effects from increases in such activities. Future State onshore or NPR-A development could result in increased eider disturbance and habitat degradation, but the extent of such development will depend on economic factors. Relatively low Steller's eider mortality is expected from oil spills (<200 individuals); however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from cumulative spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding ground and relatively low reproductive rate. Effects of the other factors (e.g., fishing-net entanglement, bioaccumulation of toxins in the food chain, subsistence harvest) on the Steller's eider population currently are unknown.

Conclusion: Routine OCS cumulative effects on the Alaskan Steller's eider population are expected to be minimal, affecting <5 percent of the population; however, recovery from any substantial oil-spill mortality is not expected to occur if population status is declining as at present. Likewise, recovery from substantial overall cumulative effect is not expected to occur if population status is declining as at present. A relatively low level of cumulative mortality still may require more than six generations for recovery, although any estimate of severity is confounded by the uncertainty regarding the population decline. The contribution of activities associated with proposed Sale 144 to the cumulative effect is not expected to represent >5 to 10 percent of the cumulative effect on the Steller's eider population.

e. Effects of a Far East Tanker Route: Bird species potentially affected by oil spilled from a tanker traveling a Far-East route include the threatened Aleutian Canada goose nesting on four islands in the central and western Aleutian Islands and one in the Semidi Islands group; the proposed (threatened) Steller's eider that winters in coastal areas from the eastern Aleutian Islands to Cook Inlet; and the endangered short-tailed albatross, potentially occurring in coastal areas of southcentral and southwestern Alaska and breeding on Torishima Island south of Japan. Rookeries and haulouts of the threatened Steller sea lion are scattered from the Prince William Sound area to the western Aleutians, and several species of endangered whales would be expected to occur in waters adjacent to the route.

In the vicinity of Alaska, the probable oil-tanker route (Fig. IV.A.6-3) lies seaward of the 200-mile EEZ boundary except in the northcentral Gulf of Alaska, where it exits Prince William Sound. Between this route and the adjacent coast, currents predominantly are westerly with the moderate (20 cm/sec) Alaska Coastal Current along the coast and the strong Alaskan Stream (peak flow ~100 cm/sec) varying in width from 300 km east of Kodiak Island to 100 km west of this area. Any oil spilled along most of this route would tend to be moved parallel to the Alaska Peninsula and Aleutian Islands, particularly by the Alaskan Stream, rather than towards the coast where vulnerable populations (birds) or population segments (sea lion pups) might be contacted. Farther offshore, adult sea lions and whales could be contacted, but they are not considered particularly vulnerable to dispersed and weathered slicks (see analysis of effects for these species in USDOI, MMS, 1995, Sec. IV.B.1.f) that would characterize a spill after hours or a few days. Oil spilled from a tanker soon after exiting Prince William Sound could contact the Kodiak and Alaska Peninsula areas, with potentially adverse effects on small numbers of geese and young sea lions. In addition to the blocking effect of currents, winds in the western Gulf of Alaska have a strong westerly component that would tend to push oil or a disabled tanker in an easterly direction, away from the coast; along the Aleutians, the more variable winds would diminish this effect.

Annual cycle activities and behavior of these species also would tend to decrease the probability of contact and resulting adverse effects associated with an oil spill. Aleutian Canada geese do not appear to spend significant amounts of time on salt water or in the intertidal zone while at the breeding islands, and nest above the intertidal, suggesting that there is little risk of oiling from a tanker spill during the breeding period. However, occasional sightings of this goose in the Kodiak area during the spring migration period suggests that a small proportion of the population could be vulnerable to a spill in the northern Gulf of Alaska at this time. Steller's eiders are present only during the winter season along the coast where only a spill carried in the coastal current would contact them. Because short-tailed albatrosses are rare anywhere outside the breeding area due to their small population and wide-ranging habits, as well as the tendency to spend much of the day in flight, it does not appear that significant numbers would be contacted by a spill along the tanker route. When most vulnerable, young sea lion pups remain at the rookery and thus are not likely to be oiled directly; oil may be transferred from females returning from sea but is not expected to result in fatal hypothermia. Juveniles and adults, insulated by a thick fat layer, are not expected to experience hypothermia. Likewise, whales are not likely to experience any mortality from exposure to offshore oil slicks.

Conclusion: Primarily due to the blocking effect of current and wind patterns, dispersed patterns of these species' distribution and abundance, and annual cycle or behavioral characteristics that decrease the probability of contact, oil spilled along a Far-East tanker route is not likely to contact significant numbers of individuals in the vulnerable populations, and thus effects are expected to be none to minimal.

7. Caribou: The additive effects on caribou of other ongoing and planned projects, as well as the base case, are discussed in this section. Although the probability of any or all planned and ongoing projects reaching developmental stages generally is unknown, this analysis assumes that all the projects discussed in this section do reach developmental stages. Motor-vehicle traffic along over 500 km (310 mi) of existing pipeline roads and an additional several hundred kilometers of future pipeline roads associated with these projects could disturb and displace caribou and alter or destroy some calving and summer range through facility construction (see Sec. IV.A.4).

Oil and gas activities associated with proposed Sale 144 and the other offshore and onshore projects would subject caribou herds and their summer ranges and calving ranges throughout the North Slope to a variety of oil-development projects (see Sec. IV.A.6). Potential oil spills from offshore as well as onshore oil activities associated with Federal, and State of Alaska leases are likely to have a small-effect on the caribou herds in general, because comparatively low numbers of caribou (perhaps a few hundred) are likely to be contaminated or ingest contaminated vegetation and die as a result of oil spills (see Sec. IV.B.7).

a. Noise and Disturbance: The primary sources of disturbance of caribou are ground-vehicle traffic, aircraft traffic, and human presence near cows with newborn calves. Disturbance of caribou associated with cumulative oil exploration (particularly by helicopter traffic) is expected to have short-term (few minutes to < 1 hour) effects on some caribou (particularly cow/calf groups), with animals being briefly displaced (about 1 km-0.62 mi) from feeding and resting areas when aircraft pass nearby. During development, the greatest concern from ground-vehicle/road-traffic disturbance of caribou is disturbance 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 a pipeline-road complex in the presence of traffic depends on motivation. During the mosquito-oestrid fly seasons, caribou are highly motivated to seek relief from insect harassment; and the frequency of crossing pipelines in the Prudhoe Bay-Kuparuk area increases (Curatolo, 1984), although increases in the percentage of disturbance reactions tend to reduce crossing frequency. However, caribou do successfully cross pipeline-road complexes and numerous highways in Alaska and Canada with no apparent effect on herd distribution, abundance, or integrity. Although some habituation of caribou to the road system on the oil fields is evident, cow caribou avoid areas of intensive human activity before and during the calving season (Smith, Cameron, and Reed, 1994). Cumulative disturbance of caribou (outside of the calving area) from road traffic (several hundred vehicles/day) associated with pipelines (> 3,000 km [1,864 mi] in the cumulative case) are expected to cause a very short-term (a few minutes to a few hours) displacement of caribou within 1 to 2 km (1.2 mi) of the road. Road traffic temporarily delays the successful crossing of pipelines and roads by some animals but has no effect on herd abundance or overall distribution. The only exception to this level of effect may be when disturbance levels are very high and development facilities (drill platforms, pump stations, roads, etc.) on the calving grounds themselves are spaced close together (within about 100-200 m [328-656 ft]) and cause some long-term (over the life of the field) displacement—local change in distribution of some cows and calves from within about 1 to 2 km (0.62-1.2 mi) of some pipeline roads that cross concentrated calving areas (Dau and Cameron, 1986; Cameron et al., 1992).

At present, cumulative oil development in the Prudhoe Bay-Kuparuk area (total of 1,797 km [1,114 mi]) of pipelines, 553 km (343 mi) of roads, and 2,847 ha of habitat covered by facilities) has caused minor displacement of CAH caribou from a small portion of the calving range (estimated 5%), with no apparent effect on herd abundance or overall distribution. The cumulative displacement of cow/calf groups from additional portions of the calving ranges (estimated 25%) with the development of additional oil fields in the Prudhoe Bay-Kuparuk area (see Sec. IV A.6), in the NPR-A (14% of the Western Arctic herd [WAH] calving range), and as a result of potential ANWR oil development (about 30% of the Porcupine caribou herd [PCH] calving area), could represent a long-term displacement (several generations effect over the life of the oil fields) of caribou from available calving habitat and have a long-term local effect on the distribution of one or more of these caribou herds (or populations).

b. Displacement from Calving Areas: At present, oil development in the Prudhoe Bay-Kuparuk River area has caused local displacement of some cow caribou from within an estimated 4 km of some pipelines, roads, and other facilities on the existing Prudhoe Bay and Milne Point oil fields but not on the Kuparuk Oil Field.

There are significantly fewer cow and calf caribou numbers occurring within 1 to 2 km (0.62-1.2 mi) of Milne Point facilities (the 11-km- (6.8 mi) long pipeline and road from Milne Point) in comparison with caribou numbers occurring on habitats beyond 2 km (1.2 mi) (Smith and Cameron, 1986; Cameron et al., 1992). This small amount of displacement has had no measurable effect on the abundance or apparently no effect on the growth of the CAH, which had been increasing annually (from 6,000 animals in 1978 to 13,000 in 1983) by about 15 percent, but increased only by 5 percent annually since 1983 (Cameron and Smith, 1992). At present, oil development has affected an estimated 5 percent of the calving range of the CAH, and oil-company leases presently include about 25 percent of the CAH calving and summer ranges. Future State oil-lease sales in the Kuparuk Uplands (Sales 47 and 48), Prudhoe Bay Uplands (Sale 51), and North Slope Foothills (Sale 57) will increase the amount of oil leases on the CAH range. If the U.S. Congress allows ANWR oil development, perhaps another 5 to 10 percent of the CAH calving range could be exposed to oil development.

If full-scenario oil development were to occur on NPR-A within the Utukok River calving area, an estimated 14 percent of the WAH's calving range could be exposed to development facilities, while full-scenario oil development within the Teshekpuk Lake area could expose 20 percent of the Teshekpuk Lake herd (TLH) calving range to development (USDOI, BLM, 1983). Oil development on ANWR could expose 78 percent of the central-calving range of the PCH to oil development (Elison, Rappaport, and Reid, 1986). Assuming cow-calf displacement within 1 to 2 km (0.62-1.2 mi) of potential ANWR oil-development facilities (several hundred kilometers of roads, pipelines, drill platforms, etc.), an estimated partial displacement (some cows and calves) of over 37 percent of the central calving area could occur (USDOI, FWS, 1987). The reduction in use of calving and summer range by some cow and calf caribou on 37 percent of the PCH central-calving range, 20 percent of the TLH calving range, 5 to 25 percent of the CAH calving range, and 14-percent of the WAH calving range could occur as a result of the displacement of some cow and calf caribou within 1 to 2 km (0.62-1.2 mi) of oil-development facilities.

Assuming this displacement (reduction in habitat use) persists beyond the construction period and lasts for more than one generation, it is expected to represent a long-term (over the life of the field) but local effect on the distribution of the various caribou herds (WAH, TLH, CAH, and PCH) occurring in the Alaskan Arctic.

The reduction in calving-habitat use within 1 to 2 km (0.62-1.2 mi) of oil-development facilities could, in theory, eventually limit the growth of the arctic caribou herds within their present ranges and may prevent the herds from reaching the maximum population size that they could achieve on their present ranges without the presence of development. Such an effect may not occur because natural changes in the distribution and productivity of the herds are likely to influence the abundance and growth of caribou herds over and above the reduction in habitat use caused by cumulative oil development. However, recent information on the productivity of CAH cow caribou calving on the oil fields compared with CAH cow caribou calving east of the oil fields suggests that disturbance-displacement of cow caribou may be affecting caribou productivity (Cameron, 1994). Changes in caribou distribution on and near the above oil-development projects may persist over the life of the oil fields in the Arctic.

c. Habitat Alteration and Destruction: Cumulative oil development in the Prudhoe Bay-Kuparuk area encompasses over 800 km^2 (496 mi^2), and hundreds of miles of gravel roads cross a major portion of the calving range of the CAH. However, a small (perhaps 1-3%) percentage of the tundra-grazing habitat has been destroyed or altered where roads, gravel pads, gravel quarries, pipelines, pump stations, and other facilities are located. The cumulative loss of range habitat from facility construction in future oil development (such as in the NPR-A and ANWR) also would represent a small percentage of the available grazing habitat of the WAH and the PCH, respectively, and is likely to represent a very small percentage (1-3%) of habitat loss.

d. Roads: The development of more transportation corridors in support of oil development on the North Slope—particularly several hundred kilometers of roads that may eventually be open to the public—would increase human access to the North Slope caribou herds, which would result in increased hunting pressure and perhaps overharvest of some of the herds. Hunting with firearms of caribou south of the oil fields along the Dalton Highway is not permitted within 8 km (5 mi) of the highway; however, hunting by bow and arrow is permitted within that distance. Noise and disturbance associated with caribou harvest are not expected to have any significant effect on caribou movements across the Dalton Highway and other North Slope roads. Caribou have continued to cross roads and highways, even when subject to heavy hunting pressure and to the increased noise and disturbance associated with hunting (Valkenburg and Davis, 1986).

e. Overall Cumulative Effects: Combined onshore oil and gas activities proposed and ongoing in the Prudhoe Bay, NPR-A, and ANWR are likely to have some long-term, local effects on the distribution of caribou herds if parts of the central calving areas of either the WAH, CAH, TLH, or the PCH were avoided by caribou cow and calves for several generations (over the life of the oil fields) and resulted in a local reduction in caribou distribution (within 1-2 km [0.62-1.2 mi] of the oil-field facilities). Aircraft traffic associated with transportation facilities from Federal and State offshore oil activities are likely to have very brief (a few minutes to < 1 hour) disturbance effects on caribou behavior.

Cumulative reduction in habitat use near facility-construction projects (such as gravel mining, roads, pipelines, and drill pads) and caribou avoidance (cows with calves) of habitat areas with continuous high levels of road (perhaps ≥50 vehicles/hour) and air traffic (of perhaps several hundred flights/day) could have a long-term but local effect on the distribution of one or more of the Arctic North Slope caribou herds by displacing some portion of the caribou herds from a small part of the calving and summer ranges for several generations (over the life of the oil fields). In theory, a reduction in caribou abundance is possible if the displacement-avoidance of calving habitat caused a long-term reduction in herd productivity, leading to a population decline that lasts several generations. However, such an effect is not evident because present levels of onshore oil development in the Prudhoe Bay area have not demonstratively affected the abundance of any caribou herds on the North Slope. However, recent information on productivity of CAH cow caribou that calve on the oil fields compared to CAH cow caribou that calve east of the oil fields suggest that disturbance-displacement of cow caribou may be affecting caribou productivity (Cameron, 1994). The construction of several hundred to perhaps over a thousand kilometers of roads in support of oil development would increase human access to the arctic caribou herds. The resultant increased hunting pressure on the herds could lead to overharvest. However, existing hunting regulations are likely to prevent excessive overharvesting of any of the caribou herds on the North Slope.

The United States and Canada initialed a draft agreement on the conservation of the PCH in December 1986. This agreement would provide for an International Porcupine Caribou Board to share information on the conservation of the herd; assist in cooperative conservation and planning for the herd throughout its range; review available data; and, as necessary, make recommendations to the respective governments concerning matters that affect the herd or its habitat. This agreement could help minimize cumulative effects on the PCH.

Conclusion: Cumulative effects on caribou distribution are likely to be long-term (several generations over the life of the oil fields) but local (within 1-2 km [0.62-1.2 mi]) of some onshore facilities). However, the cumulative reduction in calving and summer habitat use by cows and calves of the arctic herds near some oil-field facilities (such as road-pipelines with high traffic levels) may not result in a long-term effect on caribou abundance nor to reduce herd productivity. The contribution of the base case of the proposal to the cumulative case is estimated to be < 10 percent of the local but long-term displacement of caribou calving habitat and reduced habitat use.

8. Economy of the North Slope Borough: The overall revenue and employment effects of the cumulative-case 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. If and when these factors resulted in a downturn of development activity, households (especially in the smaller communities) might have trouble maintaining the standards of living attained during boom periods.

Effects on the economy of the NSB in the cumulative case are assessed in terms of (1) current conditions, described in Section III.C.1; (2) effects from the proposal described in Section IV.B.8; (3) and effects from the projects described in Section IV.A.5. Table IV.A.2-3 shows oil-spill-occurrence estimates and probabilities of one or more spills ≥1,000 bbl resulting from Federal production in the cumulative case. Analysis of effects on the economy of the NSB takes into account that effects from the increased revenues and employment are the most significant economic effects that would be generated by the existing and proposed projects in the cumulative case. Increased property tax revenues and new employment would be created with the construction, operation, and servicing of facilities associated with OCS activities. The proposed projects described in Section IV.A.6 are assumed to be fully implemented. The State of Alaska estimates that the combined production from the presently operating and to-be-developed fields will rise slightly to 1.6 MMbbl per day in 1995 and then decline to 1.1 MMbbl per day in 2000, eventually declining to a daily output of 159,000 bbl in 2015 (State of Alaska, Department of Natural Resources, 1995b). As such, the cumulative effects discussed below are contributed mostly by the base case of the proposal. The cumulative-case project also would affect the subsistence economy.

Analysis of economic effects resulting from this alternative is limited to effects on the NSB. The information that follows is from the Rural Alaska Model, prepared for MMS by the ISER, and from the NSB 1993/1994 Economic Profile and Census Report (Harcharek, 1995).

a. NSB Revenues and Expenditures: Under existing conditions, total property taxes in the NSB and NSB revenues are in general projected to decline, as discussed in Section III.C.1.

The cumulative case is projected to increase property taxes above the declining existing-condition levels starting in the year 1998 and averaging about 2 percent each year through the production period. Also under existing conditions, the two expenditure categories that affect employment—operations and the CIP—are projected to decline. Of these two categories, only expenditures on operations would be affected by the cumulative case's effects on taxable property value.

Cumulative-case projects could provide additional revenues to the NSB in the form of property taxes and provide additional employment opportunities for residents. Projects that increase NSB property-tax revenues would allow increased NSB hiring of residents. Projects that expand employment opportunities in the region without significantly increasing NSB property-tax revenues are likely to generate strong interest in employment from residents.

b. Employment: The gains from the cumulative case in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. The peak employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 jobs by 2026. (See Appendix E for a description of the methodology for employment and population forecasts.) All of these jobs would be filled by commuters who would be present at the existing enclave-support facilities approximately half of the days in any year.

The cumulative case is projected to affect employment of the region's permanent residents in two ways: (1) more residents would obtain petroleum-industry-related jobs as a consequence of Sale 144 exploration and development and production activities and (2) more residents would obtain NSB-funded jobs as a result of higher NSB expenditures.

While the cumulative case is projected to generate a large number of petroleum-industry-related jobs in the region, the number of jobs filled by permanent residents of the region is not projected to be large. Total base-case resident employment is expected to be about 4-percent greater than existing-condition employment. Overall employment should, therefore, not decline as far by the end of the production period as it would under existing conditions. The increase in employment opportunities may partially offset declines in other job opportunities and delay expected outmigration.

Employment generated by oil-spill-cleanup activities also would have economic effects. The number of cleanup workers actually used to clean up the assumed three oil spills of 7,000 bbl associated with the cumulative case would depend to a great extent on what procedures were called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities. Activities associated with the cumulative case could generate cleanup work for about 3 percent of the workers associated with the EVOS—or 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

c. Effects of Subsistence Disruptions on the NSB Economy: For a detailed discussion of effects of the cumulative case on the subsistence-harvest patterns and the sociocultural systems of the NSB, refer to Sections IV.G.9 and IV.G.10. Disruptions to the harvest of subsistence resources could affect the economic well-being of NSB residents in a number of ways. Adverse effects would be felt primarily through the direct loss of subsistence resources. In addition, loss of subsistence resources would increase demand for store-bought goods and result in an inflation of prices.

Subsistence activities are an integral component of the NSB economy as well as the culture. Subsistence is the "body and soul" of Native culture (I. Nukapigak, 1995). If one or more subsistence resources became unavailable for harvest, the economic well-being of NSB residents would be harmed. There are two components to the economic well-being associated with subsistence resources—the value of subsistence resources as a source of food and the cultural value of the resources. Both of these values can be represented as a direct source of economic well-being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased in the marketplace. This food source is a substitute for income earned in the marketplace that would have to be used to purchase food. Subsistence activities and the value derived from these pursuits, however, go beyond a substitute for food bought in the market. As a way of life, there is a real, measurable economic value gained from NSB residents having access to such activities. As explained below, disruption of a subsistence harvest would result in a real loss of economic well-being to residents.

The interaction between the "Western" market-oriented economy and subsistence activities is a complex relationship that does not fit neatly into standard economic theory. Much of the reason for this is because the unit of analysis in standard economic theory is the household, whereas the extended-kinship network is important for economic decision making in the Inupiat culture of the NSB. The kinship-sharing network that is characteristic of Inupiat culture distorts the standard economic outlook on an economy. For example, jobs in the market economy often are held in order to support subsistence activities. Earnings from these jobs frequently are not earned by the principal harvester of subsistence resources but rather are contributed to the harvester's subsistence effort by the market-wage earner. Likewise, subsistence resources are contributed to those engaged in market-oriented activities. This, however, is only one possible combination of the relationship between the market economy and subsistence activities. Market-wage earners also may directly engage in subsistence activities. Furthermore, the sharing of resources among the kinship network is not a simple trade of equally valuable goods. Rather, it is based on tradition and status among the individuals within the network.

Because of this extensive subsistence-user/-kinship network, a disruption to a subsistence resource caused by, for example, an oil spill could have ramifications that extend beyond the immediate family of the subsistence harvester to households that, by all appearances, principally engage only in market-economy activities. "Our food would be devastated by an oil spill" (E. Itta, 1995). For example, an MMS survey-research project on the North Slope found that for six North Slope communities (Barrow, Wainwright, Nuiqsut, Point Hope, Anaktuvuk Pass, and Kaktovik), about 70 percent of all households (regardless of ethnicity) obtained the majority of meat and fish in their diet from subsistence activities. A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. There is considerable evidence that Western foods are not considered equivalent to Native foods (Kruse et al., 1983). Even if an equal portion of Western foods were substituted for the lost subsistence foods, there still would be a loss in well-being and, in turn, a loss in income because the substitute foods would be an inferior product. This aspect of the loss does not begin to address the lost value associated with having to forego participating in subsistence activities and, in general, the lost value associated with not being able to participate in the Native culture. This is not to deny the possibility of local residents earning additional income through cleanup jobs; however, cleanup opportunities are not expected to fully compensate for the lost value resulting from being denied use of subsistence resources.

The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. In the cumulative case, the effects on subsistence-harvest patterns are expected to cause one or more important subsistence resources to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years in Barrow, Atqasuk, Nuiqsut, and Kaktovik and also within the region. The contribution of the proposal to the cumulative effects would be effects to subsistence resources that would render them unavailable, undesirable for use, or reduced in available numbers for a period not exceeding 1 year. (See Section IV.H.10, Subsistence-Harvest Pattterns.)

Conclusion: Cumulative effects on the economy of the NSB from activities within the arctic region combined with other activities are expected to be similar to those estimated for the base case of the proposal due to the construction schedule for new projects and the declining existing-condition of total property taxes in the NSB and NSB revenues. The contribution of the proposal is projected to increase property taxes above the declining existing-condition levels starting in the year 1998 and averaging about 2 percent each year through the production period. A peak-employment estimate of 3,553 jobs is projected for 2007, declining to under 1,000 by 2026. The number of jobs filled by permanent residents of the region is projected to be about 4-percent greater than existing-condition employment. The cleanup operation of an oil spill would generate jobs for up to 300 cleanup workers for 6 months in the first year, declining to zero by the fourth year following the spill.

A loss of a subsistence resource would be a loss of income to the entire community. This loss of income would result from the loss of the value of the food, plus the loss of the cultural value, and most likely would not be compensated for by the market economy through purchases of Western foods. The extent of loss to the subsistence economy is directly related to effects on the subsistence harvest. In the cumulative case, the effects on subsistence-harvest patterns are expected to cause one or more important subsistence resources to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years in Barrow, Atqasuk, Nuiqsut, and Kaktovik and also within the region. The contribution of the proposal to the cumulative effects would be effects to subsistence resources that would render them unavailable, undesirable for use, or reduced in available numbers for a period not exceeding 1 year.

9. Sociocultural Systems: Cumulative effects on sociocultural systems include effects of the proposed action and other ongoing or planned projects on the North Slope and in the western Canadian Arctic that would include Federal and State offshore lease sales and State and private activities expected to occur in the future. Projects expected to occur near the proposed sale area are future State of Alaska oil and gas lease sales and possible Canadian Beaufort Sea oil and gas development. In the next 5 years, the State of Alaska has scheduled Beaufort Sea Sales 86, 83, and 89 in April 1999, March 1999, and December 1999, respectively. Additional effects, besides those already considered from previous State lease sales, would be expected if these sales occur. The probability of any or all of the ongoing and planned offshore and onshore projects reaching the development and production stage is unknown; however, the following discussion assumes that all of these projects would reach the development and production stage. As in the proposed action, the effects of projects in the cumulative case on sociocultural systems would occur because of changes in social organization, cultural values, and other issues, such as stress on social systems.

a. Social Organization: In the cumulative case, effects on social organization could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns. These effects would be similar to those described for the proposed action; however, the level of effects would be increased because of the intensity of activity in the cumulative case. Additional air traffic and growth in the number of non-Natives in the North Slope region 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). Cumulative-case 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. A significant mitigation to the above discussion is the decline in North Slope oil production that by 2010 will reach a point where TAPS will be forced to shut down. Output from Sale 144 production would extend the life of TAPS; but if other new fields were not brought on line to supplement Sale 144 oil production, TAPS would become nonoperational sometime between 2015 and 2020. This is well before the expected field expiration of Sale 144 in 2028. A change of such magnitude would serve to reduce total cumulative-case effects. In the cumulative case, disruptions to sociocultural systems would be chronic and long term (2-5 years) but with no tendency toward the displacement of existing institutions and existing social organization.

b. Cultural Values: In the cumulative case, effects on cultural values could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns. These effects would be similar to those described for the proposed action; however, the level of effects would be higher due to the intensity of activity in the cumulative case. Cumulative-case effects on the social organization could lead to a decreased emphasis on the importance of the family, cooperation, sharing, and subsistence as a livelihood and to an increased emphasis on individualism, wage labor, and entrepreneurialism. In the cumu- lative case, long-term effects on subsistence-harvest patterns are expected. Chronic, long-term disruptions of subsistence-harvest patterns could affect subsistence-task groups and have a tendency to displace sharing networks, but there would not be a tendency toward the displacement of subsistence as a cultural value.

c. Other Issues: Increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide also are issues of concern in the cumulative case. The NSB already is 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. Historically, it is suggestive that abuse of alcohol and increased violence seem to be somewhat connected to the increased flow of income into North Slope communities. During the peak of commercial whaling and then again during the height of the fur trade, secondary sources have indicated the onset of socially dysfunctional behavior. During the economic declines following these periods, drinking and violence seemed to ebb. Recent evidence of the effects of employment during and just after World War II loosely substantiate this generalization. Lacking clear, incontrovertible evidence, it still could be assumed that the significant social changes encouraged and abetted by the huge cash flows from onshore oil development to date have played at least some role in the expression of these problems. It also is likely that these social changes in the North Slope have contributed to the extremely high rate of suicide among the Inupiat (90.8 per 100,000 for the Inupiat vs. 35 per 100,000 among the Yup'ik [Travis, 1989]). These long-term effects in the cumulative case would cause a displacement of existing sociocultural institutions.

Although not long term, activities associated with oil-spill cleanup (associated with the estimated three spills ≥1,000 bbl occurring over the life of the field and elsewhere) could generate up to 2,000 jobs for cleanup workers. For local Native residents employed in cleanup work (based on occurrences during the *Exxon Valdez* spill cleanup), there could be curtailed participation in subsistence activities, a large cash surplus to spend, and a tendency to not continue employment in other local, lower paying jobs in the community. This sudden and dramatic increase in income for local Native cleanup workers and the disruption or inability to pursue subsistence because of the oil spill could cause tremendous social upheaval.

Conclusion: Cumulative effects on sociocultural systems could cause chronic disruption of sociocultural systems in the communities of Barrow, Nuiqsut, and Kaktovik for a period of 2 to 5 years without a tendency toward displacing existing institutions or social organization. Lesser cumulative effects would occur in the community of Atqasuk, where disruption would be only periodic. The contribution of the proposal to the cumulative effects would be disruptions to sociocultural systems lasting for a period of < 1 year without a tendency to displace existing institutions.

10. Subsistence-Harvest Patterns: Cumulative effects on subsistence-harvest patterns include effects of the proposed action and other ongoing or planned projects on the North Slope and in the western Canadian Arctic that would include Federal and State offshore lease sales and State and private activities expected to occur in the future. Projects expected to occur near the proposed sale area are future State of Alaska oil and gas lease sales and possible Canadian Beaufort Sea oil and gas development. In the next 5 years, the State of Alaska has scheduled Beaufort Sea Sales 86, 83, and 89 in April 1999, March 1999, and December 1999, respectively. Additional effects, besides those already considered from previous State lease sales, would be expected if these sales occur. The probability of any or all of the ongoing and planned offshore and onshore projects reaching the development and production stage is unknown; however, the following discussion assumes that all of these projects would reach the development and production stage. As for the proposed action, the effects of these projects on subsistence would occur because of oil spills, noise and traffic disturbance, or disturbance from construction activities associated with the pipelines and landfalls. Noise and traffic disturbance might come from seismic activities; from constructing, installing, and operating drilling facilities; from supply efforts; or from the tankering of oil.

a. Oil Spills: The probability of a North Slope community experiencing the effects of one or more oil spills is substantially higher in the cumulative case than it is for the proposed action. In the cumulative case, the OSRA estimated a mean number of three spills ≥1,000 bbl, with an estimated 99-percent chance of one or more spills occurring over the development and production life of the proposed action. Three spills of 7,000 bbl are assumed to occur in the sale area.

In the cumulative case, as in the proposed action, an oil spill during the winter would adversely affect seal and polar bear hunting. During the spring, the harvests of bowhead whales could be affected; during the open-water period, the harvests of bowhead whales, belukha whales, seals, waterfowl, and anadromous fishes could be affected. Because of the short harvest period, an oil spill during the bowhead whale harvest could cause the harvest to be curtailed for that season, particularly in a year when the harvest period is shortened due to poor weather conditions. Because a harvestable species is more likely to experience the effects of several oil spills in the cumulative case than it is in the proposed action, the likelihood of a higher effect level also is greater. Oil spills also could affect the harvests of fish. As in the proposed action, spills are not likely to affect the population size of harvestable fish species that migrate up rivers. In the cumulative case, however, the ocean netting of anadromous fish is of concern. An oil spill that contacted anadromous fish areas could eliminate the subsistence harvests of salmon and/or capelin for 1 year or possibly more. Overall cumulative effects on subsistence-harvest patterns in the Sale 144 area as a result of oil spills would cause one or more important subsistence resources to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year.

b. Noise and Disturbance: Short-term effects from the construction of landfalls and pipelines could cause short-term disruptions to caribou hunting and waterfowl hunting. Noise and traffic disturbance from the construction of such onshore facilities are expected to have short-term effects on caribou harvests. Landfall facilities may be constructed at Pitt Point, Oliktok Point, Point McIntyre, and a point about 32 km (20 mi) east of Bullen Point. Barrow and Nuiqsut could experience effects from the construction of onshore pipelines from TAPS to Oliktok and Pitt Points and from offshore pipelines to these landfalls. Kaktovik could experience effects from the construction of a pipeline to the landfall east of Bullen Point. Certain waterfowl during their spring migration are reported to avoid areas where they see movement on the ground. Construction activities could cause them to avoid one or more locations that would otherwise have served as productive sites for subsistence hunters. However, such effects would be limited to the immediate location of construction activities.

The increased amount of oil-related traffic in the cumulative case makes it likely that subsistence-harvest activities may be occasionally disrupted by boat and air traffic, as well as barge traffic. Since most marine-hunting activities occur over a wide area of open water, such interruptions could cause boat crews to hunt longer or take extra trips but would not reduce the overall harvests of marine mammals or waterfowl.

Although belukha whales can react to active icebreaker noise 35 to 50 km (22-31 mi) away from the source, it is not anticipated that this reaction to noise would cause interference to the belukha whale harvests. Disruptions are most likely to be short term and are not expected to affect harvest levels. In the early summer, belukhas are harvested in the pack-ice leads. In the cumulative case, because the belukha hunting season for Barrow (Atqasuk), Nuiqsut, and Kaktovik 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.

As explained in the proposed action, because hunting seasons for bowhead whales are short and ice-condition dependent, bowhead whale harvests are more likely to be affected by noise and traffic disturbance than are other forms of marine-mammal hunting (other than belukha whaling). It is likely that disturbance to the bowhead whale harvest could occur. Such activities already may have affected subsistence hunting. Kaktovik whalers, for example, contended that their 1985 fall whaling season was adversely affected by the open-water operation of vessels related to oil-development activities. Because of the greater intensity of activity in the cumulative case, vessel and helicopter traffic is more likely to affect bowhead whaling than in the base case. Cumulative-case effects could disrupt the bowhead whale harvest; but bowheads would not become unavailable, undesirable for use, or greatly reduced in numbers.

Seismic-survey activity would increase substantially in the cumulative case. However, even with this increase, seismic testing is not expected to greatly alter or disrupt regional biological populations of species used for subsistence purposes. Regional effects from noise and disturbance on subsistence-harvest patterns would render one or more important subsistence resources unavailable, undesirable for use, or available only in greatly reduced in numbers for a period not exceeding 1 year.

c. Facility Sitings: Pipelines and their associated roadways may affect caribou harvests over the long term. It is likely that the biological effects from onshore sites on herd size, composition, productivity, or distribution would be concentrated in particular areas and in particular herds. The easternmost landfall in Sale 144 near Bullen Point would be located in an area intensively harvested by Kaktovik hunters. Arctic cisco may comprise >50 percent of all fishes harvested at Kaktovik, Nuiqsut, and Barrow. Anadromous fish play a central role in the subsistence system and, of the primary subsistence species harvested, are the most reliable and the least subject to large and unpredictable fluctuations in availability from year to year. Causeways have been constructed as a result of North Slope oil development, and others are proposed. According to the biological analysis, these causeways have affected the distribution and migration of some anadromous species on the North Slope, but a relationship between causeway construction and siting and anadromous fish populations has not been demonstrated. Pipelines and facilities constructed on State prospects in the Colville River delta where major subsistence-fishing activity occurs would have a more direct effect on anadromous and freshwater fish populations by disrupting overwintering habitats and killing small portions of several generations.

Conclusion: In the cumulative case, the effects on subsistence-harvest patterns are expected to cause one or more important subsistence resources to become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1 to 2 years in Barrow, Atqasuk, Nuiqsut, and Kaktovik and also within the region. The contribution of the proposal to the cumulative effects would be effects to subsistence resources that would render them unavailable, undesirable for use, or reduced in available numbers for a period not exceeding 1 year.

11. Archaeological Resources: In addition to the base case of the proposal, other activities associated with the cumulative case that may affect archaeological resources in the Beaufort Sea include State oil and gas lease sales; State oil and gas fields, oil and gas transportation, and noncrude carriers. Cumulative effects of these proposed projects would likely result in an increased amount of bottom-disturbing activity. Since remote-sensing surveys are conducted prior to approving lease actions under the proposed action, the effect of the base case of the proposal on archaeological resources is expected to be low. In-place State and Federal laws would preclude effects to most archaeological resources resulting from planned activities included in the cumulative analysis.

As in the base-case analysis, discussed in Section IV.B.11, the greatest effects to onshore archaeological sites would be from accidental oil spills. The most important understanding obtained from past large-oil-spill cleanups is that archaeological resources generally were not directly affected by the spilled oil (Bittner, 1993). Following the EVOS spill, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. This type of damage increases as the population and activities increase during the cleanup process. Direct physical disturbance of archaeological sites during cleanup work also was identified as an effect-causing factor. However, the effects of the EVOS cleanup were slight because the work plan for cleanup was constantly reviewed, and cleanup techniques were changed as needed to protect archaeological and cultural resources (Bittner, 1993). Various mitigating measures used to protect archaeological sites during oil-spill cleanup are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifact collection, and cultural resource-awareness programs (Haggarty et al., 1991).

Two studies of the numbers of archaeological sites damaged by the EVOS came to similar findings. In the first study by Mobley et al. (1990), of 1,000 archaeological sites in the area affected by the EVOS (AHRF, 1993), about 24 sites, or <3 percent, were damaged. In the second study by Wooley and Haggarty (1993), of 609 sites studied, 14 sites, or 2 to 3 percent of the total, suffered major impacts.

However, in determining the effect of damage to archaeological sites, it is not necessarily the numbers of sites that are disturbed that is important but the significance of the site that is affected. Because there has not been a complete and systematic inventory and evaluation of the archaeological resources in the coastal region of the sale area, the potential for significant effects, should an oil spill occur, cannot be determined. However, it should be noted that during the emergency situation created by the EVOS, the Advisory Council on Historic Preservation declared that all archaeological sites were to be treated as if they were significant and eligible for the National Register of Historic Places (Mobley, 1990).

The greatest cumulative effect on archaeological resources in the Beaufort Sea Planning Area is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. It is estimated that the effects of natural processes have been so severe in the past that no prehistoric archaeological resources would have survived on the continental shelf of the Beaufort Sea. Natural processes also have the most destructive cumulative effect on historic resources, especially shipwrecks, on the continental shelf. Because the destructive effects of natural processes are cumulative in nature, they have had and will continue to have a high level of effect on archaeological resources in the planning area. Of course, the effects from natural processes cannot be mitigated. (Stright, 1995).

Conclusion: Cumulative effects on archaeological sites are expected to be similar to those of the base case. The analysis completed for the base case indicates that there should be no preserved prehistoric archaeological sites within the sale area; therefore, there would be no effects on submerged prehistoric sites. The expected effect on historic shipwrecks remains low. In the event that an increased amount of bottom-disturbing activity takes place, in-place State and Federal laws and regulations should mitigate effects to archaeological resources. The expected effect on onshore archaeological resources from an oil spill is uncertain, but data from the EVOS indicate that <3 percent of the resources within a spill area would be significantly affected.

12. Air Quality:

12. ***Air Quality:*** Air-quality regulations and procedures are discussed in Section IV.B.12 (base case). That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved Offshore and Coastal Dispersion (OCD) model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. In all likelihood, effects on the adjacent Class II PSD areas would be lower than those calculated by the model.

For purposes of this analysis, the cumulative case includes the activities as described for the base case. Other factors potentially affecting air quality would be existing and projected onshore and nearshore oil and gas operations. All other oil and gas operations are well beyond the area of potential cumulative effect from this proposal. Vessel traffic also would not contribute to the air-quality effects assessed for the base case (Sec. IV.B.12). Under these assumptions, peak-year emissions from exploration would be from drilling 2 exploration wells and 4 delineation wells from 1 rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 54 production wells from 11 rigs. Peak-year production emissions would result from operations (producing 101 MMbbl of oil) and transportation. Table IV.B.12-1 lists estimated uncontrolled-pollutant emissions for the peak exploration, development, and production years. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Under Federal and State of Alaska PSD regulations, a PSD review would be required because the estimated annual uncontrolled NO_2 emissions for the peak development year would exceed 250 tons/year. The lessee would be required to control pollutant emissions through application of BACT to emissions sources. Table IV.B.12-2 shows the modeled estimated emissions with applicable regulatory limitations. The OCD model air-quality analysis performed for air pollutants emitted for exploration, development, and production under the base case showed that maximum NO_2 concentration, averaged over a year, would be 1.45, 0.81, and 0.22 $\mu g/m^3$, respectively, of the available Class II increment for NO_2. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) The existing air quality would be maintained by a large margin.

Other Effects on Air Quality: For a more detailed discussion of the potential effects of air pollution—other than those effects addressed by standards—see Section IV.B.1.

Conclusion: The effects associated with the cumulative case essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Effects on onshore air quality from cumulative-case emissions are expected to be 6 percent of the maximum allowable PSD Class II increments. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration, development, and production activities or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

13. Land Use Plans and Coastal Management Programs:

a. ***Land Use Plans:*** The oil-development projects that constitute the bases of the effects assessment contained in this section are described in Section IV.A.6. Many of the projects included in the cumulative case could occur on Federal lands, including the OCS, as well as lands covered by the NSB Land Management Regulations (LMR's). Because the LMR's areawide policies are the same as those developed by the NSB for the NSB CMP, the areawide policies of the LMR's are incorporated into the section on coastal management. Policies reviewed in this section are those related to offshore development in the portion of the Beaufort Sea within the NSB boundary and to development in transportation corridors.

Drilling in State waters is included in the cumulative case. As a result, the Offshore Development policies of the LMR's would have greater applicability. Drilling in State waters would be allowed only from bottom-founded structures (NSBMC 19.70.040.A). Drilling above threshold depth may occur year-round; drilling below threshold depth can be done only during winter (November 1 through April 15) and must be completed as early as practicable (NSBMC 19.70.040.B and C). Some types of drilling can continue until June 15 (NSBMC 19.70.040.D). Boat, barge, and air traffic associated with drilling is limited during the whale migration to only that which is essential. Essential traffic must be coordinated with the Alaska Eskimo Whaling Commission and is restricted to avoid disrupting the whale migration and subsistence activities (NSBMC 19.70.040.E). Once a proposed development has followed the steps necessary to be rezoned to the Resource Development District, drilling can occur year-round (NSBMC 19.70.040.F). These policies reflect the current State seasonal drilling restriction; therefore, no conflict is anticipated with these policies.

From the outset, effects on the Porcupine caribou herd could lead to a stringent interpretation of the Transportation Corridor policies. This could occur because this herd is subject to effects of developments that are outside the jurisdiction of the NSB LMR's, and negative effects on the herd could reach higher levels in spite of the land management policies. However, significant conflict with the Transportation Corridor policies is not anticipated.

b. Coastal Zone Management: Cumulative effects may lead to changes in the level of effects or may involve policies that were not relevant to the base case. These differences are the focus of this analysis.

(1) Energy Facilities (6 AAC 80.070) and Transportation and Utilities (6 AAC 80.080): The effects of pipeline-landfall sites, pipelines, and roads are magnified in the cumulative case. If an extensive network of pipelines and associated roads were to bisect important calving areas, effects would be greater, thereby increasing the potential for conflict with 6 AAC 80.070(b)(1)(2) and (13) and NSB CMP 2.4.5.1(g) (NSBMC 19.70.050.J.7).

(2) Subsistence (6 AAC 80.120): In the base case, effects on subsistence in Nuiqsut are estimated to be high because of potential conflict between the whalers and those conducting development activities related to this sale. The duration of possible interference with subsistence activities and potential loss of access and resources would accentuate potential conflicts with the Statewide standard that guarantees opportunities for subsistence use of coastal areas and resources and the NSB CMP policies that are addressed in Section IV.B.13.6. The duration of the potential user conflicts may cause subsequent develop- ments to fall into a more restrictive policy category. Rather than considering subsistence access reduced or restricted (NSB CMP 2.4.5.1[b]) (NSBMC 19.70.050.J.2), it may be considered precluded and be subject to NSB CMP 2.4.3(d) (NSBMC 19.70.050.D) instead. It is possible that some subsistence resources (bowhead whales for up to 1 year and birds for 2-5 years) could be depleted below the subsistence needs of local residents (NSB CMP 2.4.3[a] and NSBMC 19.70.050.A).

(3) Habitats (6 AAC 80.130): All habitats noted as at risk for the proposed action are more likely to be adversely affected in the cumulative case. This could lead to conflict with the ACMP Statewide standard and the NSB CMP habitat policies identified in Section IV.B.13.7.

One policy that likely will be implemented with greater scrutiny in all habitats is the policy that curtails vehicles, vessels, and aircraft activity when and where it may affect concentrations of sensitive populations (NSB CMP 2.4.4[a] and NSBMC 19.70.050.I.1). Potential effects resulting from noise and disturbance on birds, mammals, and caribou all increase in the cumulative case.

In the offshore habitat, increased effects relate to the increased number of oil spills and the construction of additional causeways. The NSB CMP policy 2.4.4(i) (NSBMC 19.70.050.I.9), identified previously under transportation, deals with causeway installation and also will receive greater attention with respect to the offshore habitat.

Development of State leases included in the cumulative case increases the likelihood that barrier islands and lagoons would be affected. Disruptive activities and requests for altering shores are probable because this habitat is within the area leased by the State for oil and gas exploration and development.

To some extent, the base case depicts development from Sale 144 as an add-on to the extensive development that precedes it. However, in the cumulative case, all development is included. As a result, this analysis must look at all the tundra wetlands that would be subject to infilling. Adverse effects on tundra and wetland nesting, feeding, and staging areas, particularly in the Teshekpuk Lake waterfowl-concentration area, the NPR-A oil exploration and development area, and the Mackenzie River Delta oil development in Canada, are likely to represent a greater loss of tundra habitat on the North Slope for several species and may have a long-term, local effect on the nesting distribution and density of some species for more than one generation (or over the life of the oil fields).

Pipeline and road crossings and gravel extraction would increase in riverine areas that are used extensively by anadromous fishes. Although this could lead to greater conflict with the riverine-habitat policy, development probably would be modified if conflict with this policy became evident.

(4) Air, Land, and Water Quality (6 AAC 80.140): Greater adverse effects for water quality relate to problems associated with the cumulative effects of causeways resulting in chronic degradation of water quality on a regional basis over the lives of the fields. This would create a conflict with the ACMP Statewide standard and district policies only if it were not consistent with Federal or State water-quality standards.

Air quality in the cumulative case could exceed air-quality standards if development were clustered. Local, long-term effects on vegetation could occur as a result of the deposition of sulfurous pollutants and the acidification of the tundra vegetation. If this occurred, conflict with NSB CMP policies also would occur. The NSB CMP 2.4.3(h) (NSBMC 19.70.050.H) also requires that development comply with Federal and State air-quality standards. The NSB CMP 2.4.4(c) (NSBMC 19.70.050.I.3) identified airborne emissions specifically as needing to meet the standards. Acidification of tundra vegetation is not covered under air-quality standards but would be covered under several elements, either in the facility-siting standard or the wetland-habitat standard.

(5) Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): No prehistoric archaeological sites have been identified within the Sale 144 area. However, opportunities for culturally important areas to be violated may be increased.

Summary: Policies that are most likely to conflict with development assumed for the cumulative case include those for energy-facility siting, transportation and utilities, habitat, and subsistence. Many of the conflicts would pertain to the siting and construction of pipelines, the associated roads and shore-access structures, and the noise and disturbance that would accompany these developments. Such extensive construction projects could infringe on cultural sites, thereby causing a conflict with the policies protecting culturally important areas (NSB CMP 2.4.3(e), 2.4.3(g), 2.4.3(f), and 2.4.5.2(h) and NSBMC 19.70.050.E, 19.70.050.G, 19.70.050.F, and 19.70.050.K.8). Effects of oil spills could create a conflict with several habitat policies and the water-quality standard. However, these conflicts could only be determined with hindsight.

Conclusion: For the cumulative case, there is a potential for conflict with four policies of land use plans and coastal management programs: energy-facility siting, transportation and utilities, habitat, and subsistence.

I. UNAVOIDABLE ADVERSE EFFECTS ON:

1. Water Quality: The only unavoidable adverse effects on water quality anticipated from the proposed action are expected to 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. Although an obvious impairment of the pristine water quality of the study area, spillage is judged an insignificant, long-term, low local effect for water quality.

2. Lower Trophic-Level Organisms: Unavoidable adverse effects on lower trophic-level organisms are expected due to drilling discharges, dredging and construction, and oil spills. Drilling discharges are expected to affect < 1 percent of the benthic organisms in the sale area. Recovery of benthic organisms is expected to occur within 1 year. Less than 1 percent of the immobile benthic organisms in the sale area would be affected by platform and pipeline construction. Recovery is expected within 1 year after the drilling ceases. Each of the assumed 7,000-bbl oil spills is estimated to have lethal and sublethal effects on up to 2 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. Each of the assumed base-case oil spills also is estimated to have lethal and sublethal effects on up to 2 percent of the marine invertebrate larva nearest the surface. Recovery is expected to take < 1 month.

3. Fishes: Unavoidable adverse effects are expected to result from accidental oil spills. The unavoidable effects of such spills are described in Section IV.J.3 of the FEIS for Lease Sale 124; this section incorporates that information by reference. The conclusion was that unavoidable adverse effects were expected to be low for fishes. The nature and magnitude of the risks are similar for Sale 144, i.e., the unavoidable adverse effects would, at worst, be lethal to a few thousand fishes, which would decrease population levels for <7 years.

4. 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 proposed recommendations on air and boat traffic in the proposed Information to Lessees on Bird and Marine Mammal Protection (see Sec. II.E.2.b).

The oil-spill-trajectory analysis indicates that the coastal habitats near Elson and Simpson Lagoons are at some risk from oil spills that may be associated with the proposed action. However, oil-spill-cleanup efforts could provide for protection of these lagoons by possibly diverting an oil spill away from the lagoon entrances and away from saltmarshes.

If a large spill occurred within the unconsolidated pack ice of the Beaufort 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 the loss of several thousand birds, with recovery likely to occur within about one generation (2-3 years).

5. Pinnipeds, Polar Bears, and Belukha Whales: In this discussion, most oil spills are considered unavoidable, while most human disturbance of nonendangered marine mammals is considered avoidable through voluntary compliance with the proposed recommendations on air and boat traffic in the proposed Information to Lessees on Bird and Marine Mammal Protection (see Sec. II.E.2.b).

The oil-spill-trajectory analysis indicates that the lead system and ice-flaw-zone habitat from Point Barrow to Camden Bay is at risk from oil spills that could be associated with the proposed action. However, oil-spill-cleanup efforts could provide for some reduction in spill contact to marine mammals.

If a large spill occurred within the unconsolidated pack ice of the Beaufort Sea, it would be very difficult to contain and clean up with present oil-spill-cleanup technology. Such an oil spill is expected to result in the loss of small numbers of seals, walruses, and polar bears, with recovery likely to occur within one generation (about 3-5 years).

6. Endangered and Threatened Species: Most effects of noise and disturbance are considered avoidable through voluntary compliance with appropriate stipulations and ITL's. In the event of production, the probability of an oil spill occurring and contacting certain areas indicates that the bowhead whale migration route may be subject to at least localized risk. Unmitigated, uncontrolled noise and other forms of disturbance associated with the proposed action (i.e., noise due to vessel activity, aircraft overflight, 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. A number of mitigating measures are available to reduce possible adverse effects. However, some unavoidable adverse effects are expected to occur. Overall, bowhead whales exposed to noise-producing activities and oil spills would most likely experience temporary, nonlethal effects; but exposure to oil spills could result in lethal effects to a few individuals.

7. Caribou: Most sale-related land-vehicle disturbance of caribou and caribou-habitat alterations probably are unavoidable. These displacement or reduced habitat-use effects are likely to be local (within 1-2 km of the road-pipeline corridor) and long-term (> 1 generation) and perhaps persist over the life of the field.

8. Economy of the North Slope Borough: Increased population, minor gains in revenues and employment, and potential oil spills could cause disruptions to subsistence harvests and, in turn, village economies in both the short and long terms.

9. Sociocultural Systems: Federal, NSB, and community-supported social programs with adequate funding would mitigate many of the sociocultural consequences of Sale 144. One area of unavoidable adverse effects involves the potential repercussions to the sharing of subsistence resources. Unavoidable effects expected as a result of effects on subsistence harvests, primarily from oil spills, would cause chronic disruption of sociocultural systems for a period of 1 to 2 years without a tendency toward the displacement of existing institutions.

10. Subsistence-Harvest Patterns: Oil-spill incidents that are unavoidable could lead to the localized, direct losses of small numbers of belukha whales, seals, walruses, polar bears, fishes, birds, and caribou; however, none of these losses, except for the bowhead whale harvest, could lead to elimination of any subsistence harvest. Only oil-spill effects on bowhead and belukha whales and walruses would lead to a reduction of total annual harvests. Effects on bowhead whale harvests due to noise and traffic disturbance and construction activities are expected to be avoidable if mitigated, thus decreasing the overall level of effects from noise and traffic disturbance.

11. Archaeological Resources: Unavoidable adverse effects on archaeological resources could occur in the event of an oil spill or from bottom-disturbing activity to previously undiscovered prehistoric or historic resources. Possible vandalism due to increased activity or to cleanup crews that would be present in the event of an oil spill also are unavoidable. Archaeological resources are nonrenewable.

12. Air Quality: An increase in emissions of air pollutants would occur as a result of the proposed action. In all the alternatives and the cumulative case, the additional emissions are not expected to be significant. In the event that any emissions are significant, they may be reduced by existing methods as necessary. For the proposed action, air-quality-standards limitations would not be approached.

13. Land Use Plans and Coastal Management Programs: The scenario for Sale 144 assumes transportation networks between sites on the Beaufort Sea coast will tie into existing infrastructure. As a result, unavoidable adverse effects related to major changes in land use are not anticipated, nor are they expected as a result of disturbance; disturbance typically is considered an unavoidable effect. Unavoidable adverse effects that are related to Sale 144 usually would be caused by an oil spill. To the extent that facilities are sited to minimize the effect of an oil spill on the environment, conflicts with the Statewide standards and the NSB policies of the ACMP are avoidable; therefore, it is expected that activities generally will conform with existing land use and with policies of local, State, and Federal coastal management programs and land use plans.

J. 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 in and adjacent to the Beaufort Sea Sale 144 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 and gas development and ending when natural environmental balances might be restored.

In general, "short term" refers to the useful lifetime of the proposed action as determined by the base case for Alternative I; some even shorter term uses and effects also are considered. "Long term" refers to that time beyond the estimated lifetime of the proposed action. The producing life of the field development in the Sale 144 area has been estimated to be about 25 years; this estimate is based on the base-case-resource estimate for Alternative I. In other words, short term refers to the total duration of oil and gas exploration and production, whereas long term refers to an indefinite period beyond the termination of oil and gas production.

Many of the effects discussed in Section IV are considered to be short term (being greatest during the construction, exploration, and early production phases) and could be further reduced by the mitigating measures discussed in Section II.D.

Water pollution from onshore activities is a long-term but local effect. The analysis of water-quality effects of the proposed action indicates that although the pristine water quality of the study area may be impaired, spillage is judged an insignificant, long-term, low, local effect for water quality (see Sec.IV.B.1). This level of effect may be considered an appropriate compromise for obtaining oil and gas resources.

Oil-spill pollution and habitat alteration caused by noise disturbance and construction activities would have potential short-term effects on the biological populations and their habitats and might have long-term effects. Effects would vary with the type and magnitude of the various activities.

Short-term, localized, adverse effects on biological populations and habitats are expected if, in the unlikely event, an oil spill occurred in either the marine or terrestrial environments. These potential effects include mortality of individuals, physiological stresses in surviving individuals, reduction in the number of species or species populations in the affected area, changes in the distribution of species or individuals, and changes in behavior or migration patterns. Long-term, cumulative, oil-pollution effects also might occur if recovery from the short-term effects extended beyond the estimated useful life of the proposed action. Some species might have difficulty repopulating physically altered habitats and could be permanently displaced.

The potential effects of marine- and terrestrial-habitat alteration may include the same general types of short-term, localized effects that the biota would experience as a result of an oil spill: mortality, stress, population or species decreases or redistribution, and changes in survival patterns. Long-term effects also might occur if recovery from the short-term effects extended beyond the estimated useful life of the proposed action. Also, long-term biological productivity could be lost from those areas that have been assumed as facility sites in support activities of the proposed action.

The redistribution or reduction of species populations in the short term could affect regional subsistence-harvest patterns. Such short-term effects on subsistence-harvest patterns from the proposed action would not be expected to have long-term consequences, except as a source of social disruptions, or unless chronically imposed on the resource base of the region. Habitat destruction also might cause a local reduction in subsistence species, which could threaten the regional economy.

Increased population and industrial activity, minor gains in revenues, and the consequences of potential oil spills that might occur as a result of the proposed action all contain the potential for disrupting Native communities in the short term. In addition, changes brought about by the lease sale could be a participating factor in long-term consequences for Native social and cultural systems.

Improved accessibility to remote areas from increased construction is a short-term and possible long-term consequence of the proposed action if development occurred. However, the overall wilderness value of developed areas is expected to decrease from increased land use. Archaeological and historic finds discovered during compliance prior to development would enhance long-term knowledge. Overall, such finds could help fill the gaps in our knowledge of early inhabitants of the area; but any destruction of archaeological sites or unauthorized removal of artifacts would represent long-term losses.

Land use changes would occur at shore-base sites and along pipeline routes. In potentially affected areas, short-term changes include a shift in land use from subsistence-based activities to industrial activities throughout the life of the proposed action. Land use changes could be short term in nature if, after production ceased, use of the land reverted to previous uses. Long-term effects on land use could result if use of the infrastructure or facilities continued after the estimated useful life of the proposed action. Potential users could be other resource developers or residents or nonresidents who had become accustomed to the convenience of using existing facilities, such as roads.

The production of oil and gas from the Beaufort Sea Planning 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. Economic, political, and social benefits would accrue from the availability of oil and gas. Most benefits would be short term and would decrease the Nation's dependency on oil imports. Regional planning would aid in controlling changing economics and populations and, thus, in moderating any adverse effects. If additional supplies were discovered and developed, the proposed production system would enhance extraction. However, consumption of this offshore oil and gas would be a long-term use of nonrenewable resources.

After completion of oil production, oil spills and their effects would not occur and the marine environment generally would be expected to remain at or return to its normal long-term productivity level. To date, there has been no discernible decrease in long-term productivity in OCS areas where oil and gas have been produced for many years. In areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years—prior to the beginning of North Sea oil production. However, in the Prince William Sound, 6 years after the *Exxon Valdez* oil spill (EVOS), species affected by the spill appear to be well on their way to recovery. In the long term, the species affected by the EVOS may make a full recovery. But, until more reliable data become available, the long-term effects of chronic and major spillage of hydrocarbons and other related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists if chronic spills or a major oil spill occurred as a result of the proposed action.

K. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES:

The undiscovered, economically recoverable resources assumed to be leased in the base case amount to 1.2 Bbbl of oil. Should these resources be discovered, they would be irretrievably consumed. A discussion of assumed effects follows:

1. Water Quality: Water quality would be affected by drilling discharges, dredging and construction, and oil spills associated with this proposal, but only over the life of proposal activities. There would be no irreversible or irretrievable effects on water quality.

2. Lower Trophic-Level Organisms: Lower trophic-level organisms in the Beaufort Sea area would be exposed to drilling discharges, dredging and construction, and oil spills associated with this proposal. A small percentage of these organisms are likely to be affected by these agents; however, they are not expected to experience any irreversible and irretrievable effects associated with this proposal.

3. Fishes: Offshore oil and gas development in the Beaufort Sea region would alter limited areas of benthic habitat for the foreseeable future, which probably would displace some finfish species while proving attractive to others, e.g., offshore structures provide a more diversified habitat. The distribution of finfishes would not be affected on a large scale.

4. Marine and Coastal Birds: For the proposed action, it is possible that marine and coastal birds could be subjected to direct and indirect effects of oil spills, disturbance due to noise and movement of aircraft and vessels and other human activities, or losses and/or deterioration of habitat due to facility developments. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources (see Sec. IV.B.4, Effects on Marine and Coastal Birds).

5. Pinnipeds, Polar Bears, and Belukha Whales: For the proposed action, it is possible that seals, walruses, polar bears, and belukha whales could be subjected to direct and indirect effects of oil spills, disturbance due to noise and movement of aircraft and vessels and other human activities, or losses and/or deterioration of habitat due to facility developments. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources (see Sec. IV.B.5, Effects on Pinnipeds, Polar Bears, and Belukha Whales).

6. Endangered and Threatened Species: For the proposed action, it is possible that threatened or endangered whales or birds could be subjected to direct and indirect effects of oil spills, disturbance due to noise and other human activities, or losses and/or deterioration of habitat due to facility developments. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources for most species, but loss of an insignificant proportion of spectacled eider nesting habitat through onshore facility development is viewed as irretrievable, and any substantial mortality is considered irreversible if population status is declining as at present (see Sec. IV.B.6, Effects on Endangered and Threatened Species).

7. Caribou: For the proposed action, it is possible that caribou could be subjected to direct and indirect effects of oil spills, disturbance due to noise and movement of aircraft and motor vehicles and other human activities, or losses and/or deterioration of habitat due to facility developments. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources (see Sec. IV.B.7, Effects on Caribou).

8. Economy of the North Slope Borough: The commitment of economic resources, namely human resources, would be irreversible and irretrievable. That is, the routine activity would generate resident employment in the NSB. Activity associated with accidental oil spills ≤1,000 bbl would have no effect on employment levels; however, large oil spills would generate up to 1,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill.

9. Sociocultural Systems and Subsistence-Harvest Patterns: 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 pollution permanently disrupt the harvesting of bowhead whales, there would be an irreversible and irretrievable loss to Inupiat social and cultural values. 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 they are of equal importance 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 144 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.

10. Archaeological Resources: An irretrievable commitment of archaeological resources could occur in the event of an oil spill or from bottom-disturbing activity to a previously undiscovered prehistoric or historic resource. Possible vandalism due to increased activity or to cleanup crews that would be present in the event of an oil spill also are irreversible. Archaeological resources are nonrenewable.

11. Air Quality: For the proposed action, it is probable that air quality in the area could be affected during operations. It is unlikely that these effects would lead to an irreversible impact on the air quality of the area.

L. EFFECTS OF NATURAL GAS DEVELOPMENT AND PRODUCTION ON:

Introduction: Natural gas may be discovered in the Sale 144 area during exploration drilling. Although gas resources are not considered economic to exploit at this time or in the foreseeable future (see Appendix A), they could be developed and produced at some undetermined future time. Under such circumstances, natural gas production probably would not occur until after oil production had begun. Thus, leases containing nonassociated natural gas that could be recoverable in the future probably would be retained by the leaseholder. (Associated and dissolved gases that are recovered along with the crude oil are expected to be reinjected or used as fuel, depending on the amount recovered.) The effects of potential gas development and production on the environment of the Sale 144 and adjacent areas that would be additional to the effects associated with oil development and production are described in this section.

Additional facilities and infrastructure would be needed if and when the nonassociated natural gas is developed and produced. The gas could be produced through wells drilled from gas-production platforms.

A large-diameter pipeline would be installed to transport the produced gas from the production platform(s) to an onshore gas-processing facility located in the Prudhoe Bay area; the gas pipeline would be separated from any oil pipelines to the extent necessary to minimize the risks that would arise during installation and operation; however, the main trunk gas pipeline would be constructed parallel to the trunk oil pipeline. No offshore booster-pump stations would be required between the platforms and the gas facility.

After processing, the gas would be piped to Valdez for liquefaction. The required gas pipeline would parallel the TAPS. The liquefied gas would be shipped to market, most likely in Asia. However, should a regassification plant be constructed on the U.S. West Coast, a market could also develop there.

Effects of natural gas development and production on the biological resources, social systems, and physical regimes of the Sale 144 and adjacent areas could be caused by gas blowouts; installing offshore pipelines and gas-production systems; drilling gas-production wells; installing onshore pipelines and a gas-processing facility; marine-, surface-, and air-traffic noise and disturbance; construction activities; and growth in the local economy, population, and employment.

Accidental emissions of natural gas could result from a gas-well blowout or a pipeline rupture. In the unlikely case that such an event occurred, a gas-well blowout probably would not persist for >1 day and would release perhaps 20 metric tons of gaseous hydrocarbons; 60 percent of all blowouts since 1974 have lasted ≤ 1 day. From such a blowout, a hazardous plume of gas could extend downwind for about a kilometer but quickly would dissipate once the blowout ceased. The amount of VOC released by such a blowout would be less than that evaporated from an oil spill $\geq 1{,}000$ bbl.

The rupture of a gas pipeline would result in a short-term release of gas. A sudden decrease in gas pressure automatically would initiate procedures to close those valves that would isolate the ruptured section of the pipeline and thus prevent a further escape of gas.

1. Water Quality: The risk to water quality from gas blowouts during natural gas development and production would be less than the risk from oil spills due to oil development and production. The effects of gas-pipeline trenching on water quality would be the same as for oil pipelines. Because of gas-production-well drilling, additional drill cuttings and drilling muds would be discharged; some of the drilling muds would be recycled between oil and gas wells on the same platform. Production of an associated gas cap above an oil zone would result in no additional discharge of formation waters or causeway construction beyond that anticipated for oil development. Chronic criteria for water quality may be locally exceeded over the life of the fields.

Conclusion: Chronic criteria for water quality may be locally exceeded over the life of the fields.

2. *Lower Trophic-Level Organisms and Fishes:* If a natural gas blowout occurred, some marine invertebrates and fishes in the immediate vicinity might be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but it is not expected to be hazardous for > 1 km downwind or for > 1 day. Activities associated with laying a gas pipeline would have localized effects on marine organisms. For benthic fishes and mobile lower trophic-level organisms, such as adult crabs, virtually no adverse effects are expected; however, longer-term but extremely localized effects over a small area are possible for immobile benthic organisms, such as clams. As discussed for the low-case scenario (Sec. IV.E), disturbance of the benthos during drilling and pipeline laying probably would displace fish a short distance, but they would reutilize their habitat upon completion of activities. In some instances, the alteration of the benthos by pipeline laying could enhance habitat for some lower trophic-level organisms. The projected seismic operations probably would injure a few fish, those with air bladders, for one generation in localized areas.

Conclusion: Natural gas exploration and/or development in the Beaufort Sea are expected to have little to no effect on lower trophic-level organisms. The effect on fishes would be similar to the low case: projected seismic operations would injure a few fish, those with air bladders, for one generation in localized areas.

3. *Marine and Coastal Birds:* The most likely effects associated with natural gas development and production on marine and coastal birds 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 (short-term, < 1 generation). If there were a natural gas blowout with explosion and fire, birds in the immediate vicinity would be killed, which might include several hundred birds. 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 those very near the source of the blowout.

Conclusion: The additional short-term and local effects of noise and disturbance and blowouts indicate that the level of effects on marine and coastal birds resulting from natural gas development and production is expected to be short-term (< 1 generation).

4. *Pinnipeds, Polar Bears, and Belukha Whales:* The most likely effect of natural gas development and production on pinnipeds, polar bears, and belukha whales would come from air traffic to and from the production platforms and the support facility (probably at Deadhorse) 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 (a short-term effect).

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 (1-3 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 (within about 1.6 km [1 mi] of the activity).

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 (the loss of probably < 100 animals with such losses replaced within 1 year). 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 gravel island.

Conclusion: The effects of natural gas development on pinnipeds, polar bears, and beluga whales are likely to be short-term (≤1 year) and local (within about 1.6 km [1 mi] of blowouts, noise and disturbance, and platform- and pipeline-installation activities).

5. Endangered and Threatened Species: Should natural gas development and production occur, effects described for oil exploration and development and production in the base case (Sec. IV.B.6) could occur. In addition, trenching for the gas pipeline could disturb migrating bowhead whales, which may avoid approaching within a few kilometers of the vessels involved in trenching or pipelaying operations. The fall bowhead migration might be affected to a minimal degree by these activities.

If a natural gas blowout occurred, with possible explosion and fire, bowhead whales in the immediate vicinity may 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 likely that only whales present in the immediate vicinity of the blowout would be affected; however, it is not expected that bowhead whales would often be found near a drilling vessel or a platform, where a natural gas blowout is most likely to occur.

For 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 drilling vessel or 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 and was 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, gas pockets could be more prevalent under landfast ice than under moving ice, through which bowheads would be expected to migrate. Overall, exposure of bowhead whales to noise-producing activities and blowouts from natural gas development and production operations are not expected to result in lethal effects, but some individuals could experience temporary, sublethal effects.

Any effects of natural gas development and production are expected to be limited to potential disturbance of a few migrating arctic peregrine falcons for a single season during construction of the gas pipeline. However, effects on the falcon population would likely be minimal because it is expected that any gas pipelines would be buried and would parallel oil pipelines to take advantage of existing roads. Likewise, onshore effects of natural gas development on spectacled and Steller's eiders are expected to be minimal. However, a natural gas blowout occurring from June to September could affect staging or migrating eiders; although mortality resulting from such an incident is expected to be <100 individuals, recovery is not expected to occur if population status remains similar to that at present unless losses are ≤25 individuals.

Conclusion: Exposure of bowhead whales to noise-producing activities and blowouts from natural gas development and production operations is not expected to result in lethal effects, but some individuals could experience temporary, sublethal effects. The effects of activities on peregrine falcons, spectacled eiders, and Steller's eiders are expected to be minimal. Mortality resulting from a gas blowout near eider staging habitat is expected to be <100 individuals, from which the populations may not recover if population status is declining as at present.

6. 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 systems that connects the production platforms with the onshore-processing facility. Onshore, the gas pipelines would run parallel to the oil pipelines 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.

Conclusion: The level of effects on caribou resulting from natural gas development and production is expected to be local (within 1-2 km [0.62-1.2 mi] of the pipeline-road corridor) but long term (> 1 generation) and to persist perhaps over the life of the field.

7. Effects on the Economy of the North Slope Borough: 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 declining production from the Prudhoe Bay area. The long-term downtrends in population and employment would not be reversed.

Conclusion: Natural gas exploration and development in the Beaufort Sea are expected to have little to no effect on the economy of the NSB.

8. 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 for Sale 144, there would be a slight increase in employment and population in the region adjacent to the Sale 144 area.

Conclusion: Local, short-term effects to sociocultural systems would be expected from noise-producing activities and blowouts from natural gas development and production operations, but such effects would not disrupt or displace existing institutions.

9. 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. If a natural gas blowout occurred, the subsistence harvest of any species in the vicinity could be affected. Additionally, if a natural gas blowout occurred, with possible explosion and fire, subsistence resources in the immediate vicinity probably would be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would be relatively short term and localized and would not be likely to measurably affect the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. Noise and disturbance activities due to the development of a gas field should not be appreciably different from those of the base case.

Conclusion: Local, short-term effects to subsistence resources would be expected from noise-producing activities and blowouts from natural gas development and production operations but would have no apparent effects on subsistence harvests.

10. Archaeological Resources: Prehistoric and historic archaeological resources could be affected by activities associated with the potential installation of gas-production platforms and a pipeline and any other bottom-disturbing activities. Disturbance also might occur as a result of onshore activity associated with accidents, such as a gas blowout or explosion. Any surface disturbance resulting from cleanup or emergency activities could affect archaeological sites.

Conclusion: There should be no effects on submerged prehistoric sites as a result of activities associated with natural gas development, because it is unlikely that there are preserved prehistoric sites within the sale area. The expected effect on historic shipwrecks should be low because of the requirement for review of geophysical data prior to any energy development activities.

11. Air Quality: Emmissions from gas production would be primarily in the form of NO_x due to increased power requirements for turbines for gas compression. The emissions from gas-producing platforms and storage and treatment facilities would be analogous to those discussed in Section IV.J.6 of the Norton Sound Sale 100 FEIS (USDOI, MMS, Alaska OCS Region, 1985). The emissions from any gas blowouts (principally VOC) would quickly evaporate, be burned, or be dissipated by winds with minimal effect on air quality USDOI, MMS. Alaska OCS Region, 1985).

Development drilling and platform and pipeline installation associated with natural gas resources would result in additional emissions of CO, SO_2, NO_x, and VOC. These emissions would be produced from the same sources producing emissions in oil-development and -production activities.
Accidental emissions result from gas blowouts. The number of OCS blowouts—almost entirely gas and/or water—averaged 3.3 per 1,000 wells drilled since 1956 (Fleury, 1983). The data show no statistical trend of a decreasing rate of occurrence. The blowout rate actually has averaged somewhat higher since 1974, at 4.3 per 1,000 wells drilled; but the difference between the post-1974 period and the longer 1956 to 1982 record is statistically insignificant.

Conclusion: A minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development and production activities or to accidental emissions would not be sufficient to harm vegetation.

12. ***Land Use Plans and Coastal Management Programs:*** Natural gas development and production are assumed to occur on leases in the same area and follow the same transportation routes as oil production resulting from Sale 144. No additional conflict is anticipated. The greatest disruptions would occur during construction of the gas pipeline; these effects would be comparable to those of the base case.

Conflicts with specific Statewide standards and NSB CMP policies related to potential user conflicts between offshore activities and the subsistence bowhead whale hunt, and the potential effects arising from the construction of three additional shore approaches for the pipelines is possible.

Conclusion: The level of conflict with existing land use plans and coastal management programs is the same for natural gas as it is in the base case.

M. EFFECTS OF A LOW-PROBABILITY, HIGH-EFFECTS, VERY LARGE OIL-SPILL EVENT:

Introduction: The potential effects of a catastrophic spill of 160,000 barrels (bbl) are analyzed on representative areas of sensitive resources in the Beaufort Sea region. A very large oil spill is a low-probability event but has the potential for very high effects on the environment. The size of the spill is 160,000 bbl, similar in size to the largest (160,638 bbl) of the 23 OCS-pipeline or -platform spills ≥1,000 bbl that have occurred since 1964 (Anderson and LaBelle, 1994).

The location of the spill is assumed to be in waters 20 to 30 m deep along Pipeline Segment P11 (Fig. IV.A.2-6). In the EIS scenario for the base case and the high case, this pipeline comes on shore at or in the vicinity of Point McIntyre. Based on the Sale 144 OSRA trajectories, the spill could be transported in either an easterly or westerly direction. Spill trajectories in the Beaufort Sea generally move parallel to shore but with some offshore divergence. Based on conditional probabilities, this location provides a relatively high risk to those environmental resources of concern in the vicinity of the site Figs. IV.A.2-2, -3, and -4.

Pipeline-Spill Scenario: During a November storm, an unusually deep keel of an old, multiyear-ice ridge crosses the 73,000-bbl-per-day trunk pipeline, damages a weld between two lengths, and causes a small leak of 635 bbl per day. Because the height of sails of older, multiyear ridges are eroded by surface melting and ablation, passage of this multiyear ridge through the area does not raise any suspicions; and the leak—equivalent to <0.9 percent of pipeline throughput—is not detected until July 22 the following summer, a week after breakup. The pipeline operator locates the leak, fills the pipeline with a diesel pill, shuts the line down, and makes temporary repairs pending replacement of the ice-damaged pipeline. A total of 160,000 bbl of Prudhoe Bay-like crude is lost over the 249 days of leakage.

Spill Behavior: During the winter, the spill would spread as a ribbon, approximately 100 m wide and 0.2 mm thick. This oil thickness would be insufficient for separate oil droplets or small pools to coalesce or flow into hollows underneath the ice (Sec. IV.A.3). The oil would freeze into the ice, essentially unweathered, in a matter of 5 to 10 days. Over the 249 days of leakage, the ribbon would increase in length at an average rate of 5 km per day, reaching a total length of 1,245 km. The ribbon, however, would not remain intact in the moving ice pack. The ice pack constantly deforms, and dispersion of individual ice floes in the winter is at least as great as for dispersion of surface oil in open waters.

The spill location is covered at times by both multiyear- and first-year-ice floes. In late spring and summer, the unweathered oil melts out of the ice at different rates depending on whether it is encapsulated in multiyear or first-year ice and on when the oil was frozen into the ice. In first-year ice, most of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period (see Buist, Pistruzak, and Dickins, 1981). The oil spilled in December would surface on the ice in mid-June, oil spilled in April would surface in late June, and oil spilled in May would surface in early July. About mid-July, the oil pools would drain into the water among the floes of the opening ice pack. Thus, in first-year ice, oil would be pooled on the ice surface for up to 30 days before being discharged from the ice surface to the water surface. The oil spilled earlier would surface on the ice at a much greater distance from the spill site. Oil spilled under multiyear ice would melt out more slowly over the entire (partially) open-water season, with about 10 percent of the oil not surfacing until a second summer.

For the spill scenario assumed here, the pools on the ice surface would concentrate the oil, but only to about 2 mm thick, allowing evaporation of 15 percent of the oil, the part of the oil comprised of the lighter, more toxic components of the crude (Table IV.M-1). By the time the oil is released from the melt pools on the ice surface, evaporation has almost ceased, with only an additional 4 percent of the spill evaporating during an additional 30 days on the water.

After 30 days into the open-water season, 48,000 bbl or 30 percent of the spill volume will be left on the sea surface as individual tarballs rather than as a discrete slick. The tarballs will have dispersed discontinuously over 6,600 km^2 (Table IV.M-2). Through 1,000 days, about 15 percent of the tarballs would sink (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980), with 16 percent of original slick volume persisting in the remaining tarballs. Because oil would drift over distances of thousands of square kilometers during the slow process of sinking, individual, sunken tarballs would be extremely widely dispersed in the sediments. The "average" levels of local or

Table IV.M-1
Mass Balance of Oil Through Time for a Hypothetical 160,000-bbl Spill of Prudhoe Bay-Like Crude Oil in the Beaufort Sea Planning Area[1]

Day[2]	Slick (bbl)	Evaporated (bbl)	Dispersed (bbl)	Sedimented (bbl)	Onshore (bbl)
0	136,000	23,000[3]		1,600	
3	112,000	24,000	13,000	1,600	9,900
10	78,000	26,000	34,000	1,700	21,000
30	47,000	29,000	53,000	1,800	30,000

Source: USDOI, MMS, Alaska OCS Region; based on ocean-ice weathering model of Kirstein, Payne, and Redding (1987).

1 Assuming oil pools on ice to 2 mm at 32 °F for 0 to 10 days, depending on when it was spilled, and melts out into 50-percent broken ice at 32 °F, with 11-knot winds.
2 Days after meltout of winter spilled oil (97% of total spillage) or summer spillage (3% of total spillage).
3 Evaporation on day 0 attributable to evaporation during oil pooling on the ice surface prior to oil release to the water (= meltout).

Table IV.M-2
Areas of Discontinuous and Thick Slicks from a Hypothetical Spill of 160,000 bbl in the Beaufort Sea Planning Area

	Discontinuous-Slick Area (km^2)	Area of Thick Slick (km^2)
Initial Spill Area	-	125
Area During Oil Pooling on Ice Surface	-	12
Days after Spill Reaches Water Surface[1]	-	-
3	4,100	5
10	4,700	8
30	6,600	12

Source: USDOI, MMS, Alaska OCS Region, 1995.

1 Calculated from Ford (1985) and Kirstein and Redding (1988).

regional contamination in sediments would be insignificant. Oil mixed into the shoreline and then dispersed offshore would locally elevate hydrocarbon levels in nearshore sediments.

How much oil reaches specific shorelines or other environmental resources is estimated from the conditional probabilities for a spill from Pipeline Segment P11. In Appendix B, the odd-numbered Tables B-3 through B-37 provide the winter and summer seasonal probabilities of contact for a spill originating along Pipeline Segment P11. Table IV.M-3 provides a summary of the probabilities from these tables that a spill would contact individual land segments or environmental resources within 3, 10, and 30 days of the early summer spillage or summer meltout of the spillage during the winter. A very important consideration is that this spill is both very large and of a very long duration. In such cases, the interpretation of conditional probabilities must change (see Sec. IV.A.1). The probabilities in Table IV.M-3 should be taken as representing what percentage of the spill contacts an individual land segment or environmental resource rather than how likely that contact is.

Seventeen percent of the spill, less evaporation and dispersion, would contact isolated stretches of coastline from about Point Brower (Land Segment [LS] 35) to Oliktok Point (LS 33) within 3 days of the open-water season. Within 30 days, 42 percent of the spill would be on the beaches from Cape Halkett (LS 27) to Griffin Point (LS 42), east of Barter Island.

Areas of the open water contacted by the spill are represented, in part, by the Ice/Sea Segments (Fig. IV.A.2-3). Ice/Sea Segments 7, 8, and 9 probably would be contacted within 3 days; Segment 8, directly seaward of the pipeline, probably would receive the largest amount of oil contacting Segments 7, 8 and 9. After 30 days, Ice/Sea Segments 6 through 13 also may be impacted by oil from the 160,000-bbl spill; these areas lie off the coast in an area from Harrison Bay to Mackenzie Bay, which lies east of the Sale 144 area.

Pipeline Segment P11 crosses through Subsistence Resource Area C, and this area most likely would be heavily impacted by the spill. Subsistence Resource Area D lies immediately east of the pipeline and also would be heavily impacted.

1. Effects on Water Quality: Following the spill, most of the more volatile compounds in the slick, particularly aromatic volatiles, will have evaporated while the oil is pooled on the ice surface. Over the first 10 days of a spill, only about 5 percent of a slick can be expected to dissolve. Larger quantities of the slick will disperse as stable, small droplets within the water column (Table IV.M-1). The average dispersed oil concentrations in the upper 10 m (5 fathom) of the water column underneath the discontinuous oil slick would be 0.04 ppm over 4,100 km^2 (1,200 nautical mi^2 [nmi^2]) after 3 days into the open-water season, 0.10 ppm over 4,700 km^2 (1,400 nmi^2) after 10 days, and 0.11 ppm over 6,600 km^2 (1,900 nmi^2) after 30 days.

Thus, concentrations above the chronic criterion for hydrocarbons of 0.015 ppm could persist >30 days, on the order of months, over an area >6,600 km^2 (1,900 nmi^2). The acute standard of 1.5 ppm hydrocarbons would not be exceeded.

Conclusion: The effects on water quality of a very large oil spill could persist for months, exceeding chronic criteria for water quality on a regional basis, over 6,600 km^2 (1,900 nmi^2).

2. Effects on Lower Trophic-Level Organisms: The 160,000-bbl oil spill would affect lower trophic-level organisms by exposing some to petroleum-based hydrocarbons. The effects of petroleum on lower trophic-level organisms are discussed in the base case (Sec. IV.B.3) but are again summarized below.

The effect of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms ranges from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., in bays, estuaries, and mudflats), adverse effects are expected to be greater; and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported to date. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments show that zooplankton communities experience short-lived effects

Table IV.M-3
Summary of the Percentage of the Hypothetical Spills Estimated to Contact Environmental Resources and Land and Boundary Segments from Hypothetical Pipeline Segment P11 During Summer (July-September) and Winter (October-June)

	Summer				Winter			
Environmental Resource/ Land or Boundary Segment	3-Day	10-Day	30-Day	180-Day	3-Day	10-Day	30-Day	180-Day
Land	17	30	42	46	11	14	16	42
Ice/Sea Segment 3	n	n	n	1	n	n	n	n
Ice/Sea Segment 4	n	n	n	1	n	n	n	n
Ice/Sea Segment 5	n	n	n	2	n	n	n	1
Ice/Sea Segment 6	n	1	2	4	n	n	n	1
Ice/Sea Segment 7	1	7	22	29	n	1	2	18
Ice/Sea Segment 8	30	36	44	50	17	20	23	42
Ice/Sea Segment 9	2	8	11	12	n	1	1	1
Ice/Sea Segment 10	n	3	6	6	n	n	n	5
Ice/Sea Segment 11	n	n	2	2	n	n	n	1
Ice/Sea Segment 13	n	n	1	1	n	n	n	n
Simpson Lagoon C3	6	10	13	15	n	n	n	11
Gwydyr Bay C4	1	3	7	9	n	n	n	3
Jago Lagoon C5	n	1	2	2	n	n	n	n
Subsistence Resource Area B	n	n	n	1	n	n	n	1
Subsistence Resource Area C	91	92	93	94	89	91	93	96
Subsistence Resource Area D	20	29	42	46	3	4	5	25
Land Segment 27	n	n	1	1	n	n	n	n
Land Segment 29	n	n	n	n	n	n	n	2
Land Segment 33	n	1	1	1	n	1	1	4
Land Segment 34	14	17	20	21	10	11	12	26
Land Segment 35	3	5	5	5	1	1	1	2
Land Segment 36	1	2	3	3	n	n	n	3
Land Segment 37	n	2	6	7	n	n	1	3
Land Segment 38	n	1	2	2	n	n	n	n
Land Segment 40	n	n	1	1	n	n	n	n
Land Segment 41	n	1	1	1	n	n	n	n
Land Segment 42	n	n	1	1	n	n	n	n
Northern SLS Area	n	n	n	1	n	n	n	1

Source: Source: USDOI, MMS, Alaska OCS Region, 1995.

n = values <0.5 percent.

due to oil. Affected communities appear to recover rapidly from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity.

Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have been reported. However, because of the predominance of shorefast ice along the shoreline of the Beaufort Sea, most of the shoreline is thought support little or no resident flora or fauna down to about 1 m in depth. Subtidal marine plants and invertebrates are not likely to be contacted by oil from an oil spill. Only the larval stages of marine invertebrates are likely to be contacted, and only those nearest the surface. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

The 160,000-bbl spill is assumed to occur offshore in November due to a pipeline leak (Pipeline Segment P11). It also is assumed that it leaks for 249 days and that a portion of the oil (17%) is estimated to contact the shore within 10 days. The surface oil will cover a discontinuous surface area on the water of about 4,700 km^2 (about three times that of the base case). Hence, the 160,000-bbl spill would increase the amount of oil contacting the shoreline and surface waters substantially over that of the base case. It also would substantially increase the amount of time that oil would be spilling. For these reasons, oil from the 160,000-bbl spill is likely to remain in the affected shoreline sediments longer than for the base case.

Regarding the shoreline most likely to be contacted, the OSRA estimates that the conditional probability (expressed as percent chance) of a summer oil spill (worst case) contacting the shore within 10 days ranges from 1 to 17 percent for seven land segments and three lagoons (LS's 34-38, 41, C3-C5, Table IV.M.3). The OSRA estimates that the conditional probability of contact within 30 days ranges from 1 to 36 percent for all land and sea segments during the summer (1-44% for contact within 180 days). Hence, after 30 days many of the land and sea segments are assumed to be contacted by oil from the 160,000-bbl oil spill. This analysis has assumed that the 160,000-bbl spill would contact about twice the amount of shoreline and surface water, with about five times as much oil as that of the base-case spill. Within the sale area, all of the above differences in the two oil spills are estimated to increase base-case effects on plankton, epontic, and marine invertebrates by about four times. However, these increases are expected to have little effect on recovery times once the spill has ceased. This is due to the high rate of hydrologic exchange in open-water areas and the amount of wave action in most shoreline areas.

Based on these estimates and assumptions, the 160,000-bbl oil spill is estimated to have sublethal and lethal effects on up to 15 percent of the phytoplankton and zooplankton populations in the sale area over the 249-day period. After this time, recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill (contact estimated at <1%). The spill also is estimated to have lethal and sublethal effects on the larval stages of marine invertebrates (annelids, mollusks, and crustaceans) nearest the surface. In general, the percentage of marine larva and/or epontic organisms contacted by floating or dispersed oil is expected to be similar to that expected for plankton (up to 15%). Due to their wide distribution and relatively rapid rate of regeneration, the recovery of marine larva is expected to take less than a month.

Conclusion: The assumed 160,000-bbl oil spill is estimated to have lethal and sublethal effects on up to 15 percent of the phytoplankton and zooplankton populations in the sale area. Recovery begins after the spill ceases and is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Recovery in embayment areas is expected to take 1 to 2 weeks. The assumed spill also is estimated to have lethal and sublethal effects on up to 15 percent of the epontic and marine larva nearest the surface. Recovery is expected to take less than a month.

3. Effects on Fishes: A very large oil spill that occurred in nearshore waters during the open-water season would affect the ability of fish to reach overwintering areas and spawning streams. Effects are more likely for fishes that make extensive migrations from natal streams (e.g., arctic cisco) and for fishes with high fidelity to natal streams (e.g., arctic char). The effects of such an oil spill on fishes in the Beaufort Sea region are expected to be moderate because some individuals in a localized area would be affected for a short time period; however, high effects are possible for some anadromous species (e.g., arctic cisco, arctic char, least cisco, and broad whitefish) if spawning-year individuals were affected.

Conclusion: The effects of a very large oil spill on lower trophic-level organisms and fishes are expected to be lethal to a large portion of some nearshore fish populations, decreasing population levels for one generation (<7 years).

4. *Effects on Marine and Coastal Birds:*

The potential effect of a very large (pipeline) oil spill (160,000 bbl) on marine and coastal birds could be substantial and result in long-term contamination of coastal wetlands (saltmarshes). Within 30 days of spill release from the sea ice, 36 percent of the spill (58,000 bbl) would contact over 480 km of coastline from Peard Bay (LS 15, Fig. IV.A.1-1) to Point Thomson. A substantial portion of the spill (20% or 32,000 bbl) is estimated to contact and oil Simpson Lagoon (Table IV.M-3), an important concentration area for waterfowl and shorebirds, with flocks of thousands of birds per square kilometer. Spill contact could result in the loss of ≥10,000 waterfowl and shorebirds, with predominant mortality among common species such as oldsquaw and common eider, but such loss probably would be replaced within one generation. Approximately 2 percent of the oil (3,200 bbl) would contact the Colville River Delta tidal and saltmarsh habitats, contaminating important waterfowl and shorebird habitats (Table IV.M-3, LS 30-31). This contamination is expected to have a long-term (degradation of >1-2 generations) effect on the suitability of these wetlands to some waterfowl populations.

An estimated 21 percent (33,600 bbl) of the spill is likely to contact the important seabird-foraging area offshore of Point Barrow-Northern Lead System (Table IV.M-3, NLS), during summer. This habitat has an average density of 38 birds/km^2. The 160,000-bbl spill would sweep over a discontinuous area of 6,600 km^2. If 21 percent of this spill-affected area were included in the seabird-feeding area offshore of Point Barrow, at least 53,000 seabirds could be contacted and killed by the spill. The loss of less abundant species such as the black guillemot or yellow-billed loon could take at least one to two generations to recover.

Conclusion: The effects of a very large oil spill on marine and coastal birds are expected to include the loss of tens of thousands to over 100,000 birds, with recovery of populations taking about 1 to 2 generations (2-6 years).

5. *Effects on Pinnipeds, Polar Bears, and Belukha Whales:*

The potential effect of a very large (pipeline) oil spill (160,000 bbl) on young seals, walrus calves, and polar bears could be severe, while the effect on adult walruses, seals, and belukha whales is expected to be short term (see discussion of the general effects of oil on these marine mammals, Sec. IV.B.5). Within 30 days of spill release from the sea ice, 36 percent (57,600 bbl) would contact over 480 km of coastline from Point Barrow (LS 20) to Griffin Point (LS 42). A substantial portion of the ringed seal-pupping habitat in shorefast ice could at least partially be exposed to oil-spill contamination at the end of the pupping season in June. Prior to that time, most of the oil is expected to be encapsulated in the ice.

After meltout of the oil spill in mid- to late June, an estimated 2 to 11 ringed seals/nmi^2 could be contaminated by the spill (seal numbers and densities taken from the ranges of densities and total numbers of ringed seals hauled out along the ice from Flaxman Island to Point Barrow as reported by Frost et al., 1988). This contamination could result in the death of several thousand young ringed seals through inhalation and absorption of toxic hydrocarbons in the oil fouling the seals' fur (such an effect apparently occurred with young harbor seals contaminated by the Prince William Sound oil spill). This loss of ringed seals could take more than one generation (4-5 years) but probably less than two generations for population recovery (about 10 years).

About 16 percent (or 25,600 bbl) of the oil spill is estimated to contact walrus, seal, and polar bear ice-front habitats offshore from Cape Halkett to just west of Point Barrow (represented by Ice/Sea Segments 3-5 in Fig. IV.A.1-1 and in Table IV.M-3). Several thousand walruses and bearded seals and perhaps 50 to 85 polar bears (assuming a bear density of one bear/78-130 km^2 and a total surface area of 6,600 km^2 swept by the discontinuous oil slick from the 160,000-bbl oil spill) could be exposed to the oil spill. Assuming that all young walrus calves, young bearded seals, and all polar bears contaminated by the oil died because of absorption (through the skin), inhalation, and/or ingestion of toxic hydrocarbons in the oil, this loss could take these marine-mammal populations more than one to two generations to recover (about 15 years). Although some belukha whales might encounter some of the spill during the summer west of Point Barrow, few if any whales are likely to be adversely affected (loss of <20 whales with population recovery in 1 year).

Conclusion: The effect of a very large oil spill is expected to be fairly long term (1-2 generations, about 4-7 years) on pinnipeds and polar bears and short-term (< 1 generation, about 1 year) on belukha whales.

6. Effects on Endangered and Threatened Species: A very large oil spill (160,000 bbl) resulting from a leak (635 bbl/day) in a trunk pipeline near Point McIntyre (Pipeline Segment 11 in Fig. IV.A.1-1) would occur under the ice in November and last for 249 days (up to July 22). Oil spilled in December, April, and May would surface on the ice in mid-June, late June, and early July, respectively. Oil would pool on the surface of the ice for at least 30 days prior to being discharged to the surface of the water. Approximately 18 percent of the oil spill (29,000 bbl) would evaporate while it was pooled on the surface of the ice. Approximately 33 percent of the oil spill (53,000 bbl) would be dispersed, 18 percent (30,000 bbl) would end up on shore, and 30 percent (47,000 bbl) would be left on the sea surface as tarballs rather than as a discrete slick (Table IV.M-1). The tarballs would have dispersed discontinuously over 6,600 km^2 (2,549 mi^2) (Table IV.M-2).

For conditional probabilities, the OSRA model estimated a 6- to 44-percent probability (expressed as a percent chance) of the spill contacting ERA's 7-10 (Ice/Sea Segments 7-10) within 30 days during the summer, assuming that a spill occurs at Pipeline Segment P11. The OSRA model estimated a 23-percent probability (expressed as a percent chance) of the spill contacting ERA 8 (Ice/Sea Segment 8) within 30 days during the winter, assuming that a spill occurs at Pipeline Segment P11. The OSRA probabilities should be considered as the percentage of the total spill contacting a particular environmental-resource area rather than how likely that contact would be. The highest percentages of total contact for important bowhead whale- habitat areas affected by the spill would be ERA 8 (Ice/Sea Segment 8) at 44 percent from July through September and at 23 percent from October through June. Whales could encounter the oil in the form of tarballs during the fall migration.

Tables B-41 and B-43 in Appendix B present 180-day conditional probabilities. The OSRA model estimated a 6- to 50-percent probability (expressed as a percent chance) of the spill contacting ERA's 7-10 (Ice/Sea Segments 7-10) within 180 days during the summer, assuming that a spill occurs at Pipeline Segment P11. The OSRA model estimated an 18- to 42-percent probability (expressed as a percent chance) of the spill contacting ERA's 7-8 (Ice/Sea Segments 7-8) within 180 days during the winter, assuming that a spill occurs at Pipeline Segment P11.

As discussed in the base case, the major concern for a bowhead whale/oil-spill situation is in the spring ice-lead system, where bowheads could be concentrated. In this large-spill scenario, the lead system would not be contacted by the spill. For the fall migration, the toxic hydrocarbons would be evaporated before the oil entered the water and would not be available to potentially cause respiratory distress to bowheads surfacing to breathe. The fall migration through the Beaufort Sea generally occurs in relatively open-water conditions, and the spill would not be continuous over the entire area. It is doubtful that the spill would cause an impediment to the migration. The migrating whales could come in contact with oil, but such contact would likely be brief. In some years, bowheads have been observed feeding north of Flaxman Island (near ERA 8). If bowheads were feeding in that area when tarballs were present, some of the oil could be ingested. Effects of oil contacting bowheads would be as described previously in the base case: baleen fouling, ingestion of oil or oil-contaminated prey, and irritation of skin or sensitive tissues. Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering within 1 to 3 years. However, since oil would be weathered and primarily in the form of tarballs on the sea surface and the tarballs would be fairly widely dispersed, mortalities of bowhead whales are not expected. Most individuals exposed to spilled oil are expected to experience temporary, sublethal effects.

Because the actual risk (probability) of spill contact for peregrine falcons in these areas probably is even less than suggested by the low OSRA values, due to this species' transient occurrence in the areas likely to be contacted and the fact that they do not typically contact the water surface, it is unlikely that peregrines would be significantly affected by oil spills; however, a few peregrines taking oil-contaminated prey in coastal areas following the spill could become oiled by this contact, resulting in a minimal population effect. If oil spills affected prey populations, short-term, localized reductions in food availability for peregrines could occur. Less than 2 percent of the population nesting adjacent to the arctic slope is expected to be exposed to spilled oil.

Relatively low spectacled and Steller's eider mortality is expected from a large oil spill (<200 individuals each) because its initial release would occur after the fall migration took place, and oil would be released from ice well before most females with juveniles entered the marine environment (brood-rearing takes place in tundra pond habitat).

This suggests the oil would have primarily transformed to tarballs, posing much less risk to these species than an oil slick; however, unless mortality is near the lower end of this range (e.g., ≤25), recovery from any spill-related losses is not expected to occur if population status remains similar to that at present—declining numbers on the breeding grounds and relatively low reproductive rate.

Conclusion: Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, with the population recovering within 1 to 3 years (<1 generation). However, because oil would be weathered and primarily in the form of tarballs on the sea surface and the tarballs would be fairly widely dispersed, mortalities of bowhead whales are not expected. Most individuals exposed to spilled oil are expected to experience temporary, sublethal effects. The overall effects on peregrine falcons from a large oil spill are expected to be minimal, with <2 percent of the population contacted by spilled oil. Overall oil-spill effects on the spectacled and Steller's eiders are expected to be minimal, affecting <2 percent of their populations; however, recovery from mortality resulting from a large oil spill is not expected to occur if population status is declining as at present.

7. Effects on Caribou: The potential effect of a very large pipeline oil spill (160,000 bbl) on caribou is likely to be limited to caribou groups occurring during insect-relief periods in coastal waters near shorelines with extensive oil contamination. Although the oil spill is estimated to contact over 480 km of shoreline from Griffin Point to Point Barrow, the majority of the coastline contamination would occur between Point Barrow and Oliktok Point and in the Prudhoe Bay-Flaxman Island area (LS's 20 through 38, Table IV.M-3 and Fig. IV.A.1-1). Caribou groups that belong to the Central Arctic Herd (CAH) and Teshekpuk Lake Herd (TLH) are the assemblages of caribou likely to encounter oil while in coastal waters or on the beaches.

Heavily oiled caribou might die from absorption and/or inhalation of toxic hydrocarbons. Several hundred caribou of the CAH and TLH could die from the oil spill. This loss would represent a short-term effect, with population recovery taking place within <one generation (or about 1 year).

Conclusion: The effects of a very large oil spill on caribou are expected to be short term (<1 generation or about 1 year).

8. Effects on the Economy of the North Slope Borough: The potential effects of a very large oil spill on the economy of the NSB could be substantial and result in long-term adverse effects. Because the economy of the NSB is highly dependent on subsistence resources, many of the adverse effects would be the result of losses in these resources. In addition, the local government would be burdened because of an increased demand for social services and increased pressure on infrastructure due to the influx of spill-cleanup workers.

As discussed in Section IV.M.9, the effects of a very large oil spill would cause severe effects on subsistence-harvest patterns. As discussed in Section IV.B.8, loss of subsistence resources would translate into a substantial decline in household income. Because there are limited job opportunities in the NSB, substitution of market activities for nonmarket activities would be limited. The exception to this would be jobs in cleanup activities. Some residents may find work cleaning up the spilled oil; many cleanup-related jobs were generated as a result of the *Exxon Valdez* oil spill in Prince William Sound. The assumed spill is about two-thirds that of the EVOS and is estimated to require approximately 6,500 workers for cleanup operations. These jobs, however, would be relatively short term (one or two seasons), while the effects to the various subsistence species are expected to be long term (4-5 years).

Indirect costs of an oil spill could result from an increase in demand for social services. As discussed in Section IV.B.10, the loss of access to subsistence practices could manifest itself in social pathologies that could result in an increased demand for social services. The cost of these services would most likely be borne by the government of the NSB, which would have to redirect funds from other budget items. Increased costs to local government also would result from an influx of oil-spill workers, Federal and State officials, and the media representatives, which would put strains on infrastructure such as housing, airports, and roads. These increased costs for the NSB would result in increased employment in related activities; however, this also would mean that other types of Borough-funded employment would have to be cut. This would most likely result in job losses to local residents because they might not be qualified to fill some of the spill-induced jobs, especially specialized jobs in social-service provision.

Conclusion: The effects of a very large oil spill on the economy of the NSB are expected to be severe because of the disruption of subsistence-harvest patterns (4-5 years) and the resulting pressure of NSB residents to substitute marketplace activities.

The very large oil spill would generate 6,500 cleanup jobs for 1 to 2 years, declining to zero by the fourth year following the spill.

9. Effects on Sociocultural Systems: A very large oil spill could affect sociocultural systems in a number of ways. First, overall effects on subsistence-harvest patterns are expected to be significant because of one or more important subsistence resources would become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years. As discussed in Section IV.B.9, such high effects levels on subsistence-harvest patterns would cause disruptions that could lead to a breakdown of kinship networks and sharing patterns as well as increase social stress in the community. Participating in the oil-spill cleanup, as local residents did in the *Exxon Valdez* oil spill in 1989, could cause residents to: (1) not participate in subsistence activities, (2) have a surplus of cash to spend on material goods as well as drugs and alcohol, and (3) not seek or continue employment in other jobs in the community (since oil-spill-cleanup wages are higher than average). Indications are that the sudden, dramatic increase in income earned from working on the *Exxon Valdez* oil-spill cleanup, as well as being unable to pursue subsistence harvests because of the spill, caused a tremendous amount of social upheaval. This was particularly seen in increases in depression, violence, and substance abuse (Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990e).

A disruption of the kinship networks, i.e., social organization, could lead to a decreased emphasis on the importance of the family, cooperation, and sharing. Multiyear disruptions of subsistence-harvest patterns, especially to 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 entrepreneurialism. Effects on the sociocultural system, such as increased drug and alcohol abuse, breakdown in family ties, and a weakening of social well-being, would lead to additional stresses on the health and social services available. Effects on the sociocultural systems described above would be for 2 to 5 years, with a tendency for additional stress on the sociocultural systems and tendencies toward displacement of existing institutions.

Conclusion: The effects of a very large oil spill on sociocultural systems would last for 2 to 5 years, with a tendency for additional stress on the sociocultural systems and tendencies toward displacement of existing institutions.

10. Effects on Subsistence-Harvest Patterns: A very large oil spill (160,000 bbl) resulting from a leak (635 bbl/day) in a trunk pipeline near Point McIntyre (Pipeline Segment 11 in Fig. IV.A.1-1) would occur under the ice in November and last for 249 days (up to July 22). Oil spilled in December, April, and May would surface on the ice in mid-June, late June, and early July, respectively. Oil would pool on the surface of the ice for at least 30 days prior to being discharged to the surface of the water. Approximately 18 percent of the oil spill (29,000 bbl) would evaporate while it was pooled on the surface of the ice. Approximately 33 percent of the oil spill (53,000 bbl) would be dispersed, 18 percent (30,000 bbl) would end up onshore, and 30 percent (47,000 bbl) would be left on the sea surface as tarballs rather than as a discrete slick (Table IV.M-1). The tarballs would have dispersed discontinuously over 6,600 km^2 (Table IV.M-2).

Based on conditional probabilities, environmental resources located in this region are at relatively high risk. A very large pipeline oil spill would threaten subsistence-harvest patterns because the oil spill could contact subsistence-harvest areas important to Barrow (Atqasuk), Nuiqsut, and Kaktovik.

Pipeline Segment P11 crosses SRAC (Nuiqsut's primary subsistence area), and this area would most likely be heavily affected by oil (estimated spill-contact probabilities of 91, 92, and 93 percent after 3, 10, and 30 days, respectively, in summer and 89, 91, and 93 percent, respectively, in winter [see Table IV.M-3]). The SRAD (Kaktovik's primary subsistence area) to the east of Pipeline Segment P11 also would be heavily affected (estimated spill-contact probabilities of 20, 29, and 42 percent after 3, 10, and 30 days, respectively, in summer and 3, 4, and 5 percent, respectively, in winter [see Table IV.M-3]).

Tables B-41 and B-43 present 180-day conditional probabilities. The OSRA model estimated a 94-percent probability (expressed as a percent chance) of the spill contacting SRAC within 180 days during the summer, and a 96-percent probability (expressed as a percent chance) of the spill contacting SRAC within 180 days during the winter, assuming that a spill occurs at Pipeline Segment P11. The OSRA model estimated a 46-percent probability (expressed as a percent chance) of the spill contacting SRAD within 180 days during the summer and a 25-percent probability (expressed as a percent chance) of the spill contacting SRAD within 180 days during the winter, assuming that a spill occurs at Pipeline Segment P11.

The spring bowhead whale harvest already would have occurred in Barrow by the time the oil is assumed to have surfaced in late June. Because bowheads migrate through the Beaufort Sea during June, biological effects on bowhead whales from the exposure to spilled oil could result in lethal effects to a few individuals, with the population recovering in 1 to 3 years. By this time, spilled oil will have weathered and would appear in the form of tarballs that are widely dispersed on the sea surface. It is possible, although not very likely, that Nuiqsut and Kaktovik would not be allowed to harvest the bowhead whale as the bowhead migration moved east through the Beaufort Sea in the fall. However, the likelihood of the bowhead whale harvest in Nuiqsut and Kaktovik being curtailed is not very great, given that the bowhead whale population has been increasing and the low level of biological effects. If the harvest is not curtailed or reduced, Nuiqsut's and Kaktovik's bowhead harvest could be affected for a period not exceeding 1 year but should not become unavailable or undesirable for use. However, it also is possible that while the bowhead whale harvest might not be curtailed, the quota could be reduced for >2 years, resulting in significant effects on the bowhead whale harvests of Barrow (Atqasuk), Nuiqsut, and Kaktovik by making the bowhead unavailable for use or available in greatly reduced numbers for an extended period.

Belukha whales are expected to experience localized and short-term biological effects as a result of the assumed oil spill. Because most belukha would have been harvested either prior to the spill in late spring or later in the fall, belukha harvests could be affected for a period not exceeding 1 year, but the belukhas should not become unavailable or undesirable for use.

Biological effects on seals, walruses, marine and coastal birds, fishes, and polar bears would cause long-term reductions in the harvests of these resources as the result of the oil spill. Population changes in abundance and/or distribution would require one or two generations to recover to their former status. Walrus and bearded seal harvests at Nuiqsut and bearded seal harvests at Kaktovik are likely not to occur at all for that season because the oil would be spilling during the primary harvest period. In following years, harvests would be expected to occur in greatly reduced numbers. Marine and coastal birds would have been harvested during the spring, but Nuiqsut and Kaktovik fall harvests could be reduced. Nuiqsut and Kaktovik fish harvests, particularly in the Colville River Delta and along the coast, would be expected to be available but in reduced numbers for 1 year. It is also likely that for all subsistence resources there could be reluctance to harvest any marine resources because of perceived tainting from oil.

Conclusion: Overall effects on subsistence-harvest patterns from a very large oil spill are expected to be significant because one or more important subsistence resources could become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 2 to 5 years.

11. Archaeological Resources: The 160,000-bbl oil spill would affect archaeological resources by creating surface-disturbing activities resulting from emergency shoreline treatment. Following the *Exxon Valdez* oil spill (EVOS), Exxon developed and funded a Cultural Resource Program to ensure that potential effects on archaeological sites were minimized during shoreline treatment (Betts, 1991). This program involved a team of archaeologists who performed reconnaissance surveys of the affected beach segments, reviewed proposed oil-spill treatment, and monitored treatment. As a result of the coastline surveys, hundreds of archaeological sites were discovered, recorded, and verified. This resulted in the most comprehensive archaeological record of Alaska coastline ever documented.

Although a number of sites in the EVOS area were vandalized during the 1989 cleanup season, the large number of

Exxon and government-agency archaeologists visible in the field may have lessened the amount of site vandalism that may have occurred (Mobley, 1990). Two studies of the numbers of archaeological sites damaged by the EVOS came to similar findings. In the first study by Mobley et al. (1990), of 1,000 archaeological sites in the area affected by the EVOS (AHRF, 1993), about 24 sites, or <3 percent, were damaged. In the second study by Wooley and Haggarty (1993), of 609 sites studied, 14 sites, or 2 to 3 percent of the total, suffered major effects.

The Dekin study (1993) found that small amounts of petroleum hydrocarbons may occur in most archaeological sites within the study area. This suggests a low-level petroleum contamination that had not previously been suspected. Because the researchers found no evidence of extensive soil contamination from a single definable source (i.e., the oil spilled from the *Exxon Valdez*), they " . . .now add the continuing contamination of soils from small and large petroleum spills in areas where present and past land use coincide" (Dekin, 1993). In their study, vandalism was found to have a significant effect on archaeological site integrity but could not be tied directly to the oil spill (Dekin, 1993).

Conclusion: The expected effect on onshore archaeological resources from a large oil spill is uncertain, but data from the EVOS indicate that <3 percent of the resources within a spill area would be significantly impacted or damaged.

12. Effects on Air Quality: Under this analysis, a 160,000-bbl-oil spill would affect onshore air quality in the Beaufort Sea. Emissions would result from evaporation and burning of the spilled oil.

Air-quality regulations and procedures are discussed in Section IV.B.12. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality.

Evaporation of spilled oil is a source of gaseous emissions. Modeling predictions of hydrocarbon evaporation (Payne et al., 1984a,b; 1987) from a 160,000-bbl slick over 30-day periods estimate that 44,800 bbl—or 6,254 tons—of hydrocarbons would evaporate. Because approximately 10 percent of gaseous hydrocarbons are nonmethane volatile organic compounds (VOC), 625.4 tons of VOC would be lost to the atmosphere. The movement of the oil slick during this time would result in lower concentrations and dispersal of emissions over an area several orders of magnitude larger than the slick itself. Also evaporation from oil contained under the ice would be delayed until breakup. This would delay but not otherwise affect the spilled oils effect on air quality.

In situ burning is a preferred technique for cleanup and disposal of spilled oil in oil-spill-contingency plans. For catastrophic oil spills, in situ burning may be the only effective technique for spill control.

Burning could affect air quality in two important ways. Burning would reduce emissions of gaseous hydrocarbons by 99.98 percent and slightly increase emissions—relative to quantities in other oil and gas industrial operations—of other pollutants (Table IV.B.12-3). If the oil spill were ignited immediately after spillage, the burn would combust 33 to 67 percent of the crude oil or higher amounts of fuel oil that other- wise would evaporate. On the other hand, incomplete combustion of oil would inject about 10 percent of the burned crude oil as oily soot, plus minor quantities of other pollutants, into the air (Table IV.B.12-4). For a 160,000-bbl spill, setting fire at the source could burn up to 85 percent of the oil—with 5 percent remaining as residue or droplets in the smoke plume—in addition to the 10-percent soot injection (Evans et al., 1987). Clouds of black smoke from a 360,000-bbl oil-spill tanker fire 75 km off the coast of Africa locally deposited oily residue in a rainfall 50 to 80 km inland. Later the same day, clean rain washed away most of the residue and allayed fears of permanent damage.

Coating portions of the ecosystem in oily residue is the major, but not the only, potential air-quality risk. Recent examination of polycyclic aromatic hydrocarbons (PAH) in crude oil and smoke from burning crude oil indicate that the overall amounts of PAH change little during combustion, but the kinds of PAH compounds present do change. Benzo(a)pyrene, which is often used as an indicator of the presence of carcinogenic varieties of PAH, is present in crude-oil smoke in quantities approximately three times larger than in the unburned oil. However, the amount of PAH is very small (Evans, 1988). Investigators have found that overall, the oily residue in smoke plumes from crude oil is mutagenic but not highly so (Sheppard and Georghiou, 1981; Evans et al., 1987). The Expert Committee of the World Health Organization considers daily average smoke concentrations of >250 micrograms per cubic meter to be a health hazard for bronchitis.

Large fires create their own local circulating winds—toward the fire at ground level—that affect plume motion. In any event, soot produced from burning oil spills tends to slump and wash off vegetation in subsequent rains, limiting any health effects to the very short term. Accidental emissions are, therefore, expected to have a low effect on onshore air quality.

Conclusion: Effects on onshore air quality due to a 160,000-bbl spill would vary according to whether burning is used for mitigation. Through evaporation, an unburned spill would add an estimated 625.4 tons of VOC to existing air quality. Burning would reduce emissions of gaseous hydrocarbons while slightly increasing emissions of other pollutants. Evaporation with and without burning likely would produce emissions exceeding air-quality standards; however, effects would be short term. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from burning the oil spill.

13. Effects on Land Use Plans and Coastal Management Programs: In the event of a very large oil spill, biological resources would have higher levels of effects; shorelands, especially saltmarshes and river deltas, would be more heavily oiled. However, the policies that were relevant for the base-case analysis remain relevant for this analysis—a spill of the magnitude estimated in this case accentuates rather than expands the potential policy conflicts. Although policies related to oil spills do not differentiate between low and high probabilities for oil spills, the distinction often is evident in the mitigation that is deemed necessary for different types of projects. Development such as that proposed for Sale 144 probably would be reviewed from the perspective that a large-magnitude spill is possible, and this view would form the basis of the mitigation analysis.

Conclusion: Potential conflicts between effects assumed to follow a very large oil spill and NSB Land Management Regulations and the ACMP are expected to be the same as for the base case: possible conflicts with policies related to the subsistence-hunting activities related to user conflicts, availability of the subsistence resources, and potential interference with subsistence activities.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1996 - 790-120 / 41,400 REGION NO. 10

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic