OCS EIS/EA
MMS 87-0069

Alaska Outer Continental Shelf

Beaufort Sea Sale 97

Final Environmental Impact Statement

Volume I

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

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

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

OCS EIS/EA
MMS 87-0069

Alaska Outer Continental Shelf

Beaufort Sea Sale 97

Final Environmental Impact Statement

Volume I

June 1987

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

FINAL ENVIRONMENTAL IMPACT STATEMENT

Proposed Outer Continental Shelf
Beaufort Sea Lease Sale 97

Summary Sheet

( ) Draft (X) Final

U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, 949 East 36th Avenue, Room 110, Anchorage, Alaska 99508-4302.

1. Type of Action: Proposed Oil and Gas Lease Sale 97, Beaufort Sea.

(x) Administrative ( ) Legislative

2. Description of the Proposed Action: The proposed action would offer about 3,516 blocks (approximately 7.83 million hectares or 19.37 million acres) of the Beaufort Sea Planning Area for leasing. These blocks are located in waters that are from about 5 to 260 kilometers offshore and from 2 to about 1,000 meters deep. The conditional, mean, economically recoverable resources unleased in the area are estimated to be 650 million barrels of oil with a marginal probability of 0.69 for hydrocarbons. If implemented, this lease sale is tentatively scheduled to be held in January 1988.

3. Environmental Effects: Petroleum-industrial activities pose some degree of risk to the environment if blocks are leased, explored, and developed and produced. The risk is related to adverse effects on the environment and other resource uses that may result from accidental or chronic oil spills and from industrial-noise disturbances. Socioeconomic effects from onshore development could have State, regional, and/or local implications.

Several deferral alternatives and mitigating measures have been evaluated that may reduce the type, occurrence, and extent of adverse effects associated with this proposal. Other measures, which are beyond the authority of this agency to apply, have also been identified. In spite of mitigating measures, some effects are considered unavoidable. For instance, if oil were discovered and produced, oil spills would be statistically probable, there would be some disturbance to biological resources, and some onshore development could occur in undeveloped areas.

4. Alternatives to the Proposed Action:

a. No Sale (Alternative II).

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

c. Modify the proposed lease sale by deleting 201 blocks in the vicinity of Point Barrow (Alternative IV - Barrow Deferral Alternative).

d. Modify the proposed lease sale by deleting 161 blocks in the vicinity of Kaktovik east to the Canadian boundary line (Alternative V - Kaktovik Deferral Alternative).

e. Modify the proposed lease sale by deleting 1,592 blocks located seaward of the Barrow Deferral Area in the Chukchi Sea (Alternative VI - Chukchi Deferral Alternative).

5. Other EIS's and Technical and Reference Papers: This EIS refers to other EIS's, technical and reference papers, and MMS OCS reports previously prepared by the Alaska OCS Region. The applicable portions of such EIS's, technical papers, and reports are summarized in appropriate discussions throughout this document; and the EIS's, technical papers, and reports are herein incorporated by reference. Copies of these EIS's, technical papers, and MMS OCS reports have been placed in a number of libraries throughout Alaska; in the Department of the Interior Library in Washington, D.C.; and in many Government Printing Office libraries throughout the continental United States. Single copies of these papers and reports are available from the Alaska OCS Region and also from the National Technical Information Service.

6. Public Hearings: Public hearings on the Sale 97 draft EIS were held during December 1986 in the following Alaska communities: Barrow on the 8th, Wainwright on the 9th, Kaktovik and Nuiqsut on the 11th, and Anchorage on the 17th. Oral and written comments were obtained and responded to in this final EIS.

7. Contacts: For further information regarding this EIS, contact:

Richard W. Roberts
EIS Coordinator
Minerals Management Service
949 East 36th Avenue, Room 110
Anchorage, Alaska 99508-4302
907-261-4662

Raymond R. Emerson
Chief, Arctic Unit
Minerals Management Service
949 East 36th Avenue, Room 110
Anchorage, Alaska 99508-4302
907-261-4652

Richard H. Miller
MMS (644) USDOI
18th & C Street NW
Washington, D.C. 20240
202-343-6264

Proposed Beaufort Sea Lease Sale 97

Final Environmental Impact Statement

Table of Contents

VOLUME I

	Page
Summary Sheet	i
Table of Contents	iii
List of Graphics, Figures, and Tables	ix
Summary of Environmental Impact Statement for Proposed Beaufort Sea Lease Sale 97	xvii
I. Purpose and Background of the Proposed Action	I- 1
A. Leasing Process	I- 1
1. Leasing Schedule	I- 2
2. Request for Resource Reports	I- 2
3. Call for Information and Nominations (Call) and Notice of Intent (NOI) to Prepare an Environmental Impact Statement (EIS)	I- 2
4. Area Identification	I- 2
5. Scoping	I- 3
6. Preparation of Draft Environmental Impact Statement (DEIS)	I- 3
7. Endangered Species Consultation	I- 4
8. Public Hearings	I- 4
9. Preparation of Final Environmental Impact Statement (FEIS)	I- 4
10. Secretarial Issue Document (SID)	I- 4
11. Proposed Notice of Sale	I- 4
12. Decision and Final Notice of Sale	I- 5
13. Lease Sale	I- 5
14. Lease Operations	I- 5
B. Leasing History	I- 5
1. Previous Lease Sales	I- 5
2. Drilling	I- 6
3. Litigation	I- 7
C. Legal Mandates, Authorities, and Federal Regulatory Responsibilities	I- 9
D. Results of the Scoping Process	I-10
1. Major Issues	I-10
2. Issues Not Analyzed in the EIS	I-10
3. Mitigating Measures	I-11
4. Alternatives Suggested During the Scoping Process	I-11
II. Alternatives Including the Proposed Action	II- 1
A. Resource Estimates and Basic Exploration, Production, and Transportation Assumptions for Effects Assessment	II- 1
1. Resource Estimates	II- 1

2. Activities Associated With Exploration--Mean-Case Resource Estimate .... II- 2
3. Activities Associated With Development and Production--Mean-Case Resource Estimate .... II- 5
4. Activities Associated With Oil Transportation (Pipelines)--Mean-Case Resource Estimate .... II- 8
5. Activities Associated With the Low-Case and the High-Case Resource Estimates II-10
6. Scenarios for Alternatives IV, V, and VI II-11

B. Description of the Proposal and Alternatives II-11
1. Alternative I - Proposal II-11
a. Description of the Proposal II-11
b. Mitigating Measures That Are Part of the Proposed Action II-12
c. Potential Mitigating Measures II-12
2. Description of Alternatives II through VI II-27
a. Alternative II - No Sale II-27
b. Alternative III - Delay the Sale II-27
c. Alternative IV - Barrow Deferral Alternative II-27
d. Alternative V - Kaktovik Deferral Alternative II-27
e. Alternative VI - Chukchi Deferral Alternative II-27

C. Summary and Comparison of Effects of Alternatives II-28

III. Description of the Affected Environment .... III- 1

A. Physical Characteristics of the Beaufort Sea Planning Area .... III- 1
1. Geology .... III- 1
2. Meteorological Conditions and Physical Oceanography .... III- 4
3. Sea Ice .... III- 6

B. Biological Resources III-10
1. Lower-Trophic-Level Organisms III-10
2. Fishes III-19
3. Marine and Coastal Birds III-24
4. Pinnipeds, Polar Bears, and Beluga Whales III-25
5. Endangered and Threatened Species III-28
6. Caribou III-32

C. Social Systems III-33
1. Population III-33
2. North Slope Sociocultural Systems III-36
3. Subsistence-Harvest Patterns III-48

D. Other Issues III-67
1. Economy of the North Slope Borough III-67
2. Land Use Plans and Coastal Management Programs III-70

Page

3. Archaeological Resources........ III-74
4. Recreation and Tourism Resources........ III-76
5. Water Quality........ III-78
6. Air Quality........ III-80

IV. Environmental Consequences........ IV-A- 1

A. Basic Assumptions for Effects Assessment........ IV-A- 1
1. Oil-Spill-Risk Analysis........ IV-A- 2
a. Estimated Quantity of Resource........ IV-A- 2
b. Probability of Oil Spills Occurring........ IV-A- 3
c. Oil-Spill-Trajectory Simulations........ IV-A- 6
2. Aspects of Spilled Oil........ IV-A- 9
a. Fate and Behavior of Spilled Oil........ IV-A- 9
b. Likelihood, Extent, and Persistence of Oiled Shoreline........ IV-A- 10
c. Oil-Spill-Contingency Measures........ IV-A- 13
d. Toxicity of Oil in the Marine Environment........ IV-A- 16
3. Constraints and Technology........ IV-A- 18
a. Sea Ice........ IV-A- 18
b. Other Constraints........ IV-A- 25
4. Major Projects Considered in Cumulative-Effects Assessment........ IV-A- 29

DEFINITIONS ASSUMED FOR EFFECTS ASSESSMENT........ IV-B- 1

B. Alternative I - Proposal: Effects on........ IV-B- 1
1. Lower-Trophic-Level Organisms........ IV-B- 1
2. Fishes........ IV-B- 15
3. Marine and Coastal Birds........ IV-B- 31
4. Pinnipeds, Polar Bears, and Beluga Whales........ IV-B- 40
5. Endangered and Threatened Species........ IV-B- 52
6. Caribou........ IV-B- 70
7. Population........ IV-B- 79
8. North Slope Sociocultural Systems........ IV-B- 81
9. Subsistence-Harvest Patterns........ IV-B- 92
10. Economy of the North Slope Borough........ IV-B-106
11. Land Use Plans and Coastal Management Programs........ IV-B-109
12. Archaeological Resources........ IV-B-120
13. Recreation and Tourism Resources........ IV-B-122
14. Water Quality........ IV-B-123
15. Air Quality........ IV-B-133

C. Alternative II - No Lease Sale: Effects on........ IV-C- 1
1. Lower-Trophic-Level Organisms........ IV-C- 1
2. Fishes........ IV-C- 1
3. Marine and Coastal Birds........ IV-C- 1
4. Pinnipeds, Polar Bears, and Beluga Whales........ IV-C- 1
5. Endangered and Threatened Species........ IV-C- 1
6. Caribou........ IV-C- 1

		Page
	7. Population	IV-C- 1
	8. North Slope Sociocultural Systems	IV-C- 2
	9. Subsistence-Harvest Patterns	IV-C- 2
	10. Economy of the North Slope Borough	IV-C- 2
	11. Land Use Plans and Coastal Management Programs	IV-C- 2
	12. Archaeological Resources	IV-C- 2
	13. Recreation and Tourism Resources	IV-C- 2
	14. Water Quality	IV-C- 2
	15. Air Quality	IV-C- 2
D.	Alternative III - Delay the Sale: Effects on	IV-D- 1
	1. Lower-Trophic-Level Organisms	IV-D- 1
	2. Fishes	IV-D- 1
	3. Marine and Coastal Birds	IV-D- 2
	4. Pinnipeds, Polar Bears, and Beluga Whales	IV-D- 2
	5. Endangered and Threatened Species	IV-D- 2
	6. Caribou	IV-D- 2
	7. Population	IV-D- 3
	8. North Slope Sociocultural Systems	IV-D- 3
	9. Subsistence-Harvest Patterns	IV-D- 4
	10. Economy of the North Slope Borough	IV-D- 4
	11. Land Use Plans and Coastal Management Programs	IV-D- 4
	12. Archaeological Resources	IV-D- 5
	13. Recreation and Tourism Resources	IV-D- 5
	14. Water Quality	IV-D- 5
	15. Air Quality	IV-D- 5
E.	Alternative IV - Barrow Deferral Alternative: Effects on	IV-E- 1
	1. Lower-Trophic-Level Organisms	IV-E- 1
	2. Fishes	IV-E- 2
	3. Marine and Coastal Birds	IV-E- 3
	4. Pinnipeds, Polar Bears, and Beluga Whales	IV-E- 3
	5. Endangered and Threatened Species	IV-E- 4
	6. Caribou	IV-E- 6
	7. Population	IV-E- 7
	8. North Slope Sociocultural Systems	IV-E- 7
	9. Subsistence-Harvest Patterns	IV-E- 8
	10. Economy of the North Slope Borough	IV-E- 9
	11. Land Use Plans and Coastal Management Programs	IV-E- 9
	12. Archaeological Resources	IV-E- 10
	13. Recreation and Tourism Resources	IV-E- 10
	14. Water Quality	IV-E- 10
	15. Air Quality	IV-E- 10
F.	Alternative V - Kaktovik Deferral Alternative: Effects on	IV-F- 1
	1. Lower-Trophic-Level Organisms	IV-F- 1
	2. Fishes	IV-F- 2

			Page
	3.	Marine and Coastal Birds	IV-F- 3
	4.	Pinnipeds, Polar Bears, and Beluga Whales	IV-F- 3
	5.	Endangered and Threatened Species	IV-F- 4
	6.	Caribou	IV-F- 5
	7.	Population	IV-F- 6
	8.	North Slope Sociocultural Systems	IV-F- 6
	9.	Subsistence-Harvest Patterns	IV-F- 7
	10.	Economy of the North Slope Borough	IV-F- 8
	11.	Land Use Plans and Coastal Management Programs	IV-F- 8
	12.	Archaeological Resources	IV-F- 8
	13.	Recreation and Tourism Resources	IV-F- 8
	14.	Water Quality	IV-F- 9
	15.	Air Quality	IV-F- 9
G.		Alternative VI - Chukchi Deferral Alternative: Effects on	IV-G- 1
	1.	Lower-Trophic-Level Organisms	IV-G- 1
	2.	Fishes	IV-G- 2
	3.	Marine and Coastal Birds	IV-G- 3
	4.	Pinnipeds, Polar Bears, and Beluga Whales	IV-G- 3
	5.	Endangered and Threatened Species	IV-G- 4
	6.	Caribou	IV-G- 5
	7.	Population	IV-G- 5
	8.	North Slope Sociocultural Systems	IV-G- 6
	9.	Subsistence-Harvest Patterns	IV-G- 6
	10.	Economy of the North Slope Borough	IV-G- 7
	11.	Land Use Plans and Coastal Management Programs	IV-G- 7
	12.	Archaeological Resources	IV-G- 8
	13.	Recreation and Tourism Resources	IV-G- 8
	14.	Water Quality	IV-G- 8
	15.	Air Quality	IV-G- 8
H.		Unavoidable Adverse Effects	IV-H- 1
I.		Worst-Case Analysis	IV-I- 1
J.		Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity	IV-J- 1
K.		Irreversible and Irretrievable Commitment of Resources	IV-K- 1

		Page
L.	Natural Gas Development and Production: Effects on	IV-L-1
	1. Lower-Trophic-Level Organisms and Fishes	IV-L-2
	2. Marine and Coastal Birds	IV-L-2
	3. Pinnipeds, Polar Bears, and Beluga Whales	IV-L-2
	4. Endangered and Threatened Species	IV-L-3
	5. Caribou	IV-L-4
	6. Population	IV-L-4
	7. North Slope Sociocultural Systems	IV-L-5
	8. Subsistence-Harvest Patterns	IV-L-5
	9. Economy of the North Slope Borough	IV-L-6
	10. Land Use Plans and Coastal Management Programs	IV-L-6
	11. Archaeological Resources	IV-L-6
	12. Recreation and Tourism Resources	IV-L-7
	13. Water Quality	IV-L-7
	14. Air Quality	IV-L-7
VOLUME II		
V.	Review and Analysis of Comments Received	V- 1
	A. Introduction	V- 1
	B. Letters, Comments, and Responses	V- 2
	C. Public Hearing Comments and Responses	V- 104
VI.	Consultation and Coordination	VI- 1
	A. Development of the Proposal	VI- 1
	B. Development of the EIS	VI- 1
	C. List of Contacts for Preparation of the EIS and Review of the Draft EIS	VI- 1
	D. List of Additional Contacts for Review of the Draft EIS	VI- 5
	E. Contributing Authors and Supporting-Staff Members	VI- 5
Bibliography		
List of Appendices		
	A. Alternative-Energy Sources as an Alternative to the OCS Program	
	B. Major Projects Considered in Cumulative-Effects Assessment	
	C. Oil Spills and Oil-Spill Response	

D. MMS Alaska OCS Region Studies Program

E. Summary of Minimum and Maximum Effects

F. Oil-Spill-Risk Analysis

G. Exploration, Development and Production, and Transportation Estimates and Assumptions

H. Archaeological Analysis Prepared by the MMS and Supporting Tables for Sections III.D.3 and IV.B.12

I. Supporting Tables for Section III.D.1, Economy of the North Slope Borough, and Section IV.B.10, Effects on the Economy of the North Slope Borough

J. Endangered Species Act Section 7 Consultation and Documentation

K. Supporting Table for Section III.D.4, Recreation and Tourism Resources

L. Fate and Effects of Exploratory Phase Oil and Gas Drilling Discharges in the Beaufort Sea Planning Area, Lease Sale 97 (Prepared by the Environmental Protection Agency)

Index

Acronym Glossary

List of Graphics, Figures, and Tables

List of Graphics

Graphic Number	Title	Follows Page
1	Location of Beaufort Sea Planning Area and Area Evaluated for Possible Leasing	I- 2
2	Major Trapline Pathways (Foodweb) in the Beaufort and Northeast Chukchi Seas	III-18
3	Marine and Coastal Birds	III-25
4	Marine Mammal Habitats	III-25
5	Caribou Calving Areas and Movement Patterns	III-32
6	Major Projects Included in the Cumulative Assessment	IV-A-29

List of Figures

Figure Number	Title	Follows Page
Section I		
I- 1	Map Showing the Beaufort Sea Planning Area, Sale 97 Proposal Area (Alternative I), and Proposed Deferral Areas	I- 10
Section III		
III- 1	Regional Tectonic Features and Petroleum Provinces in the Beaufort Sea Planning Area	III- 2
III- 2	Generalized Lithostratigraphic Column Showing the Relationship of Onshore Rock Units in Northern Alaska to Offshore Seismic Sequences in the Beaufort Sea Planning Area	III- 2
III- 3	Generalized Distribution of Coarse-Grained (Sand and Gravel) and Fine-Grained (Silt and Clay) Surface Sediments in the Beaufort Sea Planning Area	III- 2
III- 4	Coastal Hazards and Ice Zonation on the Alaskan Beaufort and Northeast Chukchi Shelves	III- 2
III- 5	Shallow Faults and Earthquake Epicenters in the Beaufort Sea Planning Area	III- 4

List of Figures
(Continued)

Figure Number	Title	Follows Page
III- 6	Distribution of Shallow-Gas Concentrations, the Minimum Area Inferred to be Underlain by Natural-Gas Hydrates, and the Distribution of Diapiric Structures in the Beaufort Sea Planning Area	III- 4
III- 7	Winter-Ice Zonation of the Beaufort Sea Coast	III- 6
III- 8	Generalized Distribution of Ice-Gouge Density in the Beaufort Sea Planning Area	III- 6
III- 9	Freshwater Sources and Coastal Dispersal Patterns of the Principal Anadromous Fishes Occurring Along the Beaufort Sea Coastline	III-20
III-10	Combined Distribution of Bowhead Whale Sightings, Spring 1979-1984	III-29
III-11	Combined Distribution of Bowhead Whale Sightings, Fall 1979-1984	III-29
III-12	North Slope Population Trends: 1929-1982, Total Village Population, Barrow	III-33
III-13	Traditional Village Population, Percent Non-Native by Age	III-35
III-14	Map of the Beaufort Sea and North Slope Borough Showing the Sale 97 Planning Area, Alternative I Area, Proposed Deferral Areas and Subsistence-Use Areas of Five Villages	III-53
III-15	North Slope Borough Subsistence-Use Areas-Bowhead and Beluga Whale Hunting	III-53
III-16	North Slope Borough Subsistence-Use Areas-Seal and Walrus Hunting	III-53
III-17	North Slope Borough Subsistence-Use Areas-Caribou Hunting	III-53
III-18	Wainwright Yearly Subsistence Cycle	III-53
III-19	Barrow Yearly Subsistence Cycle	III-56
III-20	Atqasuk Yearly Subsistence Cycle	III-56
III-21	Nuiqsut Yearly Subsistence Cycle	III-60
III-22	Kaktovik Yearly Subsistence Cycle	III-63

List of Figures
(Continued)

Figure Number	Title	Follows Page
III-23	NSB Expenditures (Actual and Projected) by Category, 1980 to 2010	III-69
III-24	Employment (Actual and Projected) of Native and Non-Native Residents of the NSB Under Existing Conditions, 1980 to 2010	III-69
III-25	Unemployment Rates (Actual and Projected) for Native Residents of the NSB After Migration, 1981 to 2010	III-69
III-26	North Slope Borough Automated Databases	III-72
III-27	Shipwrecks and Archaeological, Recreational, and Tourism Resources	III-75
Section IV		
IV- 1	Study Area, Land and Boundary Segments, Transportation Routes and Spill Launch Points Hypothesized in Oil-Spill-Trajectory Analysis	IV-A- 4
IV- 2	Most Likely Number and Poisson Distribution of Spill Probabilities for the Proposal	IV-A- 6
IV- 3	Most Likely Number and Poisson Distribution of Spill Probabilities for the Cumulative Case Including the Proposal	IV-A- 6
IV- 4	Most Likely Number and Poisson Distribution of Spill Probabilities for the Barrow Deferral Alternative (Alternative IV)	IV-A- 6
IV- 5	Most Likely Number and Poisson Distribution of Spill Probabilities for the Kaktovik Deferral Alternative (Alternative V)	IV-A- 6
IV- 6	Most Likely Number and Poisson Distribution of Spill Probabilities for the Chukchi Deferral Alternative (Alternative VI)	IV-A- 6
IV- 7	Essential Components of the Two-Dimensional Stochastic Weather-Simulation Model; Also Showing Interrelationship Between the Three-Dimensional Hydrodynamic Model and the Oil-Spill-Trajectory Model	IV-A- 6
IV- 8	Fate of Oil Spills in the Ocean	IV-A- 9

List of Figures
(Continued)

Figure Number	Title	Follows Page
IV- 9	Conditional Probabilities That (a) If a Spill Occurred in Summer It Would Contact Land Within 10 Days and (b) If a Spill Occurred It Would Contact Land in the Open-Water Season Within 10 Days of Spillage or Meltout of a Winter Spill	IV-A- 10
IV-10	Combined Probabilities for Contact of Land/Boundary Segments by At Least One Oil Spill of 1,000 Barrels or Greater (Within 10 Days of Spillage or Meltout of a Winter Spill)	IV-A- 10
IV-11	Combined Probabilities for Contact of Land/Boundary Segments by At Least One Oil Spill of 1,000 Barrels or Greater (Within 10 Days of Spillage or Meltout of a Winter Spill)	IV-A- 11
IV-12	Applicability of Oil-Spill-Response Techniques in the Proposed Sale Area	IV-A- 14
IV-13	Combined Probabilities of One or More Oil Spills Occurring and Contacting Seabird-Feeding and Coastal-Concentration Areas During the Open-Water Season Within 10 Days Over the Production Life of the Lease Area	IV-B- 32
IV-14	Combined Probability of One or More Oil Spills of 1,000 Barrels or Greater Occurring and Contacting Marine-Mammal Habitats (SMA and Ice/Sea Segments) During the Entire Winter Season Compared With the Open-Water-Season Probabilities of Contact Within 10 Days of Summer Spills or Meltout of Overwintering Spills During the Expected Production Life of the Lease Area	IV-B- 42
IV-15	Combined Probability of One or More Oil Spills of 1,000 Barrels or Greater Occurring and Contacting Marine-Mammal Habitats (SMA and Ice/Sea Segments) During the Entire Winter Season Compared with the Expected Production Life of the Lease Area (Cumulative Case)	IV-B- 50
IV-16	Study Area, Spill Launch Points, and Endangered Whale Habitat Areas Discussed in Oil-Spill-Trajectory Analysis	IV-B- 53
IV-17	Subsistence-Resource Areas Used in the Oil-Spill-Risk Analysis	IV-B- 95

List of Figures
(Continued)

Figure Number	Title	Follows Page
IV-18	Projected Employment Effect of Proposed Sale 97 on Native and Non-Native Residents of the NSB, 1987 to 2010	IV-B-107
IV-19	Petroleum-Industry Employment (Actual and Projected) of Native Residents of the NSB as a Result of Proposed Sale 97, 1980 to 2010	IV-B-107
IV-20	Combined Probabilities of One or More Oil Spills Occurring and Contacting Seabird-Feeding and Coastal-Concentration Areas During the Open-Water Season Within 10 Days Over the Production Life of the Lease Area	IV-E- 3
IV-21	Combined Probability of One or More Oil Spills of 1,000 Barrels or Greater Occurring and Contacting Marine-Mammal Habitats During the Entire Winter Season for Ice/Sea Segments and April 1 to June 15 for the Spring Migration Area Over the Expected Production Life of the Lease Area	IV-E- 3
IV-22	Combined Probabilities of One or More Oil Spills Occurring and Contacting Seabird-Feeding and Coastal-Concentration Areas During the Open-Water Season Within 10 Days Over the Production Life of the Lease Area	IV-F- 4
IV-23	Combined Probability of One or More Oil Spills of 1,000 Barrels or Greater Occurring and Contacting Marine-Mammal Habitats During the Entire Winter Season for Ice/Sea Segments and April 1 to June 15 for the Spring-Migration Area Over the Expected Production Life of the Lease Area	IV-F- 4
IV-24	Combined Probabilities of One or More Oil Spills Occurring and Contacting Seabird-Feeding and Coastal-Concentration Areas During the Open-Water Season Within 10 Days Over the Production Life of the Lease Area	IV-G- 3
IV-25	Combined Probability of One or More Oil Spills of 1,000 Barrels or Greater Occurring and Contacting Marine-Mammal Habitats During the Entire Winter Season for Ice/Sea and Segments and April 1 to June 15 for the Spring-Migration Area Over the Expected Production Life of the Lease Area	IV-G- 3
V- 1	Nuiqsut Fall Bowhead Whale-Hunting Area	V- 59 (on page)

List of Tables

Table Number	Title	Follows Page
S- 1	Summary of Effects for the Proposal and Deferral Alternatives	xx
S- 2	Definitions Assumed in Effects Assessment	xx
Section I		
I-D- 1	Major Scoping Issues	I-10
Section II		
II-A- 1	Summary of Basic Scenario Assumptions Regarding Estimated OCS-Related Activities in the Beaufort Sea	II- 2
II-A- 2	Summary and Comparison of Basic Scenario Assumptions for the Mean-Case Resource Estimate for Alternatives I, IV, V, and VI	II-11
II-B- 1	Energy Needed from Other Sources to Replace Anticipated Oil Production from Proposed Beaufort Sea Sale 97	II-27
II-C- 1	Summary and Comparative Analysis of Potential Effects for Alternatives I, IV, V and VI for the Beaufort Sea Sale 97	II-28
Section III		
III-B- 1	Average Number of Larvae per Station	III-12 (on page)
III-C- 1	Population of the North Slope Region, 1980, 1982 and 1985	III-33
III-C- 2	North Slope Population Trends, 1929 to 1982	III-33
III-C- 3	Summary of Subjects Mentioned in Inupiat North Slope Public Testimony Since 1970	III-35
III-C- 4	Perceptions of Sharing, NSB Residents and Leaders, 1970-1977	III-40
III-C- 5	Percentage of Adult Inupiat Who Rated Sharing Behavior "Good": 1970-1977	III-40

List of Tables
(continued)

Table Number	Title	Follows Page
III-C- 6	Inupiat-Language Retention NSB: 1970-1980	III-42
III-C- 7	Increase in the Consumer Price Differential, 1976-1985	III-46
III-C- 8	Services Provided, by Facility, for Health and Social Services Programs: Barrow	III-47
III-C- 9	NSB Offenses Known to the Police by Year, 1977-1984	III-47
III-C-10	Barrow, Alaska, Requests for Public Safety Assistance, 1978-1985	III-47
III-C-11	Biotic Resources Used by North Slope Villages	III-50
III-C-12	Indicators of Subsistence Levels and Dependency by Species	III-50
III-C-13	Annual Subsistence-Resource Harvests Averaged for the Period 1962-1982	III-50
III-C-14	Major Subsistence Resources Harvested Ranked by Percentage and Weight Contribution to Average Total Village Harvest for the Period 1962-1982	III-52
III-C-15	Wainwright's Annual Harvest for the Period 1962-1982 of Species for Which Sufficient Data Are Available	III-53
III-C-16	Barrow's Annual Harvest for the Period 1962-1982 of Species for Which Sufficient Data Are Available	III-56
III-C-17	Kaktovik's Annual Harvest for the Period 1962-1982 of Species for Which Sufficient Data Are Available	III-63
III-D- 1	Estimated Native and Non-Native Resident Employment by Category in the North Slope Region in 1985	III-69
III-D- 2	Trace-Metal Concentrations in the Beaufort Sea	III-80

List of Tables
(continued)

Table Number	Title	Follows Page
Section IV		
IV-A- 1	Summary of Hypothetical Petroleum-Industry Activities in the Beaufort Sea Planning Area	IV-A- 2
IV-A- 2	Oil Resources Assumed in Oil-Spill-Risk Analysis	IV-A- 2
IV-A- 3	Spill-Rate Contants Used in Oil-Spill-Risk Analysis, Based on Historical OCS Spill Rates	IV-A- 4
IV-A- 4	Projected Spillage and Probabilities of Spillage in the Oil-Spill-Trajectory Model Over the Expected Production Life of Proposed Beaufort Sea Sale 97, Existing State and Federal Leases, and Canadian Development	IV-A- 6
IV-A- 5	Combined Probabilities (Percentage Chance) that One or More Oil Spills Would Occur and Contact Land During the Open-Water Season Over the Production Life of the Field	IV-A- 10
IV-A- 6	Combined Probabilities (Percentage Chance) that One or More Oil Spills Would Occur and Contact Land During Winter Over the Production Life of the Field	IV-A- 10
IV-A- 7	Major Projects Considered in Cumulative Effects Assessment	IV-A- 29
IV-B- 1	Beaufort Sea Major Fish Species, Potential Oil-Spill-Interactions Analysis	IV-B- 16
IV-B- 2	North Slope Population Projection, Alternative I: Proposal	IV-B- 79
IV-B- 3	Estimated Drilling Discharges of Muds and Cuttings for Proposed Sale 97 and Previous Lease Sales (Federal)	IV-B-128
IV-B- 4	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	IV-B-128
IV-B- 5	Estimated Uncontrolled Emissions from Offshore Platforms for Proposal and Deferral Alternatives	IV-B-134

List of Tables
(continued)

Table Number	Title	Follows Page
IV-B- 6	Control Measures for Major Oil and Gas Emission Sources	IV-B-134
IV-B- 7	Emissions from Burning 20 Metric Tons Per Day of Natural Gas During a Blowout	IV-B-136
IV-B- 8	Emissions from Burning Crude Oil	IV-B-136
IV-B- 9	State of Alaska Ambient Air-Quality Standards Relevant to the Beaufort Sea	IV-B-137
IV-D- 1	Studies Pertinent to the Beaufort Sea Area that May Be Conducted During a 2-Year Delay of Sale	IV-D- 1

Summary of Environmental Impact Statement for Proposed Beaufort Sea Sale 97

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

The proposal (Alternative I) consists of about 3,516 blocks (approximately 7.83 million hectares) in the Beaufort and Chukchi Seas that range from about 5 to 260 kilometers offshore. Alternative II (No Sale) would cancel the proposed lease sale, tentatively scheduled for January 1988. Alternative III (Delay the Sale) would delay the proposed lease sale for a period of 2 years. Alternative IV (Barrow Deferral Alternative) would defer leasing on 201 blocks that are located in the vicinity of Point Barrow. Alternative V (Kaktovik Deferral Alternative) would defer leasing on 161 blocks in the vicinity of Kaktovik east to the Canadian boundary line. Alternative VI (Chukchi Deferral Alternative) would defer leasing on 1,592 blocks located seaward of the Barrow Deferral in the Chukchi Sea. After a thorough review, the Secretary of the Interior will decide which alternative or combination of alternatives will be included in the Notice of Sale.

The potential effects of this proposal are based in part on the assumption that the mean, economically recoverable resources unleased in the area are estimated to be 650 million barrels of oil with a marginal probability of 0.69 for hydrocarbons. Analysis indicates there may be an 82-percent chance that one or more oil spills of at least 1,000 barrels might occur over the life of the field. The risks from spills would be lessened to the extent that weathering of oil occurs and by the success of any oil-spill-cleanup measures undertaken.

The scenario used to assess the potential effects that petroleum exploitation may have on the environment describes possible activities and timing of events. Exploration and delineation wells are predicted to be drilled primarily from 1989 to 1994. Oil would be produced from two platforms installed in 1998; drilling of the production and service wells would occur in 1998 and 1999. Pipelines would carry the produced oil to onshore pipelines that connect to the Trans-Alaska Pipeline.

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

This EIS is not intended, nor should it be used, as a local planning document by potentially affected communities. The facility locations and transportation scenarios described in this EIS represent assumptions that were made as a basis for identifying characteristic activities and any resulting environmental effects. These assumptions do not represent a Minerals Management Service recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable State and local laws and regulations.

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

Resource Category[3/]	Alternative I Proposal: Alternative	Alternative I Proposal: Cumulative	Alternative IV Barrow Deferral: Alternative	Alternative IV Barrow Deferral: Cumulative	Alternative V Kaktovik Deferral: Alternative	Alternative V Kaktovik Deferral: Cumulative	Alternative VI Chukchi Deferral: Alternative	Alternative VI Chukchi Deferral: Cumulative
1. Lower-Trophic-Level Organisms	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR
2. Fishes	MINOR	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	MAJOR
3. Marine and Coastal Birds	MODERATE	MODERATE	MODERATE[4/]	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
4. Pinnipeds, Polar Bears, and Beluga Whales	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR	NEGLIGIBLE	MINOR
5. Endangered and Threatened Species								
Bowhead Whales	MINOR	MODERATE	MINOR	MODERATE	MINOR	MODERATE	MINOR	MODERATE
Gray Whales	MINOR	MODERATE	NEGLIGIBLE	MODERATE	MINOR	MODERATE	MINOR	MODERATE
Arctic Peregrine Falcons	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR
6. Caribou	MINOR	MODERATE	MINOR	MODERATE	MINOR	MODERATE	MINOR	MODERATE
7. Population	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR
8. North Slope Sociocultural Systems	MINOR	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	MAJOR
9. Subsistence-Harvest Patterns								
Overall (Regional)	MAJOR	MAJOR	MAJOR	MAJOR	MAJOR	MAJOR	MODERATE	MAJOR
Wainwright	MAJOR		MAJOR		MAJOR		MODERATE	
Barrow	MODERATE		MODERATE		MODERATE		MODERATE	
Kaktovik	MODERATE		MODERATE		MODERATE		MODERATE	
Nuiqsut	MODERATE		MODERATE		MODERATE		MODERATE	
10. Economy of the North Slope Borough	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	MINOR
11. Land Use Plans and Coastal Management Programs		MAJOR		MAJOR		MAJOR		MAJOR
Beaufort Sea Coastal Area	MINOR		MINOR		MINOR		MINOR	
Chukchi Sea Coastal Area	MAJOR		MAJOR		MAJOR		MINOR	
12. Archaeological Resources	MINOR	MINOR	NEGLIGIBLE	MINOR	MINOR	MINOR	NEGLIGIBLE	MINOR
13. Recreation and Tourism Resources	MINOR	MINOR	NEGLIGIBLE	MINOR	MINOR	MINOR	MINOR	MINOR
14. Water Quality	MINOR	MODERATE	MINOR	MODERATE	MINOR	MODERATE	MINOR	MODERATE
15. Air Quality[5/]	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR	MINOR

1/ Refer to Table S-2 for the definitions of levels of effect for each resource category.

2/ Alternative II (No Sale)--The effects associated with the proposal or other alternatives would not occur with this alternative. Alternative III (Delay the Sale)--The effects associated with this alternative would be the same as those of Alternative I (Proposal), except their occurrence would be delayed 3 years. Adverse effects of the sale in future years may be of less consequence to species whose populations are currently increasing (i.e., gray whales).

3/ SPECIAL NOTE TO THE READER: SEE TABLE II-3 AND SECTIONS IV.B THROUGH IV.G FOR MORE COMPREHENSIVE ANALYSES OF THE EFFECTS--PARTICULARLY FOR BIOLOGICAL RESOURCES. IT IS PARTICULARLY RELEVANT TO REFER TO THE MORE DETAILED ANALYSES RATHER THAN USING ONLY THIS SUMMARY TABLE AS THE ULTIMATE PREDICTOR OF THE POTENTIAL EFFECTS OF BEAUFORT SEA SALE 97.

4/ With this alternative, noise and disturbance effects in the Point Barrow-Elson Lagoon area could be avoided and oil-spill effects reduced; however, oil-spill, noise and disturbance, and habitat effects on birds in other parts of the planning area would be the same as the effects of the proposal.

5/ The effects on attainment of air-quality standards are MINOR for each alternative, while secondary effects of air emissions are NEGLIGIBLE for each alternative.

Table S-2
Definitions Assumed in Effects Assessment

Resource Category	MAJOR	MODERATE	MINOR	NEGLIGIBLE
Biological Resources Lower-Trophic-Level Organisms Fishes Marine and Coastal Birds Pinnipeds, Polar Bears, and Beluga Whales Caribou	A regional population or species declines in abundance and/or distribution beyond which recruitment would not return it to its former level within several generations.	A portion of a regional population changes in abundance and/or distribution over more than one generation but the change is unlikely to affect the regional population.	A specific group of individuals of a population in a localized area and/or over a short time period (one generation or less) is affected; the regional population is not affected.	No measurable short-term or long-term change in numbers or distribution of individuals occurs in a population.
Endangered and Threatened Species	A regional population or species declines substantially in abundance and/or distribution, and recovery requires at least one generation.[1]	A portion of a regional population declines in abundance and/or distribution, and more than one breeding cycle,[2] but recovery requires less than one generation.	A specific group of individuals of a population in a localized area is affected over a short time period (less than one breeding cycle).	No measurable change occurs.
Subsistence-Harvest Patterns	One or more important subsistence resources would become locally unavailable for a period of time exceeding 1 year.	One or more important subsistence resources would become locally unavailable for a period of time not exceeding 1 year.	Subsistence resources would be affected for a period of less than 1 year, but no resource would become unavailable.	Subsistence resources could be affected but with no apparent effects on subsistence harvests.
North Slope Sociocultural Systems	Long-term (5 years or more), chronic disruption of local sociocultural systems occurs with a tendency toward the displacement of existing institutions.	Long-term (5 years or more), chronic disruption of local sociocultural systems occurs without a tendency toward the displacement of existing institutions.	Short-term disruption of local sociocultural systems occurs without a tendency toward the displacement of existing institutions.	Periodic disruption of local sociocultural systems occurs without apparent effects.
Population	The capacity of the existing service or facility is exceeded by OCS-induced user demands. Demands on the service as a result of population increases and/or industrial expansion account for over 20 percent of the total demand on any individual service.	The capacity of the existing service or facility is exceeded by OCS-induced user demands. Demands on the service as a result of population increases and/or industrial expansion account for between 10 and 20 percent of the total demand on any individual service.	The capacity of the existing service or facility is exceeded by OCS-induced user demands. Demands on the service as a result of population increases and/or industrial expansion account for up to 10 percent of the total demand on any individual service.	User demands are within the capacity of the existing service or facility.
Economy of the North Slope Borough	Economic effects occur which will require major changes in governmental policies, planning, or budgeting, or which have the potential to create major problems or to cause important and sweeping changes in the economic well-being of residents of the area.	Economic effects occur which will require some but not major modification of governmental policies, planning, or budgeting, or may create problems such as an increased rate of price inflation or housing shortages, or may substantially affect the economic well-being of residents of the area.	Economic effects occur which may require slight marginal changes in governmental policies, planning, or budgeting, or may marginally affect the economic well-being of residents of the area.	Economic effects occur which have no measurable effect on governmental policies, planning, or budgeting, or no measurable effect on the economic well-being of residents of the area.

Table S-2
Definitions Assumed in Effects Assessment
(Continued)

Resource Category	MAJOR	MODERATE	MINOR	NEGLIGIBLE
Land Use Plans and Coastal Management Programs	OCS-related and gas activities and developments lead to displacement of existing or proposed land uses for which no reasonable alternative location is possible, or high incompatibility with existing or proposed land uses; or they conflict with four or more policies of local, State, or Federal coastal management programs and land use plans.	OCS-related oil and gas activities and developments alter or preclude a preferred use of an area, or conflict with three policies of local, State, or Federal coastal management programs and land use plans.	OCS-related oil and gas activities and developments conflict with two policies of local, State, or Federal coastal management programs and land use plans. Some infringement on a present or anticipated use of an area may occur.	OCS-related oil and gas activities and developments generally conform with policies of local, State, and Federal coastal management programs and land use plans.
Archaeological Resources	Many archaeological resources are expected to be present and disturbed.	Some archaeological resources are expected to be present and disturbed.	Few archaeological resources are expected to be present and disturbed.	No archaeological resources are expected to be present and disturbed.
Recreation and Tourism Resources	Much reduced recreation and tourism noneconomic qualities and economic values over the whole area for approximately 3 to 4 years or longer.	Some reduced recreation and tourism noneconomic qualities and economic values over one-half of the area lasting for approximately 2 years.	Slight reduction in recreation and tourism noneconomic qualities and economic values over one-fourth of the area lasting approximately 1 year.	No reduction in recreation and tourism noneconomic qualities and economic values.
Water Quality	Regional, long-term, measurable degradation occurs.	Regional, short-term, measurable degradation occurs.	Local but long-term, measurable degradation occurs.	Short-term, local degradation occurs.
Air Quality3/	Emmissions would be in violation of Federal standards for ambient and/or incremental air quality at the shoreline. The DOI exemption criteria would be exceeded.	Pollutant concentrations at the shoreline could approach the maximum levels permitted by Federal standards for ambient and/or incremental air quality. The DOI exemption criteria could be exceeded.	The DOI exemption criteria could be exceeded. Pollutant concentrations at the shoreline would not approach the maximum levels permitted by Federal standards for ambient and/or incremental air quality.	The DOI exemption criteria would not be exceeded and insignificant, secondary effects would occur.

1/ A generation is the average time period between the birth of the parents and birth of their offspring.
2/ A breeding cycle is the average time period between the births of successive offspring.
3/ Secondary effects from air emissions include effects other than those related directly to attainment of regulatory air-quality standards.

I

PURPOSE

FOR

ACTION

Section I - Table of Contents

Page

I. Purpose and Background of the Proposed Action 1

A. Leasing Process 1
1. Leasing Schedule 2
2. Request for Resource Reports 2
3. Call for Information and Nominations (Call) and Notice of Intent (NOI) to Prepare an Environmental Impact Statement (EIS) 2
4. Area Identification 2
5. Scoping 3
6. Preparation of Draft Environmental Impact Statement (DEIS) 3
7. Endangered Species Consultation 4
8. Public Hearings 4
9. Preparation of Final Environmental Impact Statement (FEIS) 4
10. Secretarial Issue Document (SID) 4
11. Proposed Notice of Sale 4
12. Decision and Final Notice of Sale 5
13. Lease Sale 5
14. Lease Operations 5

B. Leasing History 5

1. Previous Lease Sales 5
2. Drilling 6
3. Litigation 7
a. Coastline Definition and Delineation. 7
b. Compliance with NEPA and Endangered Species Act 8
c. Aboriginal Rights 8
d. Seasonal Drilling 8
e. ANICLA 8

C. Legal Mandates, Authorities, and Federal Regulatory Responsibilities 9

D. Results of the Scoping Process 10

1. Major Issues 10
2. Issues Not Analyzed in the EIS 10
a. Streamlining and Accelerated Leasing 10
b. Permitting and Monitoring of Seismic-Exploration Activities.... 10
c. Causeways 10
d. Offshore-Gravel Mining 10
3. Mitigating Measures 11
4. Alternatives Suggested During the Scoping Process 11
a. Delete Areas Used by Migrating Bowhead Whales, Marine Mammals, Fishes, and Birds 11
b. Delete Traditional Subsistence-Use Areas 11
c. Delete Bowhead Whale-Feeding Areas 11
d. Delete the Chukchi Sea Shelf 11
e. Delete Pack-Ice-Zone Tracts (Waters Deeper than 40 Meters) 12
f. Delete Disputed Tracts 12
g. Delete Areas Around Biologically Sensitive Areas 12
h. Delay the Sale for At Least 3 Years 12

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

The Department of the Interior (DOI) is required by law to manage the exploration and development of oil and gas resources on the Outer Continental Shelf (OCS). To help meet the energy needs of the Nation, these resources are to be developed as expeditiously, and yet as carefully, as possible. While overseeing this development, the Federal Government must, among other things, balance orderly resource development with protection of the human, marine, and coastal environments; ensure that the public receives a fair return for these resources; and preserve and maintain free-enterprise competition.

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

Current U.S. energy demands are met primarily by domestic and foreign fossil fuel. Since the 1973 Arab oil embargo, it has become increasingly apparent that our Nation must become less dependent on foreign imports, lessen our vulnerability to supply economics and supply interruptions, and prepare for the time when oil production approaches its capacity limitation. In 1978, Congress mandated the DOI to engage in "expedited exploration and development of" the OCS in order to "assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade." The Secretary has stated that "we honor that mandate, and until there is other direction, it will be our foremost guideline in all OCS activity."

The OCS leasing program does not represent a decision to lease in a particular area. Instead, it is representative only of the Department's intent to consider leasing in certain areas, and to proceed with the offering of such areas only if it should be determined that leasing and development would be technically feasible and environmentally acceptable. As a part of the OCS leasing program, the Department of the Interior has scheduled the Beaufort Sea Sale 97 for January 1988.

A. Leasing Process

The OCSLA charges the Secretary of the Interior with administering mineral exploration and development on the U.S. OCS and with conserving its natural resources. The Secretary has delegated authority to carry out offshore leasing and resource management functions to the Minerals Management Service (MMS). A vital part of the leasing program is the continuing MMS Studies Program, its direction principally guided by the OCS leasing schedule. This program provides relevant information about potential effects of oil and gas activities on the environment (OCS Environmental Studies Program) and communities, regions, or Alaska as a whole (Social and Economic Studies Program). For specific information on the MMS Studies Program, refer to Appendix D. The OCS leasing program is implemented by 30 CFR Part 256. Lease supervision and regulation of offshore operations is implemented by 30 CFR Part 250. The following steps summarize the leasing process for the proposed lease sale.

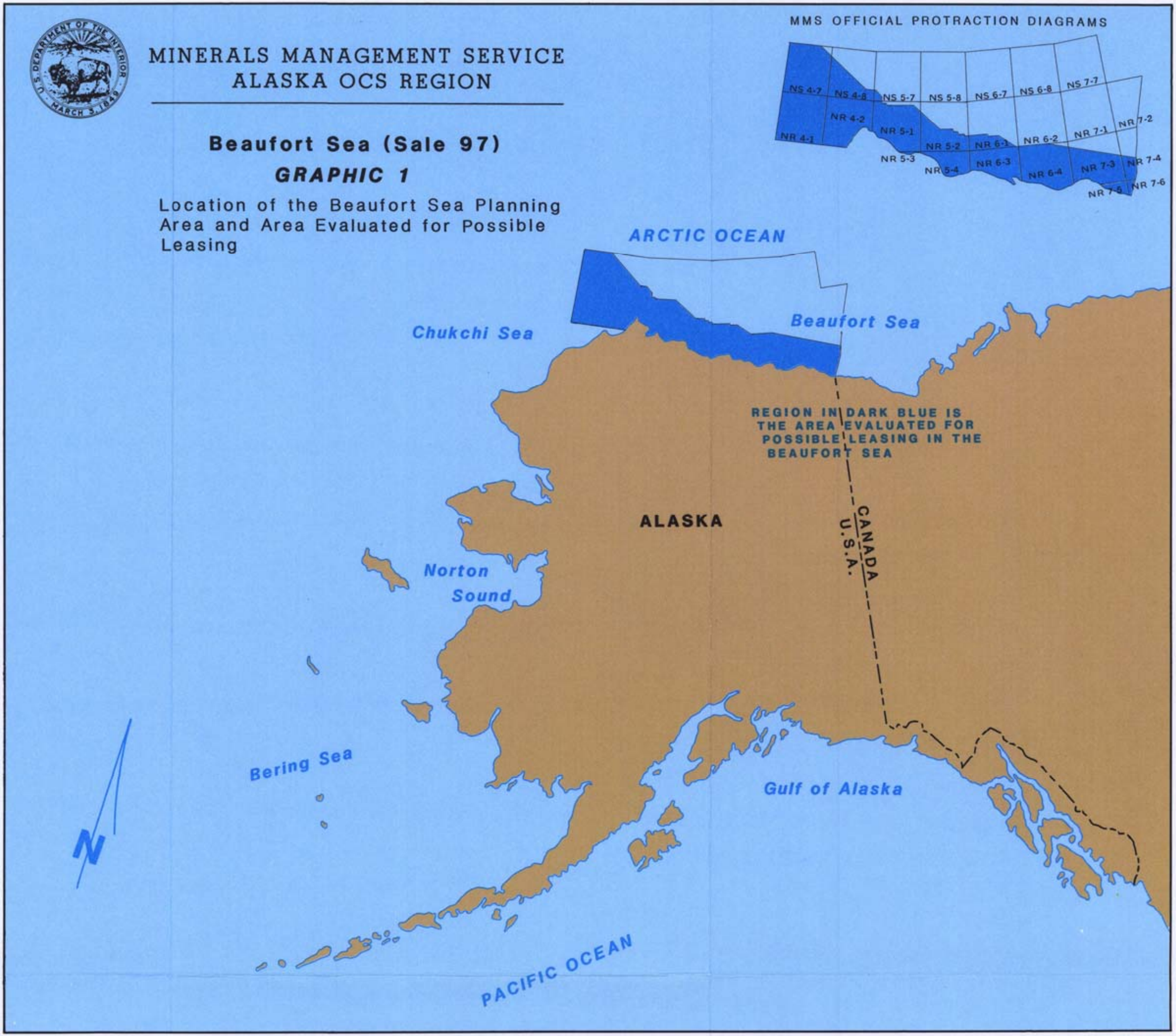
1. Leasing Schedule: The OCSLA, as amended, requires that the Secretary prepare and maintain a 5-year OCS oil and gas leasing program and that he review the program annually to ensure that it meets the Nation's energy needs. The current 5-Year OCS Oil and Gas Lease Sale Schedule announced by the Department of the Interior on July 21, 1982, consists of 41 proposed lease sales for the period August 1982 through June 1987, including 16 sales offshore Alaska. On April 27, 1987, the Secretary announced the DOI's proposed 5-year OCS oil and gas leasing program for mid-1987 to mid-1992. The 1987 proposed 5-year OCS oil and gas leasing schedule consists of 38 proposed lease sales including 3 supplemental sales. Twelve sales are scheduled offshore Alaska. Beaufort Sea Sale 97 is currently scheduled to be held in January 1988.

2. Request for Resource Reports: A request for resource reports is the first step of initiating the pre-sale process for a specific lease sale. Resource reports are requested from various Federal and State agencies on or before the Call for Information and Nominations is published. These reports provide valuable geological, biological, oceanographic, navigational, recreational, environmental, archaeological, and socioeconomic information on a proposed lease area. Resource reports for the Beaufort Sea Sale 97 area were requested in September 1983 and were received by the MMS Alaska OCS Region by December 1983.

3. Call for Information and Nominations (Call) and Notice of Intent (NOI) to Prepare an Environmental Impact Statement (EIS): A Call and 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 for the proposed Beaufort Sea Sale 97 was published in the Federal Register on September 24, 1984 (49 FR 37532), requesting comments on areas of interest and lease terms. Comments are requested on the Call no later than 45 days after publication. Comments are requested on the NOI generally 30 days after Area Identification is announced. The comments received from the NOI are discussed under scoping, below, and in Section I.D. The Beaufort Sea Call area was located generally off the northern coast of Alaska in the arctic and covered approximately 21 million hectares (49 million acres) containing 9,465 blocks (see Graphic 1).

In response to the Call, 13 companies submitted indications of interest in areas for leasing. Nominations received indicated interest in the entire Call area. Comments were received from six companies, as well as the State of Alaska (SOA), the North Slope Borough (NSB), the Alaska Eskimo Whaling Commission (AEWC), and the National Oceanic and Atmospheric Administration (NOAA). Comments received on the Call provided information on lease terms and block size and identified significant environmental concerns.

4. Area Identification: Based on information received from the resource reports and in response to the Call--together with recommendations from MMS; National Marine Fisheries Service (NMFS); Fish and Wildlife Service



Beaufort Sea (Sale 97)

GRAPHIC 1

Location of the Beaufort Sea Planning Area and Area Evaluated for Possible Leasing

(FWS); comments from the Governor on technological and socioeconomic information; and the Department of the Interior's own environmental, technological, and socioeconomic information--the Secretary selects an area for environmental analysis and study. On January 22, 1985, the Secretary of the Interior selected 3,930 blocks in the Beaufort Sea, an area of approximately 8.6 million hectares (21.2 million acres), for analysis in this EIS (see Graphic 1).

5. Scoping: The NOI, published in the same document as the Call (Step 3), serves to announce the scoping process that will be followed for the EIS. The Council on Environmental Quality defines scoping as "an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). It is a means for early identification of important issues deserving of study in an EIS. The intent of scoping is to avoid overlooking important issues that should be analyzed and to deemphasize less-important issues.

Comments are invited from affected Federal, State, and local government agencies; any affected Native groups; the industry; and any interested persons. Information obtained from the resource reports, scoping meetings, and the Call is considered part of scoping.

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

For the proposed Beaufort Sea Sale 97, MMS issued scoping letters in March of 1985. In addition, scoping meetings were conducted in Barrow, Nuiqsut, and Wainwright from April 12 through April 19, 1985. The results of the scoping process for this proposed lease sale are presented in Section I.D of this EIS. Section VI.C lists those consulted prior to and during the preparation of this EIS.

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

An integral part of preparing an EIS is the exchange of technical information that occurs during MMS-sponsored Information Update Meetings (IUM's) and Information Transfer Meetings (ITM's). IUM's are held to provide an opportunity for MMS staff to discuss with investigators from the OCS Environmental Studies Program current results of studies in a lease-sale-specific area (for information about MMS-sponsored studies, see Appendix D). An IUM for the Beaufort Sea was held March 6 and 7, 1985, at Anchorage, Alaska, to review the status of environmental knowledge and to discuss the implications of proposed oil and gas development for the Beaufort Sea Planning Area. ITM's are public meetings held to present a general overview of regional knowledge. Participants at ITM's include researchers from public and private institutions; MMS staff; representatives of other Federal agencies, State of Alaska, private industry, and regional organizations; and members of the MMS Alaska Regional Technical Working Group.

The DEIS describes the potentially affected marine and onshore environment, presents an analysis of potential adverse effects on this environment and the area's inhabitants, describes potential mitigating measures to reduce the adverse effects of offshore leasing and development, describes alternatives to the proposal, and presents a record of consultation and coordination with others during EIS preparation.

The document is filed with the EPA, and its availability is announced in the Federal Register. Any interested party may request a copy of the DEIS by contacting the MMS office listed in the Federal Register.

7. Endangered Species Consultation: Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, MMS consults with the FWS and 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 were conducted on the potential effects of OCS leasing and subsequent activities on endangered and threatened species in the Beaufort and Chukchi Seas.

In accordance with Section 7(a) of the Endangered Species Act of 1973, as amended, formal consultations on the proposed Beaufort Sea Sale 97 were initiated with NMFS and FWS on July 10, 1985. The FWS biological opinion on the arctic peregrine falcon and two candidate plant species was received on July 30, 1985; the NMFS biological opinion on endangered whales was received on May 19, 1987. Both opinions are included in Appendix J.

8. Public Hearings: Public hearings are held after release of the DEIS, and specific dates and locations for public hearings are announced in the Federal Register. Public hearings on this DEIS were held in Barrow, Wainwright, Kaktovik, Nuiqsut, and Anchorage during December 1986.

9. Preparation of the Final Environmental Impact Statement (FEIS): Oral and written comments obtained on the DEIS during the public comment period are addressed in the FEIS, which is then made available to the public and filed with the EPA. The availability of the FEIS is announced in the Federal Register.

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

11. Proposed Notice of Sale: At least 90 days before the proposed lease sale, a proposed Notice of Sale is prepared and its availability is announced in the Federal Register. A copy of the actual notice is furnished to the Governor of Alaska, pursuant to Section 19 of the OCSLA, so that he and any affected local governments may comment on the size, timing, and location of the proposed sale. Comments must reach the Secretary within 60 days after notice of the proposed lease sale.

12. Decision and Final Notice of Sale: The entire prelease process culminates in a final decision by the Secretary on whether to hold a lease sale and, if so, its size, terms, and conditions. 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 terms, i.e., size of lease sale, bidding systems, and mitigating measures.

13. Lease Sale: The Beaufort Sea Sale 97 is scheduled to be held in January 1988. Sealed bids for individual blocks and bidding units (those listed in the Notice of Sale) are opened and publicly announced at the time and place of the sale. 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 qualified 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.

14. Lease Operations: After leases are awarded, the MMS Field Operations Office is responsible for supervising and regulating operations conducted on the lease. Prior to any exploration activities on a lease, except preliminary activities, a lessee must submit an exploration plan and an environmental report--including an Oil Spill Contingency Plan and an Application for Permit to Drill (APD)--to MMS for approval. The Office of Ocean and Coastal Resource Management, FWS, NMFS, EPA, National Park Service, U.S. Army Corps of Engineers, U.S. Coast Guard, 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 Coastal Zone Management Act concurrence or presumed concurrence with the lessee's Federal consistency determination. The APD is approved after the State has concurred with the lessee's Federal consistency determination.

B. Leasing History

This section summarizes and incorporates by reference paragraphs I.B and Appendix J, Leasing History, of the FEIS for Sale 87. Additional information specifically pertaining to the Beaufort Sea Sale 97 area is summarized below.

1. Previous Lease Sales: There have been three Federal offshore lease sales conducted for the Beaufort Sea. The Joint Federal/State Beaufort Sea Oil and Gas Lease Sale (BF) was held in December 1979; Sale 71 was held in October 1982; and Sale 87 was held in August 1984. All three sales resulted in a total of 372 Federal leases (covering 791,724 hectares) being issued for 10-year terms. Effective December 31, 1986, 23 leases have been relinquished.

Sale BF resulted in the issuance of 24 Federal leases and 62 State leases. A controversy over jurisdiction of OCS lands resulted in a lawsuit being filed in the U.S. Supreme Court to resolve State and Federal boundary disputes in the area from Icy Cape in the Chukchi Sea to the U.S./Canadian border. In the BF Sale, 20 of the federally managed leases and four of the State-managed leases were affected by the dispute. A Beaufort Sea Management Committee was formed to administer State and Federal leases in the Beaufort Sea sale area in accordance with an Agreement under Section 7 of the OCS Lands Act and Alaska

Statute 38.05.137 and to manage them in accordance with a Management Plan for the Joint Federal/State Beaufort Sea Oil and Gas Lease Sale. The committee is responsible for, among other things, the consistency of operations throughout the duration of the dispute. In furtherance of its responsibility, the committee initiated the formation of a Biological Task Force (BTF) for the Beaufort Sea lease area. The BTF was established to provide consultation to the MMS and the Alaska Division of Oil and Gas (formerly the Division of Minerals and Energy Management) on biological/environmental aspects of specified Federal and State lease stipulations.

As a result of Sale 71, 121 leases were issued, including one lease on disputed lands. (For detailed information on Sales BF and 71, refer to Appendix J of the FEIS for Sale 87.)

The third Federal offshore oil and gas lease sale in the Beaufort Sea, Sale 87, was conducted in August 1984. Negotiations between the Federal Government and the State of Alaska led to the deferral of 38 blocks around Point Barrow to provide additional protection for bowhead whales and subsistence activities. Also, approximately 1,700 acres under Federal/State jurisdictional dispute northeast of the Canning River area offshore the Arctic National Wildlife Refuge were deferred because sufficient time did not exist for the State to perform its presale analyses as required by State law. The Department of the Interior did, however, enter into an agreement with the State of Alaska to offer 44 disputed blocks under Section 7 of the OCS Lands Act. The Sale 87 area consisted of approximately 3.1 million hectares (7.8 million acres), lying in waters between 3 and 160 miles from shore and 2 to 200 meters deep. Of the 1,419 blocks and bidding units offered, 232 received bids. One high bid was rejected because this area is subject to jurisdictional claims by Canada and the U.S. Bids on blocks east of the 141st meridian were subject to special procedures. Bids on four blocks in this area were determined to be adequate, but bids were neither accepted nor rejected. The one-fifth bonus amounts of these bids were placed into an interest-bearing escrow account. No leases will be issued until such time as it is determined to be in the best interest of the United States to do so. The remaining 227 high bids were accepted, and leases were issued. The Beaufort Sea BTF formed for Sale 71 assumed responsibility for consultation on biological/environmental aspects of Sale 87 leases as well.

The State of Alaska has held 15 competitive lease sales to date on the North Slope and in adjacent State waters in the Beaufort Sea, including the Joint Federal/State Beaufort Sea Sale. The 1987 State of Alaska Five-Year Oil and Gas Leasing Program has scheduled four offshore lease sales in the Beaufort Sea between January 1987 and June 1991.

2. Drilling: A deep-stratigraphic-test (DST) well was drilled on Reindeer Island during the winters of 1978/1979, but no DST wells have been drilled in the Beaufort Sea OCS. Since 1981, 18 exploratory wells have been drilled in Federal leases in the Beaufort Sea. Five wells were determined to be producible. Development plans for 4 of the producible wells are not anticipated. Amerada Hess recently discovered oil in a well drilled from Northstar Island about 4 miles northwest of Seal Island in State waters. The well is located directly south of disputed block 470. Federal lease OCS-Y-0179 contains disputed blocks 470, 471, and 515. Two wells were drilled from Seal Island directionally into leases OCS-Y-0180 and 0181. Seal Island,

also located in State waters, lies southeast of North Star. The well drilled into lease OCS-Y-0181 contained oil. Determination of the well on lease OCS-Y-0180 is not public information. The Northstar discovery appears to confirm the extension of the Seal Island reservoir, which underlies both Federal and State leases. The Seal Island field is currently under evaluation for development. Shell drilled a well from a gravel island (Sandpiper) into lease OCS-Y-0370 (block 424) located northwest of North Star. This well was determined producible. Amoco drilled a second well from the same island directionally into lease OCS-Y-0371. A determination on this well is pending. In State waters, 44 offshore exploratory wells have been drilled on natural as well as artificial islands; 25 of these wells have been plugged and abandoned and 18 have been suspended. Results from one well have not yet been made public.

Onshore, exploratory drilling has taken place in the National Petroleum Reserve-Alaska (NPR-A), where 76 wells have been drilled and 44 shallow-core tests have been conducted. Since 1982, the Bureau of Land Management (BLM) has held four competitive lease sales in the NPR-A, leasing 1.3 million acres (56 tracts). All leases in NPR-A were issued for a primary term of 10 years. As of January 1, 1987, 33 of these leases had been relinquished. In January of 1985, ARCO Alaska, Inc., drilled 1 well approximately 25 miles southwest of Barrow. The well was plugged and abandoned 2 months later. No oil or gas was discovered. The BLM has cancelled a fifth lease sale in the NPR-A that was scheduled for August 1985. A request for interest by BLM to determine leasing interest failed to justify holding a sale in 1986. The agency published another request for interest in the NPR-A in April 1987. Results of that survey are pending.

The area proposed for lease includes approximately 425,550 acres east of the 141st meridian, which is claimed by the Government of Canada. The United States has advised the Government of Canada by Diplomatic Note that it does not accept that any part of Sale 97 encroaches on Canada's sovereign rights under international law and that it does not share the Canadian view that the location of the maritime boundary in the Beaufort Sea follows the 141st meridian. However, in recognition that there is no agreed maritime boundary and that part of Sale 97 is subject to an overlapping claim by the Government of Canada, the United States has advised the Government of Canada that this portion of the sale area will be subject to special procedures. Canadian industry holds several permits for oil and gas exploration in the area. The Federal Government also offered leases in this area during the Department of the Interior's OCS Sale 87, Diapir Field, held in August 1984. The high bids received for four blocks within the contested area were determined to be adequate; however, leases were not issued (see discussion above). For Sale 97, the United States intends to follow procedures similar to those established for Sale 87 with regard to bids received on blocks in the contested area. These procedures are without prejudice to the United States' interests in a future settlement.

3. Litigation:

a. Coastline Definition and Delineation: Controversies between the U.S. Government and the State of Alaska over jurisdiction of offshore lands resulted in litigation (United States v. State of Alaska, U.S. Supreme Court No. 84, Original [1979]) to settle disagreements over the definition and delineation of the coastline. The United States and the State of Alaska jointly submitted a statement of questions to the Special Master appointed by the Supreme Court to assist in resolving the issues before the court. Oral testimony on these issues was completed on November 20, 1986. The Special Master is anticipated to submit his report and recommendations to the court in the summer of 1987. The case is expected to be scheduled for hearing before the U.S. Supreme Court sometime in the fall of 1987.

b. Compliance with NEPA and Endangered Species Act: Sale BF was litigated in Federal court (North Slope Borough v. Andrus, 642 F.2d 589 [D.C. Cir. 1980]) and resulted in an injunction by the U.S. District Court against the Department of the Interior to lease Federal tracts and a ruling that it had not complied with the NEPA and the Endangered Species Act. The Secretary of the Interior was ordered by the court to prepare a supplemental EIS. Interior's appeal to the U.S. Court of Appeals for the District of Columbia resulted in a reversal of the lower court's order and issuance of Federal leases. The NSB also filed suit against the State of Alaska (Hammond v. North Slope Borough, 645 P.2d 750 [Alaska 1982]) in Superior Court, seeking to enjoin the State from issuing leases in the Beaufort Sea. An appeal to the State Supreme Court resulted in a remand order to the Commissioner of Natural Resources to reconsider his decision that the lease sale was consistent with the Alaska Coastal Management Plan and to develop a record for further review.

c. Aboriginal Rights: In January 1981, the Inupiat Community filed suit in U.S. District Court, Anchorage, Alaska, claiming aboriginal rights to the OCS in the Beaufort and Chukchi Seas. The district court's ruling denying aboriginal rights was affirmed by the Ninth U.S. Court of Appeals in November 1984 (Inupiat Community v. United States, 746 F.2d 570 [9th Cir. 1984]). The Inupiats filed a petition with the U.S. Supreme Court to hear their case, which was denied on October 7, 1985.

d. Seasonal Drilling: In North Slope Borough v. Watt (No. 84-3672, 9th Cir., July 1984), plaintiffs challenged the legality of the decision to shorten the seasonal drilling stipulation for Sales BF and 71. The U.S. District Court ruled in favor of the U.S. Government on all issues. The ruling was appealed in March 1984 but was later withdrawn by the NSB and the case dismissed.

e. ANILCA: Four lawsuits have been filed against lease sales in the Bering Sea, charging that provisions of Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA) must be followed prior to authorizing OCS Leasing activities.

(1) Village of Gambell, et al., v. Donald P. Hodel, Civ. No. N83-003 (D. Nome, Alaska, March 4, 1983), otherwise referred to as "Gambell I." Plaintiffs were successful in delaying issuance of Sale 57, Norton Basin, leases. However, the Ninth Circuit U.S. Court of Appeals overruled the U.S. District Court, holding that Section 810 of ANILCA applied to the OCS. As a result, DOI prepared a Section 810 evaluation on OCS Lease Sale 57. The Court's decision was not appealed.

(2) Village of Gambell v. Donald P. Hodel, Civ. No. A85-201 (D. Alaska, May 23, 1985), otherwise referred to as "Gambell II." Plaintiffs succeeded in their petition for a preliminary injunction against OCS drilling activities on Sale 57 leases by order of the Ninth Circuit U.S. Court of Appeals.

(3) Villages of Gambell and Stebbins v. Hodel, Civ. No. A85-184 (D. Alaska, May 23, 1985), otherwise referred to as "Gambell II" (after consolidation with Civ. No. A85-201). Plaintiffs succeeded in their petition for a preliminary injunction against OCS drilling activities on Sale 83 leases by order of the Ninth Circuit U.S. Court of Appeals. The DOI appealed the ruling to the U.S. Supreme Court.

(4) Tribal Village of Akutan, et al., v. Hodel, Civ. No. A85-701 (D. Alaska, December 27, 1985). The Secretary of the Interior was enjoined from opening bids for Sale 92, North Aleutian Basin. The Ninth Circuit U.S. Court of Appeals upheld the injunction and the ruling was appealed to the U.S. Supreme Court.

In light of the Ninth Circuit U.S. Court of Appeals decision that Section 810 of ANILCA applied to the OCS, the MMS prepared evaluations under Section 810 of ANILCA for subsequent environmental assessments and EIS's. Both the Gambell II decision and the Sale 92 decision were appealed to the U.S. Supreme Court.

On March 24, 1987, the U.S. Supreme Court reversed the Ninth Circuit Court's ruling on ANILCA in the Gambell II case (Hodel v. Village of Gambell, et al., No. 85-1406), holding that Section 810 (a) of ANILCA unambiguously applied only to Federal lands within the State of Alaska's boundaries and that by definition the OCS is not situated in the State of Alaska.

On March 30, 1987, the U.S. Supreme Court, in light of its Gambell II decision, remanded the case on Sale 92 (Hodel v. Tribal Village of Akutan, Nos. 86-303 and 86-304) to the Ninth Circuit Court for reconsideration on the injunction it granted earlier based on its ANILCA decision.

As a result of the U.S. Supreme Court's ruling that ANILCA does not apply to the OCS, Section 810 evaluations will no longer be included in EIS's for proposed OCS lease sales.

C. Legal Mandates, Authorities, and Federal Regulatory Responsibilities

OCS Report MMS 86-0003, "Legal Mandates and Federal Regulatory Responsibilities," September 1986 (Alaska OCS Region Technical Report No. 4, 2nd Edition [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 OCS Lands Act, as amended, and related statutes; a summary of the requirements for exploration and development and production activities, including Alaska OCS Orders; a discussion of authorities of other Federal agencies that affect OCS activities; and a discussion of significant litigation affecting OCS leasing policy.

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 (ANCSA) and the Alaska National Interest Lands Conservation Act (ANILCA) on coastal management.

D. Results of the Scoping Process

The scoping process for Beaufort Sea Sale 97 included the (1) Request for Resource Reports; (2) Call for Information and Notice of Intent to Prepare an EIS; (3) scoping meetings in Barrow, Wainwright, and Nuiqsut in April 1985; (4) information gathered through personal communications between MMS staff and others; (5) an evaluation of issues analyzed in the EIS's prepared for past Beaufort Sea (formerly Diapir Field) oil and gas lease sales; and (6) MMS staff suggestions.

1. Major Issues: The major issues listed in Table I-D-1 resulted from MMS staff evaluation of issues raised during the scoping process for Sale 97. The analysis in this EIS is based on these issues.

2. Issues Not Analyzed in the EIS: The following concerns raised during the scoping process are not analyzed in this EIS for the reasons noted:

a. Streamlining and Accelerated Leasing: The lease schedule and streamlining (one aspect is the identification of large areas instead of specific blocks) were developed in accordance with Section 18 of the OCS Lands Act, as amended, and are beyond the scope of this EIS.

b. Permitting and Monitoring of Seismic-Exploration Activities: These concerns deal directly with procedural matters. The questions regarding the permitting and monitoring of seismic-exploration activities have been addressed in a letter to the NSB describing the permitting process, the monitoring procedures, and the responsible officials to notify in case there are suspected violations of the permit(s).

c. Causeways: The construction and use of causeways in the Alaskan Beaufort Sea are not discussed as separate significant issues, but the effect of causeways is analyzed in the context of other resources and activities. The MMS anticipates that the State of Alaska (SOA), the NSB, and the U.S. Army Corps of Engineers (COE) will review causeway plans for consistency with State and Borough coastal management programs and for compliance with applicable State and Federal regulations.

d. Offshore-Gravel Mining: Offshore mining of sand and gravel is not discussed as a separate significant issue. However, the effects of such activities are analyzed in the context of other resources and activities. In addition, recent advances in the technology of offshore-drilling units, along with a reduction in petroleum-resource estimates for the Beaufort Sea Planning Area, have decreased the predicted number of gravel islands that may

Table I-D-1
Major Scoping Issues

Issues	Specific Concerns	Discussion Location in EIS (Section)
BIOLOGICAL RESOURCES		
Lower-Trophic-Level Organisms	Effects:	
	from oil spills	IV.B.1.a(1), IV.B.1.b(1)
	from discharges (drilling muds and cuttings and formation waters)	IV.B.1.a(3), IV.B.1.b(3)
	from construction activities	IV.B.1.a(4), IV.B.1.b(4)
Fishes	Effects:	
	from oil spills	IV.B.2.a(1), IV.B.2.b(1)
	from discharges (drilling muds and cuttings and formation waters)	IV.B.2.a(3), IV.B.2.b(3)
	during migration	IV.B.2.a(1), IV.B.2.b(4)
Marine and Coastal Birds	Effects:	
	from oil spills	IV.B.3.a(1), IV.B.3.b(1)
	from noise and other disturbances (vessels and aircraft)	IV.B.3.a(3), IV.B.3.a(2)
	on important habitats (nesting, feeding, rearing, and molting areas)	IV.B.3.a(3), IV.B.3.a(4) IV.B.3.b(2), IV.B.3.b(3)
	during spring and fall migrations	IV.B.3.a(1)
Arctic Peregrine Falcon	Effects:	
	from oil spills	IV.B.5.b(3)
	from noise and other disturbances (vessels and aircraft)	IV.B.5.b(3)
Pinnipeds, Polar Bears and Beluga Whales (Marine Mammals)	Effects:	
	from oil spills	IV.B.4.a(1), IV.B.4.b(1)
	from noise and other disturbances (marine and over-the-ice seismic activities, marine traffic, and aircraft)	IV.B.4.a(2), IV.B.4.b(2)
	on important habitats (breeding, feeding, rearing, and haulout areas)	IV.B.4.a(1), IV.B.4.b(3)

Table I-D-1
Major Scoping Issues
(Continued)

Issues	Specific Concerns	Discussion Location in EIS (Section)
Bowhead and Gray Whales	Effects:	
	from oil spills	IV.B.5.b(1), IV.B.5.b(2), IV.B.5.c(1)
	from noise and other disturbance (seismic activities, marine traffic, offshore drilling operations, dredging, and aircraft)	IV.B.5.b(1), IV.B.5.b(2), IV.B.5.c(1)
	from discharges (drilling muds and cuttings and formation waters)	IV.B.5.b(1), IV.B.5.b(2), IV.B.5.c(1)
	on important habitats (feeding and rearing areas)	IV.B.5.b(1), IV.B.5.b(2), IV.B.5.c(1)
	during spring and fall migrations	IV.B.5.b(1), IV.B.5.b(2), IV.B.5.c(1)
Caribou	Effects:	
	of onshore pipelines	IV.B.6.a(1), IV.B.6.a(3)
	of roads and traffic	IV.B.6.a(3), IV.B.6.a(2),
	of noise and other disturbances (surface vehicles and aircraft)	IV.B.6.a(3)
Biologically Sensitive Areas	Effects:	
	from oil spills	IV.B.1.a(1), IV.B.1.b(1)
	from discharges (drilling muds and cuttings and formation waters)	IV.B.1.a(3), IV.B.1.b(3)
	from construction activities	IV.B.1.a(4), IV.B.1.b(4)
SOCIOCULTURAL ISSUES		
Subsistence Hunting and Fishing	Effects:	
	on subsistence resources	IV.B.9.a(1)
	from losses of subsistence resources	IV.B.9.a(1)
	of oil spills contaminating Native foods	IV.B.9.a(1)
Socioeconomic	Effects:	
	on local communities	IV.B.8.a, IV.B.10.a
	on Native employment	IV.B.7.a, IV.B.8.a, IV.B.10.a
	on North Slope Borough (NSB) planning efforts	IV.B.11

Table I-D-1
Major Scoping Issues
(Continued)

Issues	Specific Concerns	Discussion Location in EIS (Section)
OTHER MATTERS		
Oil Spills	Effects:	
	of oil-spill-response and -cleanup capabilities in an open-water environment, in broken-ice conditions, on and under the ice, and along coastal areas	IV.A.2.c
	oil-spill transport, particularly movement of oil through the water column	IV.A.2.a
	of mitigating measures on oil-spill-contingency plans and oil-spill-cleanup technology	IV.A.2.c
Oil-Spill-Risk Analysis	Effects:	
	of lack of understanding and confidence regarding the methodology used to predict oil-spill trajectories and estimates of oil-spill risks	IV.A.1.b, IV.A.1.c
Constraints on Development	Effects:	
	of sea ice on offshore exploration, development and production, and transportation facilities and operations	IV.A.3.a
	of other hazards (waves and currents, especially during storm surges, faults and earthquakes, permafrost, unstable seafloor sediments, and shallow and hydrate gases and erosion)	IV.A.3.b

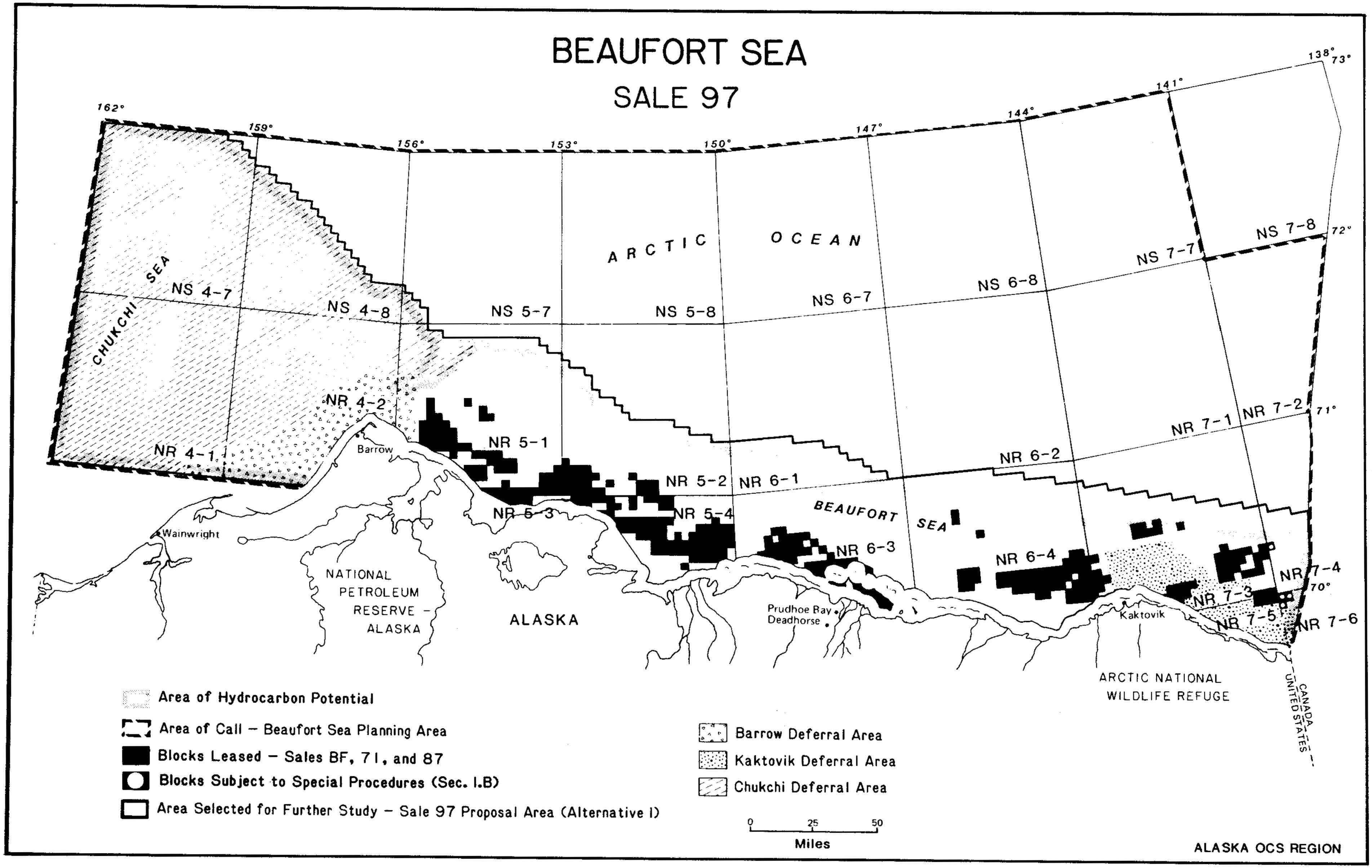


FIGURE I-1. MAP SHOWING THE BEAUFORT SEA PLANNING AREA, SALE 97 PROPOSAL AREA (ALTERNATIVE I), AND PROPOSED DEFERRAL AREAS be needed for exploration and development and production. Also, the effects of offshore sand and gravel mining were discussed in the Proposed Arctic Sand and Gravel Lease Sale FEIS (USDOI, MMS, Alaska OCS Region, 1983).

3. Mitigating Measures: Although there were not any new mitigating measures suggested during the Sale 97 scoping process, the SOA supported at a minimum the adoption of all the Stipulations and Information to Lessees (ITL's) contained in the Sale 87 Notice of Sale (NOS). If adopted, the potential mitigating measures addressed in this EIS should either reduce or eliminate the potential effects on the environment caused by the proposed action--these effects of the action are analyzed in Section IV. Measures not directly affecting environmental protection are not part of the EIS but may be included in the NOS after consideration and coordination with affected State and local governments in accordance with Section 19 of the OCS Lands Act, as amended. Stipulations that are contained in the NOS will be included in leases as noted. The mitigating measures considered as ITL's provide the lease operators with notice of special concerns in or near the lease area. These measures, however, are merely advisory in nature and in most cases carry no specific requirements that the DOI will impose. DOI's authority relates to operations actually conducted on the OCS. Regardless of their advisory nature, these measures do provide positive mitigation by creating greater awareness of these special concerns on the part of the operator(s).

4. Alternatives Suggested During the Scoping Process: The following alternatives suggested during the scoping process were evaluated by MMS staff to develop the proposed alternatives to be analyzed in the Sale 97 EIS. The results of this evaluation are also shown below.

a. Delete Areas Used by Migrating Bowhead Whales, Marine Mammals, Fishes, and Birds: Information obtained from scoping, MMS-sponsored studies, and published sources was used to determine the Barrow, Kaktovik, and Chukchi Deferral Areas: Figure I-1. Each of the deferral areas is deleted from the proposed Sale 97 area to form three alternative sale areas identified either by a Roman numeral or by a name that includes the deferral area. The Barrow Deferral Area is deleted from the proposed Sale 97 area to form Alternative IV, the Barrow Deferral Alternative; Alternative V, the Kaktovik Deferral Alternative, does not include the Kaktovik Deferral Area; and Alternative VI, the Chukchi Deferral Alternative, omits the Chukchi Deferral Area. The alternatives are described in Section II.B.2.

b. Delete Traditional Subsistence-Use Areas: Information obtained from scoping, various studies, and published sources was used to develop the Barrow and the Kaktovik Deferral Areas. These deferral alternatives were suggested by the SOA, NSB, and the AEWC.

c. Delete Bowhead Whale-Feeding Areas: Information on bowhead whale-feeding areas acquired from scoping, MMS-sponsored studies, and published sources was incorporated into the Barrow and Kaktovik Deferral Areas. These deferral alternatives were suggested by the NSB, AEWC, and NOAA.

d. Delete the Chukchi Sea Shelf: The Chukchi Deferral Area was part of the area deferred from leasing during the proposed Notice of Sale phase for Sale 87. The Chukchi Sea shelf and the summer polar pack-ice edge are important habitats. In general, fish, bird, and marine mammal abundances and distributions, physical processes, and environmental hazards in the Chukchi Sea are less well-known than they are in the Beaufort Sea. This deferral alternative was suggested by NOAA.

e. 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 was not analyzed as a separate alternative for the following reasons: (1) About 40 blocks in waters 40 meters deep in the Beaufort Sea have already been leased and several of these blocks, in the eastern Beaufort Sea, border the 100-meter isobath; (2) in the Chukchi Sea, blocks in waters deeper than 40 meters are included as part of the Chukchi Deferral Area; (3) initially, it appears that the technologies and procedures that will be used to drill exploration wells in waters deeper than 40 meters will be the same as those proven by use in the Canadian Beaufort Sea; (4) 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 Alaska OCS Region Orders Governing Oil and Gas Lease Operations (Order No. 2); and (5) the adoption of a seasonal drilling restriction would reduce the risk of oil spills affecting bowhead whales during their spring and fall migrations.

f. Delete Disputed Tracts: The State of Alaska may request deletion of the Sale 97 blocks where both the State and Federal Governments claim jurisdiction if there is no agreement between the DOI and the SOA on leasing and unitization. Resolution of this matter is beyond the scope of this EIS and involves an agreement between the DOI and the SOA.

g. Delete Areas Around Biologically Sensitive Areas: The deferral of areas around such biologically sensitive areas as Harrison Bay and the Colville River Delta, Simpson Lagoon, the Stefansson Sound Boulder Patch area, Thetis Island, and saltmarshes was recommended by the EPA. Deferral of blocks adjacent to the Colville River Delta and Simpson Lagoon was analyzed in the Sale 71 EIS. The EIS analyses indicated that the alternatives would have essentially the same oil-spill-risk and disturbance effects on the biological resources as would the leasing proposal. The proposed ITL on Information on Areas of Special Biological and Cultural Sensitivity advises lessees of areas of biological importance that should be considered when preparing their oil-spill-contingency plans. Some of the blocks in and adjacent to the biologically sensitive areas above already have been leased by the SOA and the MMS.

h. Delay the Sale for At Least 3 Years: This alternative, which was suggested by the NSB, recommends delay of the sale until much more detailed information is available on the following: (1) areawide sea-ice dynamics; (2) the refinement of the oil-spill-trajectory model; (3) the importance of the waters between Barter Island and the Canadian border as a bowhead whale-feeding area; (4) the area used by the bowheads during their spring and fall migrations; (5) possible seaward displacement of the fall bowhead migration by industrial noises; and (6) the influence of industrial noise, particularly seismic noise, on fall migrating and feeding bowheads. The factors affecting sea-ice dynamics and bowhead whales are part of past and present MMS-sponsored studies. Oil-spill trajectories presently are predicted by an operational oil-spill-trajectory model. Major refinements to the model have been completed, and no new studies are being planned. Further data would be useful, but MMS has successfully used the existing data base in the past to provide an adequate analysis of these factors. However, the effects of a 2-year delay are analyzed in Section IV.D.

II

ALTERNATIVES INCLUDING THE PROPOSED ACTION

II

Section II - Table of Contents

	Page
II. Alternatives Including the Proposed Action	1
A. Resource Estimates and Basic Exploration, Production, and Transportation Assumptions for Effects Assessment	1
1. Resource Estimates	1
2. Activities Associated With Exploration--Mean-Case Resource Estimate	2
a. Timing of Activities	2
b. Exploration-Drilling Units	2
c. Shallow-Hazards Seismic Activity	3
d. Drilling Muds and Cuttings	4
e. Support and Logistic Functions	4
f. Personnel	5
3. Activities Associated With Development and Production--Mean-Case Resource Estimate	5
a. Timing of Activities	6
b. Production Platforms	6
c. Associated Activities	7
d. Personnel	7
4. Activities Associated With Oil Transportation (Pipelines)--Mean-Case Resource Estimate	8
5. Activities Associated With the Low-Case and the High-Case Resource Estimates	10
6. Scenarios for Alternatives IV, V, and VI	11
B. Description of the Proposal and Alternatives	11
1. Alternative I - Proposal	11
a. Description of the Proposal	11
b. Mitigating Measures That Are Part of the Proposed Action	12
c. Potential Mitigating Measures	12
(1) Potential Stipulations	12
Stipulation No. 1--Protection of Archaeological Resources	13
Stipulation No. 2--Orientation Program	14
Stipulation No. 3--Protection of Biological Resources	15
Stipulation No. 4--Seasonal Drilling Restriction for Protection of Bowhead Whales from Potential Effects of Oil Spills	17
Stipulation No. 5--Transportation of Hydrocarbons	20
(2) Potential Information to Lessees (ITL)	21
ITL No. 1--Information on Bird and Marine Mammal Protection	21
ITL No. 2--Information on Areas of Special Biological and Cultural Sensitivity	22
ITL No. 3--Information on the Arctic Peregrine Falcon	23
ITL No. 4--Information on Beaufort Sea Biological Task Force	24
ITL No. 5--Information on Subsistence Whaling and Other Subsistence Activities	24
ITL No. 6--Information on Coastal Zone Management	25
ITL No. 7--Information on Endangered Whales	25
2. Description of Alternatives II through VI	27
a. Alternative II - No Sale	27
b. Alternative III - Delay the Sale	27
c. Alternative IV - Barrow Deferral Alternative	27
d. Alternative V - Kaktovik Deferral Alternative	27
e. Alternative VI - Chukchi Deferral Alternative	27
C. Summary and Comparison of Effects of Alternatives	28

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

A. Resource Estimates and Basic Exploration, Production, and Transportation Assumptions for Effects Assessment

1. Resource Estimates: The conditional, economically recoverable resource estimates in the Sale 97 area are reported by MMS for (1) a low case--110 million barrels (MMbbls) of oil (Appendix G, Table G-1); (2) a mean case--650 MMbbls of oil (Table II-A-1; and Appendix G, Table G-2); and (3) a high case--1,660 MMbbls of oil (Appendix G, Table G-3). These estimates are conditional on the assumption that recoverable oil resources are present in the area. The marginal probability, estimated by MMS to be 0.69, indicates there is about a 69-percent chance of recoverable oil being present in the unleased portion of the sale area. Sale 97 is the fourth OCS oil and gas lease sale in the Beaufort Sea, and the petroleum resources from this sale will be developed simultaneously with the resources from previous lease sales: the Joint Federal and State of Alaska Oil and Gas Lease Sale (Sale BF) (held in Dec. 1979), Diapir Field Sale 71 (held in Oct. 1982), and the Diapir Field Lease Offering (June 1984) (Sale 87, held in Aug. 1984).

The conditional, mean, economically recoverable resource estimates for blocks leased as a result of Sales BF, 71, and 87 are reported by MMS to be 600 MMbbls of oil (Appendix G, Table G-4). The effects assessment for each of the previous sales was based on oil- and gas-resource estimates for the entire area being offered (Appendix G, Table G-8). However, these estimates were revised to obtain an estimate of the amount of oil that may be present only in those blocks leased--600 MMbbls. The estimated level of activities associated with the revised mean-case resource estimate forms the existing conditions for the assessment of the environmental effects that may occur as a result of Sale 97.

Eleven exploration wells have already been drilled in Sales 71 and 87 leased blocks and seven wells in the federally managed disputed blocks of Sale BF. (Appendix G, Table G-9). The estimated level of activities and scheduling of events for the exploration-drilling phase in the previous sale areas are shown in Table II-A-1 and Appendix G, Table G-4.

It is assumed that natural gas will also be discovered but will not be economical to produce for the foreseeable future (Cooke, 1985). Thus, the effects of potential gas development and production on the environment are discussed in Section IV.L, separate from the analysis of the effects of oil development and production in Section IV.B.

The strategies used to explore, develop and produce, and transport the potential petroleum resources of the Beaufort Sea area will vary. They will depend upon many factors, any number of which are unique to each leaseholder or operator. Because of these variables and because of the uncertainties with regard to the petroleum resources, there is no single development scenario.

The strategies and technologies that are described in the exploration, development and production, and transportation scenarios, Sections II.A.2 through 4, represent only some of possible types of activities that might be used to exploit the petroleum resources of the Beaufort Sea Planning Area. These strategies are used to identify characteristic activities and areas where these activities may occur, but they do not represent a recommendation, preference, or endorsement by the U.S. Department of the Interior. Alternative strategies and technologies are discussed in Section IV.A.3.

2. Activities Associated with Exploration--Mean-Case Resource Estimate: The mean, economically recoverable oil resources unleased in the area are estimated to be 650 MMbbls of oil. This estimate was used to formulate the primary oil-development scenario for the Sale 97 area. Also, this resource estimate is the one selected from the low-, mean-, and high-case estimates because it (1) represents quantities of oil that are large enough to be recoverable and (2) offers a reasonable chance for discovery and development.

a. Timing of Activities: The level of activities and the scheduling of events associated with the Sale 97 mean-case resource estimate are shown in Table II-A-1 and Appendix G, Table G-2. Exploratory drilling is estimated to begin in 1989. The first delineation well is expected to be drilled in 1990 or during the second drilling season. The first discovery may thus occur between the second or third year of the exploration-drilling phase. Eleven exploration and four delineation wells may be drilled in the Sale 97 area; the drilling of these wells could be completed by 1994. The amount of time required to drill and test each of the exploration or delineation wells is estimated to average 90 days (Roberts, 1987).

The activities associated with Sale 97 are assumed to be a continuation of the activities associated with previous Federal lease sales. Drilling of an additional 35 exploration wells in the previous sale areas could continue through 1990 (Table II-A-1 and Appendix G, Table G-2).

b. Exploration-Drilling Units: The types of units that may be used to drill exploration and delineation wells in the Sale 97 area will depend on (1) the water depth, (2) sea-ice conditions, (3) ice-resistant capabilities of the units, and (4) availability of drilling units.

Drilling units that are capable of operating in water depths of less than 20 meters include (1) artificial islands, (2) ice islands, and (3) bottom-founded mobile drilling units such as the Concrete Island Drilling System (CIDS) or the Single Steel Drilling Caisson (SSDC). A total of 16 artificial islands have been constructed in the Alaskan Beaufort Sea--12 in State of Alaska waters and 4 in Federal waters. Two ice islands were used to drill 1 well in State waters and another well in Federal waters. The CIDS has been used to drill 3 wells in Federal waters. The SSDC has been used to drill several exploration wells in the stamukhi zone in the Mackenzie Delta region of the Canadian Beaufort Sea. In the Alaskan Beaufort Sea, the SSDC was used to drill an exploration well in Harrison Bay in waters about 19 meters deep; drilling occurred between September 23 and December 19, 1986. The artificial islands and bottom-founded units can be used year-round but the ice islands only from about midwinter to early spring.

Bottom-founded mobile units and floating units can also be used to drill wells in waters deeper than 20 meters. Present-day bottom-founded mobile units that are designed to operate year-round have been used in waters as deep as about 30 meters. With icebreaker assistance, floating vessels, such as ice-strengthened drillships or the Conical Drilling Unit (CDU), are capable of

Table II-A-1

Summary of Basic Scenario Assumptions Regarding Estimated OCS-Related Activities in the Beaufort Sea

PHASE Facility or Event	SALE 97 MEAN CASE[1]		PREVIOUS LEASE AREAS MEAN CASE [2]		BEAUFORT SEA SUMMARY	
	Number or Amount	Time-Frame	Number or Amount	Time-Frame	Number or Amount	Time-Frame
EXPLORATION						
Exploration and Delineation Well Drilling		1989-1994		1985-1990		1985-1994
from Artificial Islands	1		2		3	
from Bottom-Founded Mobile Drilling Units, Floating Drilling Units, Ice Islands	14		33		47	
Total Drilling Muds and Cuttings						
Drilling Muds--Tons	14,500		33,950		48,500	
Cuttings--Tons	23,250		63,000		86,250	
Shallow-Hazards Survey						
Total Area Covered--km²	345		805		1,150	
Total Support Activities for Exploration Phase						
Helicopter Flights	1,350		3,150		4,500	
DEVELOPMENT AND PRODUCTION						
Workforce--Peak Year Oil (Work-Years)	2,190	1998				
Platforms[3] Installation	2	1998	2	1992	4	1992&1998
Production & Service Well Drilling	39	1998-1999	36	1992-1993	75	1992-1999
Production						
Total--MMbbls[4]	650	2000-2018	600	1993-2011	[4]	1993-2018
Peak		2001-2006		1994-1999		
Yearly--MMbbls	55		50		105	
Daily--Barrels	150,000		137,000		287,000	
Total Drilling Muds and Cuttings						
Drilling Muds Disposed--Tons	3,003		2,772		5,775	
Cuttings--Tons	62,400		66,000		128,400	
Shallow-Hazards Survey						
Total Area Covered--km²	184		184		368	
Total Support Activities for Development Phase						
Helicopter Flights	1,755		1,620		3,375	
TRANSPORTATION						
Oil Pipelines						
Installation		1998-1999		1990-1992		
Offshore Length--km	160		200		360	
Onshore Length--km	160		200		360	
Road Length--km [5]	160		200		360	
Offshore Area Disturbed (hectares)[6]	2,370		2,082		4,432	
OIL SPILLS[7]						
Assumed for Analysis ≥1,000 bbls	1		3		24[8]	
Assumed for Analysis± ≥100,000 bbls	0		0		1[8]	
Assumed for Analysis <1,000 bbls[9]						
Exploration						
Number of Spills	23					
Total Oil--bbls	6					
Production						
Number of Spills	172					
Total Oil--bbls	758					

1/ Based on Appendix G, Table 2.
2/ Based on Appendix G, Table 4.
3/ Facility or facilities are assumed to operate from time of installation until cessation of production.
4/ The mean-case resource estimates for Sale 97 and previous lease sales occur at different percentiles; thus, they should not be added to obtain statistically valid estimates of oil in the entire Beaufort Sea area.
5/ The numbers of kilometers of road associated with the onshore portion of the pipeline is estimated to equal the length of the onshore pipeline. Road construction will occur at about the same time as the pipeline is installed.
6/ See Appendix G, Table 12, for assumptions.
7/ See Table IV-3.
8/ The number of oil spills for the Beaufort Sea Summary also includes the predicted spills associated with Sale 109 (Chukchi Sea), Sale 124 (Beaufort Sea), and Canadian Beaufort Sea oil development.
9/ Section IV.A.1.b.

operating in limited sea-ice conditions. The Canmar II, an ice-strengthened drillship, has been used to drill 3 exploration wells in the eastern part of the Alaskan Beaufort Sea; the wells were drilled during the 1985 and 1986 summer/fall drilling seasons. The drillships can be used in waters as deep as 300 meters and the CDU in waters as deep as 180 meters.

For the purpose of the exploration scenario, it is assumed that one artificial island will be constructed during the open-water period in the Sale 97 area and two additional artificial islands will be constructed during the winter in the previous-lease-sale areas. The three islands would be constructed in waters about 15 meters deep with material mined from onshore ground deposits. Hence, the islands would most likely be constructed east of Cape Halkett because of an apparent shortage of onshore gravel west of the Colville River (Schlegel and Mahmood, 1985). The characteristics of the islands are shown in Appendix G, Table G-10.

Construction of the Sale 97 island during the open-water period was selected because it would allow an analysis of the environmental effects of one aspect of constructing artificial islands with dredges--that of dumping material from a barge. Furthermore, changes in ice conditions could result in barges replacing trucks as the anticipated method of transporting gravel to build or complete an island. Most of the artificial islands in the Alaskan Beaufort Sea have been constructed during the winter with trucks hauling gravel over ice roads. However, three islands, including Mukluk, have utilized barges as part of the gravel-transportation system. Construction of the Sale 97 island would require about 645,000 cubic meters of gravel and take 25 to 30 days, assuming a barging rate of 24,000 cubic meters per day and 20-percent downtime (Roberts, 1987).

It is anticipated that drilling units capable of operating in the deeper waters of the sale area will be more extensively used than they have been in the past. A preliminary estimate shows that 90 to 95 percent of the Sale 97 blocks lie in waters deeper than 20 meters; only about 40 percent of the previously leased blocks lie in waters deeper than 20 meters (Roberts, 1987). For Sale 97, it is estimated that 14 exploration and delineation wells (93% of the estimated 15 wells) will be drilled from bottom-founded mobile and floating drilling units.

Although most of the sale-area blocks lie in waters deeper than 20 meters, it is estimated that the 33 wells in the previous-sale areas will also be drilled from bottom-founded mobile and floating drilling units. Because most of the previously leased blocks lie in waters shallower than 20 meters, bottom-founded mobile drilling units probably will be more widely used than the floating units. Also, some of the wells in the shallower waters may be drilled from ice islands instead of the bottom-founded mobile units.

c. Shallow-Hazards 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 upon the nature and extent of the surveys that may be required (Notice to Lessees [NTL] 83-5, Minimum Requirements, Shallow Hazards Survey) and the predicted number of wells drilled. Seismic surveys of the exploration-/delineation-well sites would be conducted in the ice-free seasons during the years of the exploration phase. The total seismic activity in the Sale 97 area is estimated to take 30 days and cover 963 seismic-line kilometers in 15 areas that total 345 square kilometers. The total seismic activity in the previous lease areas is estimated to take 70 days and cover 2,247 line kilometers in 35 areas that total 805 square kilometers. (The assumptions used to determine the amount of seismic activity are shown in Appendix G, Table G-11.)

d. Drilling Muds and Cuttings: Approximately 970 tons of dry solids will be used in the drilling muds for each exploration and delineation well drilled in the Sale 97 area and the previously leased areas. Also, each Sale 97 well is expected to produce approximately 1,550 tons (dry weight) of drill cuttings and each previous lease-sale well 1,800 tons. The disposal of these materials will be, primarily, at the drilling site under conditions prescribed by the Environmental Protection Agency's (EPA's) pollutant-discharge permit (see Rathbun, 1986; Clean Water Act, as amended).

e. Support and Logistic Functions: Offshore exploration-drilling operations in the Sale 97 area will require onshore support facilities. Where possible, existing facilities would be used or upgraded. The 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 (Han-Padron, 1985).

Also, existing systems would be utilized to transport equipment, material, supplies, and personnel. The description of North Slope Transportation Systems as contained in Section III.D.2 of the 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference; a summary of this description follows.

The NSB is linked to interior Alaska by the Dalton Highway. Use of the Haul Road north of Dietrich Camp is restricted to commercial carriers. The Annual Average Daily Vehicle Traffic (AADT) vehicle counts in the past few years have been at or below 100 AADT; this is well below the estimated capacity of 175 to 550 AADT. 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 Borough (Maynard-Partch/Woodward Clyde Consultants, 1983a). 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 has ranged from a low of 2 barges in 1979 to a high of 26 in 1983 and 1986. Typically, 10 to 15 barges per year have been in the sealift. During the initial development of the Prudhoe Bay Unit in 1975, 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 Borough. All public airstrips, except those at Barrow and Deadhorse, are gravel. Upgrading of local roads and airports has occurred continuously through the North Slope Borough Capital Improvements Program (CIP).

Personnel and routine supplies and materials are expected to be transported to the drilling units from the support base by helicopters; these helicopters would be certified for instrument flight. The number of helicopter trips flown in support of exploration- and delineation-well drilling in the Sale 97 area is estimated to range from about 90 in the years when only 1 well is expected to be drilled to 270 in the years from 1990 through 1993, when 3 wells could be drilled in each year. These estimates are based on the assumptions that, for each well, there will be 1 flight 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 1989 to 1994, the total number of helicopter flights supporting drilling operations is estimated to be 1,350.

To support drilling in previously leased tracts, the number of helicopter flights is estimated to range from 270 to 630 per year. The total number of flights between 1985 and 1990 is estimated to be 3,150.

The number of required support vessels for each 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 5 miles or a 20-minute steaming distance of the unit, whichever is less.) The primary reason for this requirement is to ensure evacuation of personnel in the event of an emergency, 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.

f. Personnel: Estimates on the number of work-months of direct OCS employment for each unit of work during the exploration phase are given in Appendix I, Table I-1. The projected number of units for the exploration phase of the proposal is given in Appendix I, Table I-1.

3. Activities Associated with Development and Production--Mean-Case Resource Estimate: It is assumed that the oil resources from the previous lease sales and Sale 97 will be developed simultaneously. The discovery of economically recoverable oil in the previous-lease-sale tracts would initiate the process to plan, design, and construct the production platforms, support facilities, and transportation infrastructure for petroleum exploitation in the Federal waters of the Beaufort Sea.

Work on offshore and onshore production and transportation facilities would not begin until the engineering and economic assessments of the potential reservoirs have been completed and the conditions of all the permits have been evaluated. The initial discovery of previous-sale oil is projected to occur in the second or third year of the lease; the first delineation well is projected to be drilled in 1990. The first oil discovery in the Sale 97 leased blocks could be in 1990.

a. <u>Timing of Activities</u>: As noted in Table II-A-1, installation of the production platforms in previous-lease-sale tracts could begin in 1993. Construction of a production platform is predicted to begin about 2 or 3 years before installation; fabrication of these platforms would take place outside Alaska. Drilling of the production and service wells is expected to take place from 1992 through 1993. Production of oil from previous-lease-sale tracts is estimated to begin in 1993, peak from 1994 through 1999, and continue through 2011.

Sale 97 oil would be produced from two platforms installed in 1998. It is estimated that a total of 39 wells would be drilled from these two platforms. Production of Sale 97 oil is forecast to begin in 2000, peak from 2001 through 2006, and continue through 2018. Many of the tracts in the Beaufort Sea that may be leased as a result of Sale 97 could be potential drainage tracts (USDOI, MMS, 1985c). (A drainage tract is an offshore tract contiguous to producing tracts whose subsurface geologic structure is a continuation of the producing area and therefore more or less valuable as a source of additional oil or gas.) Thus, some Sale 97 oil could be produced as a result of discoveries made in tracts leased during previous sales.

Shallow-hazards seismic surveys will also be conducted in support of development and production activities. Since the size of the individual prospects is unknown, it is assumed that block-wide surveys will be conducted for all the production platforms in both the Sale 97 area and previous-lease-sale areas. (For other assumptions, see Appendix G, Table G-11.) The total seismic activity associated with platform installation in both the Sale 97 area and the previously leased areas is estimated to take 14 days and cover 604 line kilometers in two areas that total 184 square kilometers. Individual platform sites may be surveyed several years prior to installation of the platforms; surveys would be conducted during the ice-free period.

Drilling of the production and service wells in both the Sale 97 area and the previous-lease-sale areas would result in a net average disposal of 77 tons (dry weight) of drilling mud for each well. (Mud used in drilling production and service wells is assumed to be recycled through each subsequent well drilled on a particular platform.) Also, each well in the Sale 97 area is expected to produce approximately 1,650 tons (dry weight) of drill cuttings and, for the previous-sale areas, 1,850. The disposal of the drilling muds and cuttings would be in accordance with approved EPA National Pollutant Discharge Elimination System (NPDES) permits for development-well drilling; muds and cuttings also may be transported to shore and disposed at approved sites. The amount of time required to drill and complete each production or service well is estimated to average 45 days.

b. <u>Production Platforms</u>: If commercial discoveries are made in the Sale 97 area, the hydrocarbons would be produced from platforms installed on the seafloor. Depending on the water depth, seafloor conditions, ice conditions, and size of the reservoir, several types of platforms could be used.

Artificial and caisson-retained islands may be used as production platforms in the shallower parts of the Beaufort Sea. To accommodate multiple wells, production equipment, and drilling rigs, these platforms would be larger than the islands used for exploratory drilling. Two artificial islands have been constructed in State of Alaska waters to produce oil from the Endicott Reservoir (USDOD, U.S. Army COE, 1984). See Appendix B for a description of the Endicott Development Project.

Concepts are also being developed for Arctic production platforms that are based on monolithic, multi-sided 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. The 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.

The production platforms for Sale 97 and previous-lease-sale areas are assumed to be located in four general areas of the Beaufort Sea Planning Area. These assumptions have been made to evaluate the effects of pipeline construction and operation, even though predicting the locations of future oil fields is extremely uncertain.

For the Sale 97 development and production scenarios, one of the production platforms is assumed to be located about 40 kilometers north of Oliktok Point and the other in the Chukchi Sea about 120 kilometers north of Point Belcher. One of the production platforms in the previously leased sale areas is assumed to be located about 130 kilometers north and east of Bullen Point. The Sale 87 leased tracts in the eastern Beaufort Sea lie between 25 and 235 kilometers north and east of Point Bullen; the mid-distance for this range is about 130 kilometers. The second platform used to produce oil from tracts leased in previous sales is assumed to be located about 70 kilometers west of Cape Halkett.

c. Associated Activities: For the purpose of this scenario, it is assumed that the infrastructure at Prudhoe Bay will be used to support major construction and operation activities for the development and production and transportation of crude oil. If development were to occur in the Chukchi Sea as a result of Beaufort or Chukchi Sea Planning Area lease sales, a support base adjacent to or near the northeastern part of the Chukchi Sea may be developed.

The number of helicopter flights to be flown in support of the drilling of production and service wells in the Sale 97 area is estimated to be 540 during 1998 and 1,215 in 1999. These estimates are based on the assumption that there will be one flight for each day of drilling; the time required to drill and complete a production and service well is estimated to be about 45 days. In 1998, 12 wells are predicted to be drilled; in 1999, 27 wells (Table II-A-1). The number of flights to be flown in the previously leased areas is estimated to be 270 in 1992 and 1,350 in 1993.

d. Personnel: Estimates on the number of work-months of direct OCS employment for each unit of work during the development and production phase are given in Appendix I, Table I-1. The projected number of units for the development and production phase of the proposal is given Appendix I, Table I-1.

4. Activities Associated with Oil Transportation (Pipelines)--Mean-Case Resource Estimate: The purpose of the pipeline-transportation scenario is to identify a range of activities and a variety of locations to analyze the effects that construction and operation of pipelines would have on the environment; the purpose is not to identify future pipeline routes.

Pipelines would be used to transfer the oil from the production platforms to TAP Pump Stations 1 or 3. The amount of pipeline required is estimated to be about 320 kilometers for the Sale 97 area and 400 kilometers for previous-sale areas. It is assumed that one-half of the pipelines in both the previous-sale areas and the Sale 97 area lie offshore and the other half onshore. Installation of the pipelines for the Sale 97 leases is expected to begin in 1998 and continue through 1999. Pipelines for previously leased tracts would be installed from 1990 through 1992.

Offshore pipelines can be laid during the open-water period by a variety of existing pipelaying techniques. These methods include laying pipe from a conventional lay or reel barge or by bottom or surface tows. Most present-day techniques for laying marine pipe were developed in an ice-free environment. 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 will probably be installed by the bottom-pull method.

Pipelines would be buried in trenches to prevent damage by the keels of drifting ice masses and current scouring. The trenches may be excavated by cutter-suction dredges or mechanical plows (Han-Padron, 1985). Cutter-suction dredges are more efficient than plows for deep-trenching in a variety of soils. However, because existing cutter-suction dredges are limited to dredging depths of 30 meters and have forward speeds that are too slow for the short open-water season in the sale areas, specially designed new equipment will be required (Han-Padron, 1985).

Design studies indicate that trenches as deep as 1 to 2 meters can be cut by a single pass of a large mechanical plow but that cutting trenches deeper than 2 meters will probably require multiple passes (Brown and Palmer, 1985). In the Beaufort Sea, Brown and Palmer (1985) estimate that trenching to a depth of 1 meter can be done at an average rate of 4.8 kilometers per day.

The amount of time it might take to cut the pipeline trenches in the sale areas can be estimated (1) from the pipeline length and trench-depth data shown in Appendix G, Table G-12, and (2) by assuming an average trenching rate of 4.8 kilometers per day and that each meter of trench depth will require a separate pass of the plow (i.e., a 3-meter-deep trench will require three passes). Based on these assumptions, pipeline trenching in the previous lease-sale areas is estimated to take about 144 days and in the Sale 97 area about 164 days. These estimates do not include plow deployment or recovery times. Neither do they include downtime due to mechanical problems or adverse weather or ice conditions. Trenching will probably be done during the open-water period. The relatively short period of time in the summer and early fall when the amount of sea-ice cover is less than 50 percent indicates that some of the trenching may have to be done in the presence of ice and that trenching and pipelaying may thus require more seasons than are estimated in

Table II-A-1. However, as experience in other areas increases, plowing or dredging systems may be developed that can cut trenches more rapidly or deeper on a single pass, or both.

The hypothetical pipeline locations for this scenario involve a number of assumptions. Although estimates are given for the total length of both offshore and onshore segments of pipelines for Sale 97 and previous lease sales (Table II-A-1), many factors, including the potential locations of the offshore production platforms, are unknown. One of the assumptions is that, to the extent possible, marine pipelines would take the most direct route from the production platforms to the shore. As discussed below, possible offshore trunk-pipeline routes and landfalls include those suggested in the FEIS's for Sale 71 (USDOI, BLM, 1982) and Sale 87 (USDOI, MMS, 1984a). Furthermore, in order to work within the pipeline-length estimates shown in Table II-A-1, it is assumed that the pipelines in this scenario will join with existing, proposed, or hypothetical pipelines connected to TAP.

For Sale 97, the pipeline from the platform north of Oliktok Point would be about 40 kilometers long and cross the shore at or near Oliktok Point (Appendix B, Figure B-1). The onshore segment of the pipeline would be about 20 kilometers long and connect to the Kuparuk Pipeline; the pipeline could also run parallel to the Kuparuk Pipeline to TAP Pump Station 1.

The second Sale 97 pipeline is estimated to be in the Chukchi Sea and originate from a platform located about 120 kilometers north of Point Belcher. This point, located just south of Peard Bay, is considered to be the landfall. From Point Belcher, the pipeline would trend southeast and connect with a pipeline across the southern part of the National Petroleum Reserve-Alaska (NPR-A); the pipeline would connect with TAP at Pump Station 3 (Graphic 6). The length of the onshore segment of the Chukchi Pipeline is estimated to be about 140 kilometers. To justify a pipeline across the southern part of NPR-A, it is assumed oil is also discovered in the Chukchi Sea Planning Area (proposed OCS Sale 109), in the southern part of NPR-A, or both.

Bullen Point, located west of the Canning River, was selected as a possible landfall for a pipeline carrying oil from the Sale 87 leased tracts in the eastern part of the planning area. If there are any production platforms installed north of the Arctic National Wildlife Refuge (ANWR), the pipeline connecting the platforms to the mainland would be routed offshore until a shoreline-crossing site west of the ANWR is reached. Current regulations pertaining to petroleum exploitation in the ANWR prevent the use of pipelines in the refuge. The Sale 87 leased tracts in the eastern Beaufort Sea lie between 25 and 235 kilometers north and east of Bullen Point; the mid-distance for this range is about 130 kilometers. Most of the tracts lie north of the ANWR. From Bullen Point, the pipeline could connect with TAP Pump Station 1--a distance of about 90 kilometers. The pipeline from Bullen Point could also connect with the Endicott Pipeline.

The second platform used to produce oil from tracts leased in previous sales is hypothesized to be located west of Cape Halkett. The trunk pipeline from this platform to the shore would be about 70 kilometers long and cross the shore in the vicinity of Camp Lonely. The onshore segment of the pipeline is assumed to be about 100 kilometers long. Given these conditions, this pipeline would have to connect with an existing line to TAP across the northern part of NPR-A. (Pipeline routing within the NPR-A may be restricted in certain areas. These areas have been designated as Special Areas by the Secretary of the Interior because of their significant subsistence, recreational, and fish and wildlife values [USDOI, BLM, 1985]; these areas are the Teshekpuk Lake, Utukok Uplands, and Colville River.)

The FEIS on oil and gas leasing in the NPR-A has evaluated a number of potential pipeline routes from hypothetical fields to TAP (USDOI, BLM, 1983). These include routes beginning (1) east of Teshekpuk Lake; (2) on the peninsula separating Dease Inlet, Admiralty Bay, and Smith Bay; and (3) in the southern part of NPR-A. Pipelines in the northern part of the reserve would join TAP at Pump Station 1, while those in the southern part would join TAP at Pump Station 3.

To estimate the seafloor area that would be disturbed because of the trenching operation, it is assumed that (1) one of the Sale 97 production platforms would be located in waters 30 meters deep and the other in waters 40 meters deep, and (2) the two platforms in previous-sale areas would be located in waters 20 meters deep and 40 meters deep. The total area disturbed by trenching is estimated to be 2,370 hectares in the Sale 97 area and 2,082 hectares in the previous-sale areas. The assumptions used to estimate the amount of disturbed area are shown in the Appendix G, Table G-12.

Shallow-hazards surveys are also required along offshore-pipeline routes. The total length of offshore pipelines is estimated to be 160 kilometers for the Sale 97 area and 200 kilometers for the previously leased areas. However, specific requirements for pipeline shallow-hazards surveys in the Alaska OCS Region have not been drafted.

It is assumed that the onshore segments of the pipelines will be elevated or buried in a manner similar to other pipelines in Alaska's North Slope Region; these include TAP and the Kuparuk Pipeline. There is considerable experience in the construction and operation of onshore pipelines in the Arctic; it will be used to construct and operate the onshore segments of pipeline carrying Beaufort Sea oil.

5. Activities Associated with the Low-Case and the High-Case Resource Estimates: As described in Sections II.A.2 through II.A.4, the scenarios for Sale 97 are based on the discovery of 650 MMbbls of oil--the estimated conditional, mean, economically recoverable resources unleased in the area--and simultaneous development with the economically recoverable petroleum discovered in the tracts leased in previous sales. Alternative-resource estimates are less than or more than mean-case estimates. Regardless of the resource estimate, the technologies for exploration, development, and transportation would remain the same as described in the previous sections. Differences would be evident, however, in the level of activities and the timing of events. (See Appendix E, Summary of Minimum and Maximum Effects, for a more detailed discussion of the scenarios associated with the low- and high-case resource estimates and for analyses of these two cases.)

If the amount of oil discovered were less than the conditional mean-case resource estimate, the activity levels described for the mean case would be reduced. The discovery of a considerably smaller amount of oil and gas is represented by the low-case resource estimate of 110 MMbbls of oil (Appendix G, Table G-1). The quantity of oil represented by the low case may be too small to permit economical recovery until sometime in the future. In that event, only activities associated with the exploration phase would be undertaken. Because future recovery of low-case resources may depend on advances in technology and changes in economics, a considerable time interval might exist between exploration and the beginning of development and production.

Activities associated with discovery of a relatively large quantity of oil and gas in the Sale 97 area are represented by the high-case resource estimate of 1,660 MMbbls of oil (Appendix G, Table G-3). Activity levels for the high case would be greater than those for the mean case. For the high-case resource estimate: (1) 38 exploration and delineation wells would be drilled (15 for the mean-case estimate [MCE]), (2) 6 production platforms installed (2 MCE), (3) 101 production and service wells drilled (39 MCE), (4) 480 kilometers of pipeline laid (320 MCE), and (5) 1,660 MMbbls of oil produced (650 MMbbls MCE). Also for the high case, production-platform installation, production and service-well drilling, and pipeline installation each would take 1 year longer than for the mean case and would begin 1 year earlier.

6. Scenarios for Alternatives IV, V, and VI: Like the scenarios for Alternative I, the scenarios for Alternatives IV, V, and VI are based on the resource estimates for each alternative. These figures represent the conditional, mean, economically recoverable oil estimated to be present in a Sale 97 area that has been modified by deleting each of the deferral areas shown in Figure I-1. The alternative configurations for the sale area are defined by deleting from the Sale 97 area either (1) the Barrow Deferral Area to form Alternative IV--the Barrow Deferral Alternative, (2) the Kaktovik Deferral Area to form Alternative V--the Kaktovik Deferral Alternative, or (3) the Chukchi Deferral Area to form Alternative VI--the Chukchi Deferral Alternative. The mean-case oil-resource estimates are reported by MMS for (1) Alternative IV to be 630 MMbbls (Appendix G, Table G-5), (2) Alternative V to be 560 MMbbls (Appendix G, Table G-6), and (3) Alternative VI to be 620 MMbbls (Appendix G, Table G-7).

A comparison of the resource estimates, timing of events, and level of activities for Alternatives I, IV, V, and VI is shown in Table II-A-2. The timing of events in the scenarios for each of the four alternatives is predicted to be the same. Except for the amount of oil that may be produced and slight differences in the number of production and service wells that may be drilled, the level of other activities for the four alternatives is estimated to be the same. Thus, the basic exploration, development and production, and transportation scenarios for Alternatives IV, V, and VI would be the same as they are for Alternative I as described in Sections II.A.1 through II.A.4 and summarized in Table II.A.1.

B. Description of the Proposal and Alternatives

1. Alternative I - Proposal:

a. Description of the Proposal: The proposed action would offer about 3,516 blocks (approximately 7.83 million hectares or 19.37 million acres) of the Beaufort Sea Planning Area for leasing; this is the unleased

Table II-A-2
Summary and Comparison of Basic Scenario Assumptions for
the Mean-Case Resource Estimate for Alternatives I, IV, V, and VI

	Alternative I Proposal 1/	Alternative IV Barrow Deferral Alternative 2/	Alternative V Kaktovik Deferral Alternative 3/	Alternative VI Chukchi Deferral Alternative 4/
Mean-Case Resource Estimate (MMbbls)	650	630	560	620
EXPLORATION				
Exploration and Delineation Wells	15	15	15	15
Drilling Period	1989 - 1994	1989 - 1994	1989 - 1994	1989 - 1994
DEVELOPMENT AND PRODUCTION				
Platforms	2	2	2	2
Installation	1998	1998	1998	1998
Production and Service Wells	39	38	34	38
Drilling Period	1998 - 1999	1998 - 1999	1998 - 1999	1998 - 1999
Production				
Start	2000	2000	2000	2000
Peak	2001 - 2006	2001 - 2006	2001 - 2006	2001 - 2006
Rate (MMbbls/Year)	55	53	47	52
End	2018	2018	2018	2018
TRANSPORTATION				
Oil Pipeline (Offshore/Onshore)				
Kilometers	160/160	160/160	160/160	160/160
Installation	1998 - 1999	1998 - 1999	1998 - 1999	1998 - 1999

1/ Appendix G, Table G-2.
2/ Appendix G, Table G-5.
3/ Appendix G, Table G-6.
4/ Appendix G, Table G-7.

part of the planning area that has been identified for further study. The study area consists of approximately 8.58 million hectares (approximately 21.21 million acres) of Outer Continental Shelf (OCS) lands located in the Beaufort and Chukchi Seas and comprises 3,930 blocks. Approximately 414 whole and partial blocks in the study area covering about 0.75 million hectares (about 1.84 million acres) are currently under lease as a result of previous Beaufort Sea Planning Area oil and gas lease sales. Lease relinquishments received and approved by MMS prior to issuance of the NOS may result in additional areas being included in the proposal. The blocks that comprise the proposed action are located about 5 to 260 kilometers offshore in water depths that range from about 2 meters to about 1,000 meters. The MMS has estimated that the conditional, mean, economically recoverable resources for the proposal are 650 MMbbls of petroleum. Natural gas also may be discovered and, although it will not be economical to produce for the foreseeable future, the effects of gas exploitation are discussed in Section IV.L.

b. Mitigating Measures That Are Part of the Proposed Action: Laws, regulations, and orders that provide mitigation are considered part of the proposal. Examples include the OCS Lands Act, which grants broad authority to the Secretary of the Interior to control lease operations; the Alaska OCS Orders; the Fisherman's Contingency Fund; and the Offshore Oil Pollution Compensation Fund. Incorporated by reference and summarized in Section I.C are: OCS Report MMS 86-0003, Legal Mandates and Federal Regulatory Responsibilities for the Alaska Outer Continental Shelf (Rathbun, 1986), and Reference Paper No. 83-1, Federal and State Coastal Management Programs (McCrea, 1983). Also incorporated by reference are the Alaska OCS Orders published in the Federal Register on October 22, 1982, at 47 FR 47180. OCS Orders describe in detail requirements and specifications for oil and gas operations, including the requirement to use the best available and safest technologies (BAST). Permit requirements, engineering criteria, testing procedures, and information requirements also are outlined. These requirements are developed and administered by the MMS. The mitigating effect of these measures has been factored into the environmental effects analysis.

c. Potential Mitigating Measures: The following measures are considered to help reduce or eliminate effects identified in Section IV. A Secretarial decision on these mitigating measures has not occurred; they are noted here as potential measures that could further mitigate the effects of this proposed lease sale. The Secretary has imposed similar measures in previous Federal oil and gas lease sales. If any of these measures are adopted, they will appear in the Notice of Sale. The analysis in this EIS does not assume that the following mitigating measures are in place; however, they are evaluated in the discussions of the effectiveness of stipulations or ITL's that follow each of the potential measures.

(1) Potential Stipulations: The following stipulations will be considered for Beaufort Sea Sale 97:

No. 1 - Protection of Archaeological Resources
No. 2 - Orientation Program
No. 3 - Protection of Biological Resources

No. 4 - Seasonal Drilling Restriction for Protection of Bowhead Whales from Potential Effects of Oil Spills
No. 5 - Transportation of Hydrocarbons

Stipulation No. 1--Protection of Archaeological Resources

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

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

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

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

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

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

(3) If the RSFO determines that an archaeological resource is likely to be present in the lease area and may be adversely affected by operations, he will notify the lessee immediately. The lessee shall take no action that may adversely affect the archaeological resource until the RSFO has told the lessee how to protect it.

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

Purpose of Stipulation No. 1: The purpose of this measure, which would apply to all lease blocks, is to protect prehistoric and historic archaeological resources that are known or may be discovered in a lease area by surveying prior to any petroleum-industry activities that would disturb the area. It would also protect historic resources such as shipwrecks if these are detected on the lease blocks. The January 1983 MMS Archaeological Analysis, Proposed Lease Sale No. 87, Beaufort and Northeast Chukchi Seas Offshore Areas, Appendix H, concludes that the zone to 20 meters offshore is extensively ice-gouged and would eliminate any chance of prehistoric-site survival.

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

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

Stipulation No. 2--Orientation Program

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.34 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the Regional Supervisor, Field Operations (RSFO). The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns which relate to the sale and adjacent area. The program shall be formulated by qualified instructors experienced in each pertinent field of study and shall employ effective methods to ensure that personnel are informed of archaeological and biological resources and habitats including endangered species, fisheries, bird colonies, and marine mammals, and to ensure that personnel understand the importance of not disturbing archaeological resources and of avoidance and nonharassment of wildlife resources. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program also shall include information concerning avoidance of conflicts with subsistence activities. The program also shall include presentations and information about all pertinent lease-sale stipulations and information to lessees provisions.

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

Purpose of Stipulation No. 2: The purpose of this proposed mitigating measure, which addresses the concerns of residents, is to provide increased protection to the environment. The orientation program would promote an understanding of, and appreciation for, local community values, customs, and lifestyles of Alaskans. It would also provide necessary information to industry personnel about the biological resources used for commercial and subsistence activities, about archaeological resources of the area and appropriate ways to protect them from adverse effects, and about the concerns for reducing industrial noise and disturbance effects on marine mammals and marine and coastal birds.

Effectiveness of Stipulation No. 2: This measure provides positive mitigating effects, in that it would make all personnel involved in petroleum-industry activities aware of the unique environmental, social, and cultural values of North Slope Inupiat residents and their environment. There is concern that uninformed workers and subcontractors could unknowingly destroy or damage the environment; be insensitive to local historical or cultural values, as well as biological resources; or unnecessarily disrupt the local economy. This stipulation also would help to minimize conflicts between subsistence-hunting activities and activities of the oil and gas industry.

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

Stipulation No. 3--Protection of Biological Resources

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

Based on any surveys which the RSFO may require of the lessee or on other information available to the RSFO on special biological resources, the RSFO may require the lessee to: (1) relocate the site of operations; (2) establish to the satisfaction of the RSFO, on the basis of a site-specific survey, either that such operation will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist; (3) operate during those periods of time, as established by the RSFO, that do not adversely affect the biological resources; and/or (4) modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

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

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

Purpose of Stipulation No. 3: Important biological populations and habitats in addition to those already identified in the Information to Lessees on Areas of Special Biological and Cultural Sensitivity may exist in the proposed sale area. Such populations and habitats may require additional protection. If such biological resources are identified, measures could be developed to reduce possible disturbances from oil and gas activities. These measures could include shifts in operational sites, modifications in drilling procedures, and increased consideration of the areas during oil-spill-contingency planning.

Effectiveness of Stipulation No. 3: This stipulation provides a formal mechanism for identifying important or unique biological populations or habitats that require additional protection because of their sensitivity and/or vulnerability. If these populations or habitats are found to exist in the lease area, the stipulation provides a means for developing measures to reduce possible adverse effects from oil and gas activities. Through such protection to benthic habitats and associated fauna that could be indirectly important to some marine and coastal bird and marine mammal species, this measure also could provide some local benefits to birds and mammals. Through identification of biological populations or habitats requiring special protection, this stipulation also could provide data to the environmental report required for exploration and development plans that must be reviewed and approved according to 30 CFR 250.34. Stipulation No. 3 is not likely to change the overall effect levels of the proposal on lower-trophic-level organisms, marine and coastal birds, and marine mammals, although some local reduction in habitat effects may occur.

With respect to bowhead whales, the seasonal drilling stipulation has been presented in the past as necessary to provide protection to these whales. However, the Sale 97 Endangered Species Act Biological Opinion provided by NMFS just prior to publication of the FEIS did not find a possibility of jeopardy during exploration drilling but did suggest some optional conservation measures. Accordingly, MMS will consider these measures and use its authority to keep areas used by bowhead whales free of spilled oil when they are present.

Stipulation No. 4--Seasonal Drilling Restriction for Protection of Bowhead Whales from Potential Effects of Oil Spills

Exploratory drilling, testing, and other downhole exploratory activities will be prohibited during the spring bowhead whale migration period generally from April 15 through June 15 in the Spring Migration Area. Exploratory drilling, testing, and other downhole exploratory activities will be prohibited in the Fall Migration Areas, generally from August 1 through October 31 in the eastern blocks, from September 1 through October 31 in the central blocks, and from September 15 through October 31 in the western blocks. The precise dates will be set each season by the Regional Supervisor, Field Operations (RSFO), based on available information concerning the presence of bowhead whales in the area. The RSFO may determine that continued operations are necessary to prevent a loss of well control or to ensure human safety. This stipulation will remain in effect until termination or modification by the Department of the Interior, after conferring with the State of Alaska and the North Slope Borough, and in consultation with the National Marine Fisheries Service. This stipulation applies to the following blocks for the dates indicated:

Spring Migration Area
April 15 to June 15

Official Protraction Diagram	Blocks Included
NR 4-1	770, 771, 813-815, 856-859, 899-903, 942-947, 985-991.
NR 4-2	241, 242, 283-286, 326-330, 369-374, 412-419, 454-463, 496-507, 538-551, 579-590, 593-595, 621-633, 663-676, 705-720, 749-763, 793-806, 837-850, 881-893, 925-937, 969-980.
NR 5-1	243-264, 287-308, 331-352, 374-396, 418-440, 462-466, 468-471, 473-484, 506-510, 512-517, 519-528, 550-554, 557-561, 564-572, 594-597, 602-616, 654-660, 699-704.
NR 5-2	221, 265-267, 309-312, 353-356, 397-401, 441-447, 485-492, 529-537, 573-587, 617-631, 661-675.

Fall Migration Areas

Western Blocks - September 15 through October 31

Official Protraction Diagram	Blocks Included
NR 4-1	416-419, 460-463, 500-507, 542-551, 584-595, 626-639, 669-683, 712-727, 755-771, 798-815, 841-859, 884-903, 927-947, 970-991.

NR 4-2	231-242, 275-286, 314-330, 358-375, 397-419, 441-463, 485-507, 529-551, 573-590, 593-595, 617-633, 661-676, 705-720, 749-763, 793-806, 837-850, 881-893, 925-937, 969-980.

Central Blocks - September 1 through October 31

Official Protraction Diagram	Blocks Included
NR 5-1	243-264, 287-308, 331-352, 374-396, 418-440, 462-466, 468-471, 473-484, 506-510, 512-517, 519-528, 550-554, 557-561, 564-572, 594-597, 602-616, 639-641, 647-660, 684, 685, 691-704, 729, 737-748, 775-777, 779-780, 785-792, 821-826, 831-836, 867, 871, 876-879, 915-921, 957-960, 962-965.
NR 5-2	221, 265-267, 309-312, 353-356, 397-401, 441-447, 485-492, 529-537, 573-587, 617-633, 661-680, 705-727, 749-771, 794-815, 841-859, 886-889, 891-903, 929, 930, 932-934, 938-947, 976-978, 982-991.
NR 5-3	41-44, 85, 86.
NR 5-4	1, 8, 9, 11, 16-23, 49, 50, 53, 55-57, 60-67, 96-111, 148-152, 154, 155,191-194, 228-230, 235,237, 273-276, 318-320, 331, 332, 362-367, 375, 376, 407-412, 414-417, 452-459, 496-500.
NR 6-1	726-734, 770-782, 814-828, 858-873, 902-919, 946-964, 990-1010.
NR 6-3	22-44, 66-88, 110-132, 154-176, 198-220, 241-246, 249-264, 285-289, 291, 296-308, 329-333, 339, 341-352, 373-376, 384, 386-396, 426-429, 431-440, 469, 470, 478-484, 522-528, 568-572, 613-616, 659, 660.
NR 6-4	1-8, 45-52, 89-96, 133-140, 177-184, 221-226, 228, 265-270, 272, 309-316, 353-360, 397-404, 441-448, 485-492, 529-536, 573-578, 617-622, 661-666, 706-712, 755, 756.

Eastern Blocks - August 1 through October 31

Official Protraction Diagram	Blocks Included
NR 6-4	9-12, 53-60, 97-108, 141-155, 185-199, 229-244, 273-288, 317-332, 361, 363-376, 405-420, 449-464,

	493-508, 537-549, 552, 582-592, 626, 627, 669-671, 682, 713-717, 725, 757-764, 767, 768, 802-812, 847-860, 893-902, 940-944, 986, 987.
NR 7-3	134, 178-181, 221-227, 265-274, 309-321, 353-368, 397-415, 441-447, 450, 452-462, 485-491, 496, 497, 499-508, 529-552, 575-596, 618-640, 663-678, 680-684, 708-721, 727, 751-765, 770, 794-809, 813, 814, 816, 844-846, 851-853, 856, 860, 894-904, 937-948, 981-989.
NR 7-4	485, 529-532, 573-579, 617-623, 661-667, 706-710, 749-754, 793-798, 837-842, 881-886, 925-929, 969-973.
NR 7-5	15-22, 60-69, 105-113, 150-157, 196-201, 242-245, 287-289.
NR 7-6	3, 4, 46-48, 89-91, 133-135, 177-179, 221, 222, 265, 266, 309.

Purpose of Stipulation No. 4: This stipulation could protect endangered bowhead whales from the risk of oil spills during their spring and fall migrations through the sale area during exploratory drilling. During the peak migration periods, exploratory drilling, testing, and other downhole exploratory activities would be prohibited in those blocks that are part of important migratory and feeding areas and from which the oil-spill-risk analysis indicates oil spills would have a significant likelihood of contacting bowhead whale habitat. The actual closure dates would float, recognizing that the whales may reach the areas before or after the specified dates. Information on general locations of bowhead whales would be provided by a bowhead-monitoring program. The bowhead whale-studies effort is continuing and may provide new information to allow further refinement, modification, or replacement of this proposed measure.

This stipulation specifically excludes the Federal parts of Blocks 564, 608, and 652 of Official Protraction Diagram NR 6-3; these blocks are located between the Alaskan coast and the barrier islands. Whale-sighting data indicates that the bowhead whale-migration corridor is located seaward of the barrier islands. Because bowheads do not migrate shoreward of the barrier islands, it is highly unlikely that they would respond to noise associated with drilling, testing, or other downhole exploratory activities from federally leased blocks located shoreward of the barrier islands. Neither is it likely that any oil spilled on Federal leases inside the barrier islands would adversely affect bowhead whales migrating outside the barrier islands. This is because spilled oil would be well-weathered and of little potential harm to bowheads should it reach the bowhead-migration corridor.

Effectiveness of Stipulation No. 4: The seasonal prohibition on exploratory drilling in the presence of bowhead whales could eliminate the risk (a low probability) that a major spill from exploration-drilling activities could occur when bowhead whales were present in the vicinity of an exploration-drilling unit. If an oil spill were to occur within the sale area during exploration drilling--again, a low probability--Stipulation No. 4 could reduce the degree of effects on bowhead whales within the sale area from MINOR to

NEGLIGIBLE. A similar measure was adopted for the Joint/Federal Beaufort Sea Lease Sale, December 1979; Sale 71, October 1982; and Sale 87, August 1984. For Sale 97, this measure would extend generally from April 15 through June 15 for the Spring Migration Area, and for the Fall Migration Areas from August 1 through October 31 for the Eastern Blocks, September 1 through October 31 for the Central Blocks, and September 15 through October 31 for the Western Blocks, representing peak bowhead whale-migration periods.

This measure also could reduce the potential during exploration for adverse effects on gray whales from oil spills (a low probability) during the spring and fall periods. However, because they may be present in the sale area during the summer months when exploratory drilling is most likely, gray whales in the vicinity of exploratory-drilling units may be subject to injury or mortality as a result of an oil spill. Likewise, gray whale-feeding habitat might be degraded by a spill. Consequently, effects on gray whales would remain MINOR.

Stipulation No. 5--Transportation of Hydrocarbons

> Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to any recommendation of the Regional Technical Working Group, or other similar advisory groups with participation of Federal, State, and local governments and industry.
>
> Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the Regional Supervisor, Field Operations.

Purpose of Stipulation No. 5: This stipulation provides a formal way of selecting the environmentally preferable means of transporting petroleum from a lease-sale area. It also informs the lessee that (1) MMS reserves the right to require the placement of pipelines in certain designated management areas and (2) pipelines must be designed and constructed to withstand the hazardous conditions that may be encountered in the lease-sale area.

Effectiveness of Stipulation No. 5: This stipulation is intended to ensure that the decision on which method to use in transporting hydrocarbons considers the social and environmental consequences as well as the economic feasibility of pipelines. These considerations would include the following oil-spill information: (1) tankers tend to have fewer but larger spills than do pipelines and (2) pipelines or tanker spills would occur along different transportation corridors. This stipulation is not expected to significantly reduce the overall effect levels of the proposal on water quality; marine and coastal birds; pinnipeds, polar bears, and beluga whales; caribou; or endangered species.

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

The following ITL's are proposed for Beaufort Sea Sale 97:

No. 1 - Information on Bird and Marine Mammal Protection
No. 2 - Information on Areas of Special Biological and Cultural Sensitivity
No. 3 - Information on the Arctic Peregrine Falcon
No. 4 - Information on the Beaufort Sea Biological Task Force
No. 5 - Information on Subsistence Whaling and Other Subsistence Activities
No. 6 - Information on Coastal Zone Management
No. 7 - Information on Endangered Whales

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

Lessees are advised that during the conduct of all activities related to leases issued as a result of this sale, the lessee and its agents, contractors, and subcontractors will be subject to, among others, the provisions of the Marine Mammal Protection Act of 1972, as amended; the Endangered Species Act of 1973, as amended; and International Treaties.

Lessees and their contractors should be aware that disturbance of wildlife could be determined to constitute harm or harassment and thereby be in violation of existing laws. With respect to endangered species, disturbance could be determined to constitute a "taking" situation in violation of the Endangered Species Act. Under the Endangered Species Act, the term "take" has been defined to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Violations under these acts and treaties may be reported to the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), as appropriate.

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

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

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

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

Purpose of ITL No. 1: The purpose of this measure is to help minimize behavioral disturbance of wildlife, particularly at known concentration areas. The Beaufort Sea is an important habitat for endangered and nonendangered marine mammals and marine birds and waterfowl.

Effectiveness of ITL No. 1: The Beaufort Sea Planning Area is an important habitat for endangered and nonendangered marine mammals and marine birds. Of particular concern are (1) bowhead whale populations that migrate through the area from April through June and from September through October; (2) gray whales that spend the summer and early fall feeding in the far western part of the planning area (June through October); (3) other endangered whale species (fin and humpback) that occasionally occur in the far western part of the planning area during the summer; (4) large groups of Pacific walruses hauled out along the pack-ice front in the far western part of the planning area; (5) fairly large numbers of bearded and ringed seals occurring throughout the planning area, especially along the pack-ice front; (6) large concentrations of spotted seals that haul out along the Colville River Delta and in Dease Inlet; (7) large numbers of seabirds that concentrate off Point Barrow during the summer; (8) waterfowl and shorebird concentrations at Elson and Simpson Lagoons and the Colville and Canning River Deltas; and (9) other areas identified in ITL No. 2 as areas of special biological sensitivity.

Due to the advisory nature of this measure and the characteristics of aircraft and vessel controls, it is likely that some marine mammals and birds would interact with the activity associated with platforms and all attendant exploration and development and production traffic over the life of the field (about 20 years). It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. Some effects on whales, walruses, seals, and seabirds can be expected.

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

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, or other biological resources. Identified areas of special biological sensitivity include the following: (1) the lead system off Point

Barrow; (2) Plover Islands; (3) Boulder Patch in Stefansson Sound; (4) Camden Bay area (especially the Nuvugag and Kaninniivik hunting sites); (5) Canning River Delta; (6) Barter Island - Demarcation Point area; (7) Colville River Delta; and (8) Cross, Pole, Egg, and Thetis Islands. These areas are among areas of special biological sensitivity to be considered in the oil-spill-contingency plan section of Alaska OCS Order No. 7. Lessees are advised that they have the primary responsibility for identifying these areas in their oil-spill-contingency plans and for providing specific protective measures. Additional areas of special biological and cultural sensitivity may be identified during review of exploration plans and development and production plans.

Consideration should be given in oil-spill-contingency plans as to whether use of dispersants is an appropriate defense in the vicinity of an area of special biological or cultural sensitivity. Lessees are advised that prior approval must be obtained before dispersants are used.

Purpose of ITL No. 2: The purpose of this ITL is to protect birds, marine mammals, fishes, and lower-trophic-level organisms from oil spills in those areas that have been identified as important to the continued well-being of the biological resources.

Effectiveness of ITL No. 2: Consideration of the identified areas of special biological and cultural sensitivity would help develop measures to protect these, as well as other identified areas, from oil spills. Protection of special biological areas would reduce the effects on the biological and cultural resources of the areas. This may reduce oil-spill effects on local water quality and some coastal wetland habitats of birds and also may reduce the chance of caribou encountering oil along the coast, but the overall levels of effects on caribou and marine and coastal birds--as well as effects on pinnipeds, polar bears, beluga whales, and water quality--would not be reduced by this ITL. However, any local reduction of the effects on birds, marine mammals, and fishes should also reduce adverse effects on subsistence-hunting activities.

ITL No. 3--Information on the Arctic Peregrine Falcon

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

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

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

Purpose of ITL No. 3: The purpose of this measure is to prevent noise and disturbance from OCS exploration and development and production activities from adversely affecting peregrine falcons adjacent to the sale area. This protection is accomplished by advising the lessees (1) of minimum distances that aircraft should maintain from known or potential peregrine nest sites and (2) the role of the FWS in reviewing exploration plans and development and production plans and determining what restrictions, if any, may be applied.

Effectiveness of ITL No. 3: Compliance by lessees with the recommendations described in the ITL should eliminate the adverse effects of aircraft traffic on peregrines. Likewise, it is believed that noise and disturbance effects from onshore facilities can be precluded if such facilities are located away from known nest sites.

ITL No. 4--Information on Beaufort Sea Biological Task Force

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

Purpose of ITL No. 4: The purpose of this ITL is to establish a formal means of advising the RSFO about matters regarding enforcement of the Protection of Biological Resources stipulation. These recommendations of the Beaufort Sea BTF should provide for better decisionmaking concerning biological resources and increased protection of these resources from possible adverse effects.

Effectiveness of ITL No. 4: The Beaufort Sea BTF has proven helpful in providing technical guidance to the RSFO in decisions concerning the Sales BF, 71, and 87 areas. The imposition of this ITL for the next lease sale in the Beaufort Sea would extend the area of concern of the BTF throughout the Beaufort Sea region. However, effects levels of the proposal on marine and coastal birds, pinnipeds, polar bears, beluga whales, caribou, and water quality would remain the same.

ITL No. 5--Information on Subsistence Whaling and Other Subsistence Activities

Federal and State laws recognize subsistence as a priority use of wildlife resources. Lessees are therefore advised that operations should be conducted so as to avoid unnecessary interference with subsistence harvests.

Lessees are advised that the following areas are used extensively by whaling crews from the communities of Wainwright, Barrow, Nuiqsut, and Kaktovik. Conflicts with these crews and related activities should be avoided during the following active whaling periods.

April to June: Barrow whalers use lead systems off Point Barrow and west of Barrow in the Chukchi Sea. Wainwright whalers use lead systems between Wainwright and Peard Bay.

August to October: Kaktovik/Nuiqsut hunters 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. Occasional use may extend from Thetis Island 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.

Lessees are encouraged to consult with local communities and regional organizations, including the Alaska Eskimo Whaling Commission and local whaling captains, to develop a program of exploration and development that minimizes disturbance of these critically significant subsistence activities.

Purpose of ITL No. 5: The activities and attitudes that surround subsistence form the core of Native cultures in the Beaufort Sea area. Local concerns about effects to subsistence are a major scoping issue. The purpose of this ITL is to encourage lessees to conduct themselves in a responsible manner with regards to Native subsistence needs in the hope that many adverse effects to local subsistence and culture could thus be avoided.

Effectiveness of ITL No. 5: Lessee awareness of and sensitivity to Inupiat subsistence whaling and other subsistence activities would avoid or minimize adverse effects to local subsistence and sociocultural systems.

ITL No. 6--Information on Coastal Zone Management

Lessees are advised that the Alaska Coastal Management Program (ACMP) contains policies and standards which are relevant to exploration and development and production activities associated with leases resulting from this sale. In addition, the North Slope Borough Coastal Management Program (NSB CMP) has been adopted by the State and will become part of the ACMP upon approval of the U.S. Department of Commerce. The NSB CMP contains more specific policies related to energy-facility siting; areas with particular geologic hazards, subsistence uses, habitats, and transportation uses; and areas which have historic or prehistoric resources. Relevant policies are applicable to ACMP consistency reviews of postlease activities. Early consultation and coordination with those involved in coastal management review are encouraged.

Purpose of ITL No. 6: The purpose of this ITL is to inform lessees of pertinent policy areas contained in the ACMP and to alert lessees to the fact that the State reviews exploration plans and development and production plans, including the siting of energy-related facilities, for consistency with these policies. Furthermore, it informs the lessee of local coastal management programs that may have policies supplementing those of the ACMP.

Effectiveness of ITL No. 6: This ITL could help to alleviate potential conflicts with both land use regulations and the Alaska Coastal Management Program by alerting lessees that Alaska has an approved CMP that may be amended by the North Slope Borough's district program. Policies included in the ACMP are designed to prevent or to mitigate environmental and social problems associated with development. Conformance with these policies would help to alleviate potential effects, especially those identified for caribou and subsistence. Several other stipulations and ITL's complement the objectives of the State's coastal management policies and would work in accord with the CMP to mitigate potential effects. Although the application of CMP policies would not necessarily modify the levels of effects identified in this EIS, the process of getting final approval of projects could be substantially eased.

ITL No. 7--Information on Endangered Whales

Lessees are advised that the Regional Supervisor, Field Operations (RSFO), has the authority and intends to limit or suspend any noise-producing operations, including preliminary activities, as defined under 30 CFR 250.34-1(a)(1), on a lease whenever endangered whales are near enough to be subject to noise disturbance from offshore oil and gas activities which would be likely to result in jeopardy to the species.

Notice to Lessees No. 86-2 specifies performance standards for preliminary activities.

Purpose of ITL No. 7: The purpose of this measure is to prevent jeopardy to endangered species by reducing the risk of endangered whales being adversely affected by noise-producing seismic activities and oil and gas operations in the Beaufort Sea Planning Area.

Effectiveness of ITL No. 7: A small portion of the gray whale population spends the summer and early fall feeding in the far western part of the planning area. The entire western bowhead whale population migrates through the planning area in the spring and fall.

Because it is advisory, this measure would not prevent interaction of the endangered whales with exploration and development and production activities and vessel traffic over the life of the field. It cannot be assumed that inadvertent conflict can be avoided completely or that incidental "taking" would not occur. Effects on whales can be expected.

2. Description of Alternatives II through VI: In addition to the proposal (Alternative I), there are five alternatives considered in this EIS. These alternatives are listed below, shown in Figure I-1, and described in paragraphs a through e. The approximate number of blocks deferred for each alternative is shown below.

Alternative II - No Sale
Alternative III - Delay the Sale
Alternative IV - Barrow Deferral Alternative (201 blocks)
Alternative V - Kaktovik Deferral Alternative (161 blocks)
Alternative VI - Chukchi Deferral Alternative (1,592 blocks)

a. Alternative II - No Sale: This alternative would eliminate the entire area proposed for leasing from further consideration. Table II-B-1 shows the amount of energy needed from other sources to replace the anticipated oil production from the proposal.

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

c. Alternative IV - Barrow Deferral Alternative: This alternative would remove from the Sale 97 area 201 whole and partial blocks--about 412,354 hectares--located along the coast from Elson Lagoon on the Beaufort Sea side of Point Barrow to Peard Bay on the Chukchi Sea side (Fig. I-1); these blocks comprise the Barrow Deferral Area. (A list of blocks within the deferral area is available from the Alaska OCS Region office.) This area is part of the area that the State of Alaska (SOA), NSB, Alaska Eskimo Whaling Commission (AEWC), National Oceanic and Atmospheric Administration (NOAA), and the Environmental Protection Agency (EPA) recommended for deferral. The boundaries of the deferral area lie between 6 and 47 kilometers offshore. Bowhead whales pass through this area during their spring and fall migrations to and from the eastern Beaufort Sea and during some years have been observed feeding within the deferral area. The Inupiat people of Barrow use the deferral area in the spring and fall to hunt bowhead whales for subsistence purposes. The deferral area also contains polar bears, ringed seals, and migratory birds that are hunted for subsistence purposes by people from Barrow and Wainwright. Based on the mean-case resource estimate, it is estimated that the Alternative IV area contains about 630 MMbbls of oil.

d. Alternative V - Kaktovik Deferral Alternative: This alternative would remove from the Sale 97 area 161 whole and partial blocks--about 327,022 hectares--located between Kaktovik (Barter Island) and the Canadian border; these blocks comprise the Kaktovik Deferral Area. (A list of blocks within the deferral area is available from the Alaska OCS Region office.) This area is part of areas that the SOA, NSB, AEWC, and NOAA recommended for deferral. The boundaries of the deferral alternative lie between 6 and 40 kilometers offshore. Blocks that were leased as a result of Sale 87 are located near or adjacent to the boundaries of the deferral area. Bowhead whales use this area as part of the fall migration route and for feeding. The Inupiat residents of Kaktovik use the area to hunt bowheads--as well as polar bears, ringed seals, and migratory birds--for subsistence purposes. Based on the mean-case resource estimate, it is estimated that the Alternative V area contains about 560 MMbbls of oil.

Table II-B-1
Energy Needed from Other Sources to Replace Anticipated
Oil Production from Proposed
Beaufort Sea Sale 97
(Mean Level of Resources if Resources are Found)

	Billions
Total Crude Oil Production (bbls) (19-year production schedule)	0.650
Crude Oil BTU Equivalent at 5.6 x 10^6 BTU/bbl (BTU)	3,64,000
<u>Alternative Energy Sources Equivalents</u>	
Oil (bbls)	0.650
Gas (cf)	3,525
Coal (tons)	
Anthracite 1/	6.143
Bituminous 2/	0.138
Sub-bituminous 3/	0.191
Lignite 4/	0.271
Oil Shale (tons) 5/	0.928
Tar Sands (tons) 6/	0.866
Nuclear (Uranium Ore) (tons)	
Light Water Reactor 7/	0.0061
Breeder Reactor 8/	0.0000434

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

e. Alternative VI - Chukchi Deferral Alternative: This alternative would remove from the Sale 97 area 1,592 whole or partial blocks--about 3,595,670 hectares--located seaward of the Barrow Deferral Area on the Chukchi Sea shelf and upper part of the continental slope; the blocks comprise the Chukchi Deferral Area. (A list of blocks within the deferral area is available from the Alaska OCS Region office.) Based on the mean-case resource estimate, it is estimated that the Alternative VI area contains about 620 MMbbls of oil.

C. Summary and Comparison of Effects of Alternatives

Table II-C-1 presents a summary and comparison of potential effects for Alternatives I, IV, V, and VI. The summaries are in tabular form to allow the reader to compare alternatives. Please see the analyses in Section IV for more in-depth discussion of the topics summarized here. Terms that indicate levels of effect (i.e., NEGLIGIBLE, MINOR, MODERATE, MAJOR) are defined in Table S-2 (located in the front of this EIS). A summary of scenario assumptions for the mean-case resource estimates for Alternatives I, IV, V, and VI is shown in Table II-A-2.

Table II-C-1
Summary and Comparative Analysis of Potential
Effects for Alternatives I, IV, V, and VI
for the Beaufort Sea Sale 97

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
LOWER-TROPHIC-LEVEL ORGANISMS			
Oil spills are more likely to cause widespread negative effects to marine plants and invertebrates than are other activities associated with exploration and development and production of oil resources. In general, oil spills are expected to have MINOR effects on marine plants and invertebrates. At greater risk to effects are benthic and epibenthic organisms living in nearshore shallow environments where contact with oil is more probable. Even if the abundant epibenthic invertebrates in nearshore environments were affected locally, it is most likely that populations of their fish predators would not be affected significantly and that recolonization by invertebrates could be rapid. Oil-spill effects on the planktonic and epontic communities are expected to be MINOR due to the limited area likely to be affected. Some local effects to higher-trophic-level organisms may be observed. Effects from other activities associated with the proposal be very localized and are not expected to exceed MINOR. The Stefansson Sound Boulder Patch community is more vulnerable to effects from oil-related activities, since it is a very restricted community spatially. If oil contacted the community, then a MODERATE effect is possible, since productivity and successful recruitment could be affected. If construction activities were sited too close to this community, then a MAJOR effect is possible. However, MINOR effects to this community are expected. Under the cumulative case, the effect of oil exploration and production on marine plants and invertebrates is expected to be MINOR.	Alternative IV would insignificantly alter the probability of oil spills occurring and contacting marine plants and invertebrates of greatest concern. Effects from other oil-associated activities are not expected to be appreciably affected by this deferral alternative. Thus, the level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for the Stefansson Sound Boulder Patch if it were contacted by oil. Cumulative effects under this alternative are expected to be similar to those under the proposal--MINOR.	Alternative V offers some advantage to epibenthic invertebrates in nearshore waters by reducing the probability of an oil spill contacting land. For other marine plants and invertebrates of concern, this alternative changes effects insignificantly. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative. The level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for the Stefansson Sound Boulder Patch if it were contacted by oil. Cumulative effects under this alternative are expected to be similar to those under the proposal--MINOR.	Alternative VI would insignificantly alter the probability of oil spills occurring and contacting marine plants and invertebrates of greatest concern. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative. Thus, the level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for the Stefansson Sound Boulder Patch if it were contacted by oil. Cumulative effects under this alternative are expected to be similar to those under the proposal--MINOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
FISHES			
Of all the potential direct effects of oil and gas development on fishes in the Sale 97 area due to this proposal, oil spills pose the greatest threat. Anadromous fishes migrating to feeding, overwintering, or spawning areas and juvenile stages in near-shore areas are susceptible to spilled oil. An oil spill contacting the nearshore zone in the open-water season when these fishes are widely dispersed is expected to have a MINOR effect on them. However, MODERATE effects are possible if spawning- year individuals, aggregated multi-aged assemblages, or a year class of young were affected. Oil is unlikely to contact the river deltas where these fishes are most vulnerable. A MINOR effect is expected for anadromous fishes. Capelin spawn in coastal sandy areas and thus are susceptible to negative effects from an oil spill. The effect of an oil spill on capelin is expected to be MINOR but could be MODERATE if most individuals die after spawning. Effects from other activities (seismic exploration, discharge of drilling fluids, and construction activities) should be very localized. The effect of these activities on fishes is expected to be MINOR. In conclusion, the effect on fishes in the Sale 97 area is expected to be MINOR, although MODERATE effects are possible for some species (e.g., capelin and some anadromous species) if spawning-year individuals, aggregated multi-aged assemblages, or a year class of young are affected. The effect of the cumulative case on fishes in the Sale 97 area is expected to be MAJOR.	Alternative IV would reduce somewhat the probability of oil spills occurring and contacting fishes of greatest concern; however, its overall effect is probably not significant. Effects from other oil-associated activities are not expected to be appreciably affected by this deferral alternative. Thus, the level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for some anadromous species and capelin. Cumulative effects under this alternative are expected to be similar to those under the proposal--MAJOR.	Alternative V would reduce somewhat the probability of oil spills occurring and contacting fishes of greatest concern; however, its overall effect is probably not significant. Anadromous fishes in nearshore areas derive no real benefit from this deferral alternative since there is a negligible change in the probability of oil contacting their most sensitive and important habitat, the river deltas. Effects from other oil-associated activities are not expected to be appreciably affected by this deferral alternative. Thus, the level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for some anadromous species and capelin. Cumulative effects under this alternative are expected to be similar to those under the proposal--MAJOR.	Alternative VI would not significantly affect the probability of oil spills occurring and contacting fishes of greatest concern. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative. Thus, the level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for some anadromous species and capelin. Cumulative effects under this alternative are expected to be similar to those under the proposal--MAJOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
MARINE AND COASTAL BIRDS			
Over the life of the proposal, one or more oil spills is likely to contaminate one or more coastal habitats or an important pelagic habitat of marine and coastal birds. This contamination could result perhaps in the death of several hundred to several thousand birds. Some local habitats are likely to be contaminated, temporarily affecting available food sources of some parts of various regional populations. Effects of oil spills on marine and coastal birds are expected to be MODERATE if recovery of the affected portion of the regional population or habitat takes more than one generation. Industrial activities (90 to 270 helicopter trips per year) would temporarily disturb some of nesting, feeding, and molting birds. These effects are expected to be MINOR. Other industrial activities that could affect birds include dredging, island and causeway construction, gravel mining, fill storage and transportation, and onshore pipeline and road development. Offshore activities would temporarily displace some birds near the activity sites and temporarily disrupt or remove food sources near the two drill platforms and the pipeline and dredging sites. Onshore-construction activities would destroy or alter a small amount of tundra-nesting and -feeding habitat along the 160 kilometers of onshore pipelines. These effects are expected to be MINOR. The combined effect of potential oil spills, disturbance, and onshore and offshore construction activities is expected to be MODERATE. Cumulative oil and gas exploration and development and production from the above activities and the proposal are likely to have MODERATE effects on some marine and coastal birds (particularly oldsquaw, common eider, snow geese, and Pacific brant).	This alternative could slightly reduce potential oil-spill effects on thousands of seabirds that forage in the concentration area off Point Barrow. Alternative IV also could prevent or greatly reduce disturbance effects on birds using Elson Lagoon and the Plover Islands; however, oil-spill, noise and disturbance, and adverse-habitat effects on marine and coastal birds in other parts of the planning area are expected to be the same as those of the proposal. The effect of this alternative on marine and coastal birds is expected to be MODERATE, the same level of effect as that of the proposal. Cumulative effects are expected to be essentially the same as for the proposal--MODERATE.	This alternative would substantially reduce potential oil-spill effects to moderate numbers of birds in habitats east of Jago Lagoon. However, it would only slightly reduce oil-spill effects to high numbers of birds in other habitats, and it would not reduce noise and disturbance and habitat-alteration effects to greater numbers of marine and coastal birds throughout other parts of the planning area. Therefore, effects on marine and coastal birds are likely to be MODERATE, the same level of effect as that of the proposal. Cumulative effects are expected to be essentially the same as for the proposal--MODERATE.	This alternative could slightly reduce oil-spill risks and potential oil-spill and habitat effects on birds that feed in offshore habitats northwest of Point Barrow in the Chukchi Sea; however, oil-spill risks and potential oil-spill, disturbance, and habitat effects on birds using coastal habitats in the rest of the sale area would be essentially the same for this alternative as for the proposal. Therefore, effects on marine and coastal birds are likely to be MODERATE, the same as for the proposal. Cumulative effects are expected to be essentially the same as for the proposal--MODERATE.

Table II-C-1
(Continued)

Alternative I - Proposal

PINNIPEDS, POLAR BEARS, AND BELUGA WHALES

Aggregations of ringed, spotted, and bearded seals and walruses could be contaminated by an oil spill and suffer minor sublethal effects. Few pupping and breeding ringed seals are likely to be contaminated by a winter oil spill. Polar bears would be most vulnerable to oil spills in the ice-flaw zone; however, few bears are likely to be affected due to their sparse distribution. Walrus herds and their seasonal feeding habitat are at some risk of oil-spill contact; however, healthy walruses are not likely to die from oil-spill contact, and oil-spill effects on benthic prey are likely to be very local. Belugas could have some contact with hydrocarbons in the water column or on the surface if an oil spill contaminates the lead system off Point Barrow, but few beluga whales are likely to be seriously affected by their probable brief exposure to the spill. Effects of oil spills are expected to be MINOR.

Air and vessel traffic associated with the proposal (90 to 270 helicopter trips per year) is likely to cause some temporary short-term disturbance to some marine mammals, resulting in brief flight responses when aircraft and boats pass nearby. Lowflying aircraft could cause injury or death to a small number of walrus calves. However, these events are likely to be uncommon or rare. Effects of noise and disturbance are expected to be MINOR. Dredging and island, causeway, and offshore-pipeline-construction activities associated with the proposal are expected to have brief MINOR disturbance effects on marine mammals. The combined effects of oil spills, disturbance, and offshore-construction activities are expected to be MINOR.

Cumulative oil and gas exploration and development and production from the above activities and the proposal are expected to have MINOR effects on pinnipeds, polar bears, and beluga whales occurring in the Beaufort Sea.

Alternative IV - Barrow Deferral

This deferral alternative could reduce oil-spill effects on marine mammals and their habitats near Point Barrow. Noise and disturbance of marine mammals and habitat alterations due to industrial activities also could be reduced locally in this area. However, overall effects on nonendangered marine mammals are expected to be MINOR, since ringed seals, polar bears, walruses, and other species would be exposed to potential oil spills and other effects in other parts of the planning area.

The cumulative effects are expected to be essentially the same as those for the proposal--MINOR.

Alternative V - Kaktovik Deferral

Although oil-spill, disturbance, and habitat-alteration effects on marine mammals would be reduced or eliminated in offshore habitats east of Kaktovik, effects on large numbers of walruses, bearded seals, and beluga whales and on important marine mammal habitats west of Prudhoe Bay would not be reduced from those effects described under the proposal. Effects under this alternative are expected to be MINOR, the same level of effect as under the proposal.

Cumulative effects are expected to be the same as for the proposal--MINOR.

Alternative VI - Chukchi Deferral

This alternative could reduce oil-spill effects on marine mammals, particularly on walruses, and their habitats west of Point Barrow. Noise and disturbance of marine mammals and habitat alterations due to drill-platform and pipeline construction would not occur in this area. Therefore, effects on nonendangered marine mammals are estimated to be reduced from MINOR under the proposal to NEGLIGIBLE for this alternative.

Cumulative effects are expected to be essentially the same as for the proposal--MINOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
ENDANGERED AND THREATENED SPECIES			
As a result of an oil spill, some bowhead and gray whales may experience 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. Habitat alterations may disturb or eliminate a small amount of benthic-feeding habitat used by bowheads and gray whales. Whales would be affected by noise-generating activities such as aircraft and vessel traffic, geophysical-seismic activity, drilling units, production platforms, and artificial-island construction. Reactions are expected to be short-term and temporary in nature, consisting of movements away from the sound source; however, many whales may avoid feeding and migrating within a range of several to 10 kilometers of drilling units and production platforms. It is not anticipated that feeding activities in late summer/early fall would be precluded or seriously impaired by acoustic disturbance from operations associated with Sale 97. The overall effect of the sale on the bowhead and gray whale is expected to be MINOR. There is a low probability that arctic peregrine falcons would contact spilled oil or be disturbed by onshore activities associated with the sale. The effect of the sale on the arctic peregrine falcon is expected to be NEGLIGIBLE. Under the cumulative case, the combined effects from OCS activities are expected to be MODERATE on the bowhead and gray whales and MINOR on the artic peregrine falcon.	Potential acoustic and nonacoustic effects of this alternative would be qualitatively similar to the proposal. The probability of an oil spill contacting endangered whale habitat would be slightly reduced under this alternative. Noise disturbance from industrial activity, aircraft, and vessels also would be reduced within the deferral area. Bowhead whales would, however, be affected by exploratory and production activities outside the deferral area; and effects on this species are expected to remain MINOR. Most gray whales within the lease-sale area are found within the deferral area; consequently, effects on the gray whale under this alternative are expected to be NEGLIGIBLE, as compared with MINOR under the proposal. The effects on the arctic peregrine falcon are expected to be NEGLIGIBLE, the same as for the proposal. Cumulative effects on the bowhead and gray whales are expected to remain the same as those of the proposal--MODERATE. Cumulative effects on the arctic peregrine falcon also are expected to be the same as those of the proposal--MINOR.	Effects of this alternative on endangered bowhead and gray whales would be quite similar to the effects of the proposal. There would be a small reduction in oil-spill risk to a few bowhead whale-habitat areas, and industrial noise would be reduced in the bowhead fall-feeding area east of Kaktovik. However, effects on bowheads would be the same outside the deferral area as under the proposal. Overall effect levels are expected to be the same as for the proposal--MINOR for bowhead and gray whales and NEGLIGIBLE for the arctic peregrine falcon. Cumulative effects on the bowhead and gray whales are expected to remain the same as those of the proposal--MODERATE. Cumulative effects on the arctic peregrine falcon also are expected to be the same as those of the proposal--MINOR.	Oil-spill risks and industrial noise would be reduced within the deferral area; however, bowhead whales migrate through the deferral area rather quickly, and gray whales are present in low numbers. Effects on these species outside the deferral area would be similar to those under the proposal--overall effects on these species are expected to remain MINOR, as under the proposal. Arctic peregrine falcons are not found within the deferral area; effects on this species are expected to remain NEGLIGIBLE, as under the proposal. Cumulative effects on the bowhead and gray whales are expected to remain the same as those of the proposal--MODERATE. Cumulative effects on the arctic peregrine falcon also are expected to be the same as those of the proposal--MINOR.

Table II-C-I
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
CARIBOU			
The primary concern under the proposal is disturbance of caribou from onshore oil and gas activities that would be associated with development and transportation. Vehicle traffic, human presence, and spreading onshore development are disturbance factors to caribou, particularly to cow/calf groups on their calving and summer ranges. Oil development could cause some local changes in distribution and movements of caribou. However, motor-vehicle- traffic disturbance of caribou is likely to subside after pipeline construction is complete, and caribou would successfully cross the pipelines and roads associated with the proposal. Effects on caribou are expected to be MINOR. Cumulative oil and gas exploration and development and production from the above projects and the proposal are likely to have MODERATE effects on the distribution of one or more caribou herds.	The deferral of leasing blocks in the Point Barrow-Elson Lagoon area would not reduce the potential effects of the proposal on caribou, since this alternative is assumed to include the same onshore-pipeline-transportation systems as the proposal; thus, potential onshore-disturbance and -habitat effects on caribou are expected to be the same as the effects of the proposal--MINOR. The cumulative effects are expected to be essentially the same as those of the proposal--MODERATE.	This alternative could reduce potential disturbance of the Porcupine caribou herd and possible oil-spill effects on caribou of this herd that use coastal barrier islands and beaches between Jago Lagoon and Demarcation Bay for insect relief. However, caribou of the Western Arctic herd and of the Central Arctic herd would still be exposed to disturbance sources and habitat alteration associated with onshore-pipeline transportation of oil from leases in other parts of the Sale 97 area. Caribou of these two herds would still be temporarily displaced during construction of the onshore pipelines and roads, although their use of summer-forage range is not likely to be greatly affected by the proposal or this alternative. This alternative is expected to have the same effect level as that of the proposal--MINOR--although motor-vehicle disturbance on the Porcupine Caribou herd could be greatly reduced under this alternative. The cumulative effects are expected to be essentially the same as those of the proposal--MODERATE.	The deferral of leasing blocks offshore and northwest of Point Barrow would not reduce potential oil-spill-contact risks to coastal habitats southwest of Point Barrow that are used by caribou for insect relief. This alternative also is assumed to include the same onshore oil-pipeline-transportation system as the proposal; thus, potential onshore-disturbance and -habitat effects on caribou are expected to be the same as those of the proposal--MINOR. The cumulative effects are expected to be essentially the same as those of the proposal--MODERATE.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
POPULATION			
Effects on North Slope Borough population are expected to be NEGLIGIBLE. Native-resident population would grow through 2003 and experience a small decline through 2010. The sale would both provide direct employment and indirectly sustain Borough Capital Improvements Program (CIP) and operating employment, thereby moderating Native out-migration. The effect on the level and trend of population growth on the North Slope attributable to the proposal is expected to be NEGLIGIBLE. The cumulative effects on population are expected to be MINOR.	Since the development infrastructure of the sale would be only slightly different in this alternative than in the proposal, the effect of this alternative on NSB population would be the same as the effect of the proposal. The sale as proposed has the effect of moderating the initial decline in the population expected from reduced Borough operating and CIP revenues. These revenues associated with the development infrastructure of this alternative would be less than those of the proposal. Hence, the growth rate of the resident population following 1988 would be slightly less, and its peak would be lower. The Barrow deferral would have the same effect as the proposal on the population of the North Slope Borough--NEGLIGIBLE. The cumulative effects on population are expected to be the same as those of the proposal--MINOR.	Since the development infrastructure would be only slightly different in this alternative than in the proposal, the effect of this alternative on NSB population would be the same as the effect of the proposal. The sale as proposed has the effect of moderating the initial decline in the population expected from reduced Borough operating and CIP revenues. These revenues associated with the development infrastructure of this alternative would be less than those of the proposal. Hence, the growth rate of the resident population following 1988 would be slightly less, and its peak would be lower. The Kaktovik Deferral Alternative would have the same effect as the proposal on the population of the North Slope Borough--NEGLIGIBLE. The cumulative effects on population are expected to be the same as those of the proposal--MINOR.	Since the development infrastructure would be only slightly different in this alternative than in the proposal, the effect of this alternative on NSB population would be the same as the effect of the proposal. The sale as proposed has the effect of moderating the initial decline in the population expected from reduced Borough operating and CIP revenues. These revenues associated with the development infrastructure of this alternative would be less than those of the proposal. Hence, the growth rate of the resident population following 1988 would be slightly less, and its peak would be lower. The Chukchi Deferral Alternative would have the same effect as the proposal on the population of the North Slope Borough--NEGLIGIBLE. The cumulative effects on population are expected to be the same as those of the proposal--MINOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
NORTH SLOPE SOCIOCULTURAL SYSTEMS			
Sale 97 would provide limited revenues to the NSB. As a result, this sale is expected to have NEGLIGIBLE effects on the cost-of-living aspect of the quality of life of NSB communities. With miniscule revenues predicted for the NSB and with very little CIP employment projected in the smaller coastal communities, opportunities for Native entrepreneurs would decline in Barrow and decrease dramatically in the other NSB communities. Community social services are more a product of onshore revenues and ongoing social change, and their effects on traditional social behaviors is expected to be NEGLIGIBLE. The presence of enclaves and the considerable influence of other forces should limit the sale's effects on social pathologies to MINOR levels. Available information indicates that Sale 97 is expected to have MINOR consequences for Inupiat sharing and reciprocal behaviors. The overall consequence of Sale 97 for North Slope sociocultural systems is expected to be MINOR. The cumulative effects to North Slope sociocultural systems from both onshore and offshore development are expected to be MAJOR.	The Barrow Deferral Alternative with a subsequent disruptive oil spill in the Kaktovik and/or Wainwright areas could worsen the existing differences between the small coastal communities and their attitudes towards the concentration of administrative decisionmaking in Barrow. That is, given that most administrative decisions are made in Barrow, an oil spill anywhere but in the Barrow area may be perceived as discrimination against the sovereignty of the small coastal communities. However, even with these conditions, the most drastic scenario should not exceed the expectations of the effects of the proposal. The effects of the Barrow deferral are expected to be no worse than the effects of the proposal, that is, overall MINOR effects are expected with MODERATE detrimental consequences anticipated for community attitudes toward governing and administrative institutions. Thus, although an oil spill (or spills) is expected to have MODERATE consequences for community governing and administrative institutions, the overall effect should not cause long-term, chronic disruption of the entire sociocultural system or lead to the displacement of the broad range of social and cultural institutions discussed in this analysis. The cumulative effects are expected to be the same as those of the proposal--MAJOR.	Because there is only a slight reduction in the oil resources, the sociocultural consequences of the Kaktovik Deferral Alternative are, for most of the Sale 97 area, expected to be about the same as for the proposal--MINOR (with MODERATE effects on community attitudes toward their governing and administrative institutions). However, for Kaktovik--a small, tightly integrated community dependent on subsistence activities--this alternative is expected to have a MODERATE, positive consequence for the community. The cumulative effects on population are expected to be the same as those of the proposal--MAJOR.	A deferral of the Chukchi tracts should make little difference to North Slope sociocultural systems as outlined in the effects of the proposal. Revenues would be only slightly affected, and the potential consequences of oil spills from the Barrow and Kaktovik tracts should do little to alter the analysis contained in the effects of the proposal. The effects of the Chukchi Deferral Alternative are expected to be no worse than the effects of the proposal, that is, overall MINOR effects are expected with MODERATE detrimental consequences anticipated for community attitudes toward governing and administrative institutions. The cumulative effects on population are expected to be the same as those of the proposal--MAJOR.

Table II-C-1
(Continued)

Alternative I - Proposal

SUBSISTENCE-HARVEST PATTERNS

Subsistence resources harvested by North Slope Natives include bowhead whales, caribou, seals, walruses, polar bears, beluga whales, fishes, and game birds.

Because bowhead whaling occurs in the lead systems, MAJOR effects to bowhead subsistence harvests could be expected if an oil spill occurred and contacted the narrow leads. MODERATE effects are expected from localized, short-term noise- and traffic-disturbance effects, which may intermittently and temporarily affect subsistence whaling. A pipeline landfall at Point Belcher is expected to have a MAJOR effect on Wainwright's harvest of bowheads.

Noise-related effects are expected to be MINOR for the harvest of pinnipeds and polar bears and MAJOR for beluga whales.

Effects of both seismic activities and oil spills on fish harvests are expected to be NEGLIGIBLE. Although unlikely, an oil spill contacting a river delta during spawning is expected to have a MINOR or greater effect.

Effects from oil spills and noise on waterfowl harvests are expected to be short term and MODERATE and concentrated in areas used by Barrow and/or Kaktovik hunters. Effects for Wainwright are expected to be MAJOR because of the pipeline landfall of Point Belcher.

The overall effects of this proposal on subsistence harvests are expected to be MAJOR.

In the cumulative case, effects to North Slope subsistence harvests are expected to be MAJOR.

Alternative IV - Barrow Deferral

Alternative IV, would not change the regionwide levels of oil-related activities. Neither would this alternative reduce the overall risks of one or more oil spills. For these reasons, effects on subsistence harvests are expected to remain MODERATE except at Wainwright, where they are likely to remain MAJOR. However, this alternative would remove most exploratory and development and production activities from much of the area intensively used by Barrow's hunters and from virtually all of the area used by Wainwright's hunters. While seaborne-supply activities would still occur within this deferral area, the deferral would nevertheless substantially reduce effects of noise and traffic disturbance on Wainwright's and Barrow's subsistence-harvest patterns.

As for the proposal, cumulative effects under this alternative are expected to be MAJOR.

Alternative V - Kaktovik Deferral

Alternative V would not change the regionwide effects of the proposal on subsistence resources or on subsistence activities. Overall effects on subsistence are expected to remain MODERATE except at Wainwright, where they are expected to remain MAJOR. However, this alternative would mitigate, to a degree, effects in the area east of Kaktovik, an area used by a community whose subsistence areas to the west may be affected.

Cumulative effects under this alternative are expected to remain MAJOR.

Alternative VI - Chukchi Deferral

Alternative VI would not change the expected regionwide levels of oil-related activities or reduce the overall risks of one or more oil spills. For these reasons, effects on subsistence are expected to remain MODERATE for Barrow, Nuiqsuit, and Kaktovik. However, this alternative would eliminate a pipeline landfall at Point Belcher associated with Sale 97. For this reason, with the Chukchi Referral Alternative, effects on subsistence for Wainwright would drop from MAJOR to MODERATE. This alternative may also decrease effects of noise and traffic disturbance on subsistence activities in the immediate vicinity of Barrow.

Cumulative effects of this alternative are expected to be the same as those of the proposal--MAJOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
ECONOMY OF THE NORTH SLOPE BOROUGH			
Because of projected fiscal and resident employment declines in the NSB, the economic effects of the proposal would have none of the typical growth-related adverse consequences on the NSB government or residents. While most of the jobs in sale-related activities would be filled by commuters from outside the region, fiscal and employment conditions in the region would be improved. The effect of the proposed sale on resident employment would be less than 10 percent above employment with the sale in all years except 2009 and 2010. Sale effects on Native and non-Native resident employment would be slightly higher and slightly lower, respectively. However, the unemployment rate for Native residents would still reach 50 percent by 2002, with or without the sale. Economic benefits from new jobs, income, taxes, etc., that would result from the proposed sale are expected to occur after the level of petroleum activities on the North Slope (e.g., Prudhoe Bay) has begun to decline. This decline would not be reversed by the projected effects of proposed Sale 97. The economic effects on the NSB are expected to be NEGLIGIBLE. Cumulative effects on the economy of the NSB are expected to be MINOR in the North Slope region.	The revenue and employment effects of this alternative would be virtually identical to those of the proposal, because the resource estimates for this alternative are only 3 percent less than those for the proposal. Consequently, the resulting employment effects would probably be the same as those of the proposal. The economic effects of this alternative in the North Slope region are expected to be the same as those of the proposal--NEGLIGIBLE. The cumulative effects of this alternative are expected to be the same as the proposal--MINOR.	The employment effects of this alternative would be only slightly less than those of the proposal, because the resource estimates for this alternative are only 14 percent less than those for the proposal. This difference in resource estimates probably would not change the number of production platforms installed and operated, but it might reduce slightly the number of production wells drilled. The employment effects of this alternative would, therefore, probably be about 95 percent as great as the effects indicated for the proposal in Section IV.B.10. The economic effects of this alternative in the NSB are expected to be classified the same as those of the proposal--NEGLIGIBLE. The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.	The employment effects of this alternative are projected to be virtually identical to those of the proposal, because the resource estimates for this alternative are only 5 percent less than those for the proposal. The economic effects of this alternative would be classified the same as those of the proposal--NEGLIGIBLE in the NSB. The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
LAND USE PLANS AND COASTAL MANAGEMENT PROGRAMS			
The potential level of conflict between CMP policies and the proposal differs for the two coasts. Along the Beaufort Sea coast where development would be comparatively limited and an extension of existing industrial growth, some conflict with Best Efforts Policies is likely. This would be especially true for subsistence policy because the proposal includes all the offshore area used by three communities, and some alterations in subsistence patterns could result. Most other policy areas where conflict could occur (e.g., transportation or habitat policies) cannot be identified by generic types of activities. Rather, site-specific analyses would be needed. Along the Chukchi Sea coast, however, onshore development would occur in an area currently used for subsistence whaling--an area that has three important archaeological sites used during this hunting. Depending upon the provisions made for continued use of this area for subsistence purposes, development could conflict with the mandatory subsistence policy that would preclude the development. Surface-transportation systems and additional airfields would be placed in an area served at the present time only by a local airstrip. The transportation facilities and shore base would be major shifts in land use. Changes along the Beaufort Sea coast are expected to cause MINOR conflicts with NSB Land Management Regulations and the Alaska Coastal Management Program. Along the Chukchi Sea coast, changes are expected to lead to MAJOR conflicts. Full development as described in the cumulative case is expected to lead--for the entire planning area--to MAJOR conflicts with existing land uses and land and coastal management regulations as opposed to MINOR for the proposal along the Beaufort Sea and MAJOR for the proposal along the Chukchi Sea.	Because most of the regional effects and the transportation scenario do not change with this alternative, land use changes and potential conflicts with NSB Land Management Regulations and ACMP policies are expected to remain the same as for the proposal--MINOR for development along the Beaufort Sea coast and MAJOR on the Chukchi Sea coast. Effects of the cumulative case with the alternative are expected to be almost identical to those of the proposal--MAJOR.	Deferring the area around Kaktovik slightly reduces the oil resources of the proposal. However, production is expected to occur from this eastern portion of the sale area regardless of Sale 97. Therefore, effects on land use and conflicts with NSB Land Management Regulations and ACMP policies would not be significantly different from those anticipated for the proposal. Potential conflicts are expected to remain MINOR for development along the Beaufort Sea coast and MAJOR along the Chukchi Sea coast. For the cumulative case, MAJOR conflicts with land use plans and regulations and coastal management policies are expected to occur.	Deferring the Chukchi Sea portion of the lease sale eliminates the need for a shore base at Point Belcher. The major changes in land use in the area would not occur, and archaeological sites near Point Belcher would be preserved. Development along the Beaufort Sea coast would be comparable to that of the proposal. By removing the portion of the proposal most closely associated with MAJOR effects, the over-all effect of the lease sale is expected to be MINOR. Cumulative effects would remain MAJOR because the Point Belcher landfall site would be constructed to support development associated with Sale 109, the next sale scheduled for the Chukchi Sea, and cumulative development along the Beaufort Sea coast would remain the same as for the proposal.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
ARCHAEOLOGICAL RESOURCES			
The overall effect of the proposal on archaeological resources is expected to be MINOR. The cumulative effects on archaeological resources are expected to be MINOR.	This deferral is expected to reduce the effects of the proposal from MINOR to NEGLIGIBLE by reducing oil and gas activity north of Barrow (near OSRA Segment 20), the location of the largest number of shipwrecks and many archaeological sites. The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.	Because there is only a slight reduction in the oil resources associated with this alternative, the archaeological resources of the sale area would be affected by the same level of activities as discussed for the proposal. The effects of the Kaktovik Deferral Alternative are expected to be the same as those of the proposal--MINOR. The cumulative effects of the alternative are expected to be the same as those of the proposal--MINOR.	This deferral is expected to reduce the effects of the proposal from MINOR to NEGLIGIBLE by reducing activities associated with oil development west of Point Belcher (OSRA Segment 15), the location of the largest number of shipwrecks and many archaeological sites. The cumulative effects of the alternative are expected to be the same as those of the proposal--MINOR.

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
RECREATION AND TOURISM RESOURCES			
The effect of the proposal on recreation and tourism resources is expected to be MINOR. The cumulative effects on recreation and tourism resources are expected to be MINOR.	This deferral is expected to reduce the effects of the proposal from MINOR to NEGLIGIBLE by reducing activities associated with oil development north of Barrow (near OSRA Segment 20), where the largest number of recreationists and tourists come for outdoor activities. The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.	Because there is only a slight reduction in the oil resources of the Kaktovik Deferral Alternative, the recreation and tourism resources of the Sale 97 area are expected to be affected by the same level of activities as discussed for the proposal. The effects of this alternative are expected to be the same as they are for the proposal--MINOR. The cumulative effects of the alternative are expected to be the same as those of the proposal--MINOR.	Because there is only a slight reduction in the oil resources of the Chukchi Deferral Alternative, the recreation and tourism resources of the Sale 97 area would be affected by the same level of activities as discussed for the proposal in Section IV.B.13. The land segments near the deferral area contain fewer recreation and tourism resources than other segments near the proposed sale area. Thus, with this alternative, there would be very little, if any, reduction in the effects caused by petroleum activities when compared with the effects of the proposal. The effects of the Chukchi Deferral Alternative on recreation and tourism resources are expected to be the same as the effects of the proposal--MINOR. The cumulative effects of the alternative are expected to be the same as those of the proposal--MINOR.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
WATER QUALITY			
An oil spill of 1,000 barrels or greater would temporarily and locally increase water-column hydrocarbon concentrations. A spill of 100,000 barrels or more is expected to temporarily degrade water quality over several hundred kilometers for a MODERATE effect on water quality, but a spill of such magnitude is not anticipated. The large number of very small spills anticipated over the production life of the field could result in local, chronic hydrocarbon contamination within the margins of the oil field for a MINOR effect on water quality. Construction activities, including artificial-island removal, would at most increase turbidity over a few square kilometers in the immediate vicinity of the construction and only while the activity persisted. Abandonment of an artificial island could locally increase turbidity over the years it took the island to erode, producing a MINOR effect on water quality. Deliberate discharges are regulated by EPA such that any effects on water quality must be extremely local; water-quality criteria cannot be exceeded at greater than a 100-meter distance from the discharge point. Discharge of formation waters--rather than their reinjection into the seafloor--is expected to result in long-term pollution (hydrocarbon, trace metals, and salt) in the vicinity of the oil field, a MINOR effect on water quality. Significant long-term or regional effects are unlikely for the proposal. Local short-term and long-term degradation of water quality is likely. Effects on water quality are expected to be MINOR. Cumulative development in the vicinity of the Beaufort Sea Planning Area could result in an oil spill of 100,000 barrels or greater, for a MODERATE effect on water quality. Other agents would have relatively little effect on water quality, and the overall cumulative effect is expected to remain MODERATE.	Alternative IV does not significantly reduce the oil resource or the level of effect on water quality. There would be some lessening of pollution risks from artificial-island construction or removal and local deliberate (permitted) discharges. Oil-spill risk to the deferral area is mostly from spills originating outside the deferral area. Both long-term and short-term local effects would still occur. The effect of Alternative IV on water quality is expected to be MINOR. The cumulative effect of this alternative is expected to be the same as that of the proposal--MODERATE.	Alternative V would not significantly reduce the projected oil spillage or level of effects on water quality. There would be some lessening of pollution risks from artificial-island construction or removal and local deliberate (permitted) discharges. This alternative would eliminate the slight risk of spills occurring or contacting waters of the deferred area. Both long-term and short-term local effects would still occur. The effect of Alternative V on water quality is expected to be MINOR. The cumulative effects of the alternative are expected to be the same as those of the proposal--MODERATE.	Alternative VI would not significantly reduce the projected oil spillage or level of effects on water quality. There would be some lessening of pollution risks from artificial-island construction or removal and local deliberate (permitted) discharges in the deferred area. This alternative would eliminate the risk of spills occurring in the deferred area but would not greatly reduce the number or likelihood of spills contacting the deferred area or part of the sale area that would remain under this alternative. (Any spills in the deferred area would move westward out of the planning area.) Both long-term and short-term local effects would still occur. The effect of Alternative VI on water quality is expected to be MINOR. The cumulative effects of the alternative are expected to be the same as those of the proposal--MODERATE.

Table II-C-1
(Continued)

Alternative I - Proposal	Alternative IV - Barrow Deferral	Alternative V - Kaktovik Deferral	Alternative VI - Chukchi Deferral
AIR QUALITY			
Direct effects on air quality (as regulated by standards) from the proposal are expected to be MINOR, based on current attainment of air-quality standards and projected emissions based upon prior OCS experience and analyses. Air-quality effects ensuing from the proposal are expected to be analogous to those identified in the EIS's for Lease Sales 87 (Diapir Field; USDOI, MMS, 1984b) and 100 (Norton Basin; USDOI, MMS, 1985d). Leaseholders would most likely have to conduct additional air-quality analyses to verify compliance with air-quality standards prior to production from any Sale 97 leases. Secondary effects of air emissions are expected to be NEGLIGIBLE, based upon the small areas that could be affected given conservative assumptions for analysis and likely disperson of emissions. Cumulative effects on air quality are not expected to be more than MINOR, relative to attainment of air-quality standards, and are expected to have NEGLIGIBLE secondary effects.	The effects are expected to be substantially the same as those under the proposal--MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects. Emissions would be approximately proportionate to the mean-case oil resource. The cumulative effects on air quality are expected to be the same as those of the proposal--MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.	The effects would be substantially the same as under the proposal; effects are expected to be MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects. Emissions would be approximately proportionate to the mean-case oil resource. The cumulative effects on air quality are expected to be the same as those of the proposal--MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.	The effects would be substantially the same as under the proposal; effects are expected to be MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects. Emissions would be approximately proportionate to the mean-case oil resource. The cumulative effects on air quality are expected to be the same as those of the proposal--MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

III

Section III - Table of Contents

Page

III. Description of the Affected Environment.......... 1

A. Physical Characteristics of the Beaufort Sea Planning Area.............................. 1
1. Geology.................................. 1
a. Petroleum Geology.................. 1
b. Other Geological and Environmental Considerations.................... 1
(1) Physiography and Bathymetry.... 1
(2) Surficial Sediments............ 2
(3) Mudslides...................... 2
(4) Coastal Erosion................ 2
(5) Faults and Earthquakes......... 3
(6) Permafrost..................... 3
(7) Natural Gas Hydrates........... 3
(8) Shallow Gas.................... 3
(9) Overpressured Shale............ 4
2. Meteorological Conditions and Physical Oceanography.......................... 4
a. Climate............................ 4
b. Physical Oceanography.............. 4
(1) Waves and Swells............... 5
(2) Storm Surges................... 6
(3) Tides.......................... 6
(4) River Discharge................ 6
3. Sea Ice.................................. 6
a. Winter Conditions.................. 6
(1) Landfast-Ice Zone.............. 6
(2) Stamukhi Zone.................. 7
(3) Pack-Ice Zone.................. 8
(a) Floes...................... 8
(b) Ridges..................... 9
(c) Floebergs.................. 9
(d) Ice Islands................ 9
(e) Leads and Open-Water Areas.................. 9
b. Summer Conditions.................. 10

B. Biological Resources......................... 10
1. Lower-Trophic-Level Organisms............ 10
a. Planktonic Communities............. 10
(1) Phytoplankton.................. 10
(2) Zooplankton.................... 12
b. Epontic Communities................ 13
c. Benthic Communities................ 14
(1) Marine Plants and Bacteria..... 14
(a) Macrophytic Algae......... 14
(b) Benthic Microalgae and Bacteria................ 15
(2) Benthic Invertebrates.......... 15
d. Trophic Interactions............... 17
2. Fishes................................... 19
Freshwater Species................. 20
Anadromous Species................. 20
Marine Species..................... 22
Sport and Commercial Use of Fish Resources........................ 23
3. Marine and Coastal Birds................. 24
4. Pinnipeds, Polar Bears, and Beluga Whales.................................. 25
a. Pinnipeds.......................... 25
Ringed Seal................... 25
Bearded Seal.................. 26
Spotted Seal.................. 26
Walrus........................ 26
b. Polar Bears........................ 27
c. Beluga Whales...................... 28
5. Endangered and Threatened Species........ 28
a. Bowhead Whale...................... 28
b. Gray Whale......................... 30
c. Arctic Peregrine Falcon............ 31
d. Candidate Plant Species............ 32
6. Caribou.................................. 32

C. Social Systems............................... 33
1. Population............................... 33
a. Introduction....................... 33
b. Traditional Communities............ 33
2. North Slope Sociocultural Systems........ 36
a. Introduction....................... 36
b. Subsistence Values................. 36
c. The Important Inupiat Values and Behaviors........................ 37

Page

(1) The Importance of Kinship and Sharing in Inupiat Culture... 37
(a) The Definition of Household, Family, and Domestic Function....... 37
(b) The Contrast Between Inupiat and Independent Nuclear Households...... 38
(c) Inupiat Extended Households as Economic Units.................. 39
(d) The Consequences of Energy Development on Inupiat Sharing................. 40
(e) Sharing Among Eskimo Households.............. 40
(f) Gifting Versus Reciprocity............. 41
(2) Native-Language Retention...... 42
(3) Community Governance and Administration............... 44
d. Other Factors Affecting Inupiat Sociocultural Systems............. 45
(1) Household Income............... 45
(2) Recent Changes in the Quality of Life: Cost-of-Living..... 45
(3) Private-Sector Opportunities for Native Entrepreneurs..... 46
(4) Health and Social Services..... 47
(5) Social Pathologies............. 47
3. Subsistence-Harvest Patterns............. 48
a. General Considerations............. 50
b. Community Subsistence Patterns...... 53
(1) Wainwright..................... 53
(a) Bowhead Whales............ 53
(b) Beluga Whales............. 53
(c) Seals..................... 54
(d) Walruses.................. 54
(e) Polar Bears............... 54
(f) Caribou................... 55
(g) Fishes.................... 55
(h) Marine and Coastal Birds.. 56
(2) Barrow-Atqasuk................. 56
(a) Bowhead Whales............ 56
(b) Beluga Whales............. 57
(c) Seals..................... 57
(d) Walruses.................. 57
(e) Polar Bears............... 58
(f) Caribou................... 58
(g) Fishes.................... 58
(h) Marine and Coastal Birds.. 59
Information on the Teshekpuk Lake Special Area................... 59
(3) Nuiqsut........................ 60
(a) Bowhead Whales............ 60
(b) Beluga Whales............. 61
(c) Seals..................... 61
(d) Walruses.................. 61
(e) Polar Bears............... 61
(f) Caribou................... 61
(g) Fishes.................... 62
(h) Marine and Coastal Birds.. 63
(4) Kaktovik....................... 63
(a) Bowhead Whales............ 63
(b) Beluga Whales............. 63
(c) Seals..................... 63
(d) Walruses.................. 64
(e) Polar Bears............... 64
(f) Caribou................... 64
(g) Fishes.................... 65
(h) Marine and Coastal Birds.. 66

D. Other Issues................................. 67
1. Economy of the North Slope Borough....... 67
a. NSB Revenues and Expenditures....... 67
b. Employment......................... 68
2. Land Use Plans and Coastal Management Programs............................... 70
a. Land Status and Use................ 70
b. Land Use Planning Documents......... 70
(1) Capital Improvements Program (CIP)....................... 70

Section III - Table of Contents
(continued)

	Page
(2) NSB Comprehensive Plan and Land Management Regulations	71
(a) Policies	71
(b) Zoning Districts	71
(c) Automated Graphic Information System	72
c. Coastal Management Programs (CMP)	72
(1) State Coastal Management Policies	72
(2) North Slope Borough District CMP	73
3. Archaeological Resources	74
a. Onshore Sites	75
b. Offshore Sites	75
c. Shipwrecks	76
4. Recreation and Tourism Resources	76
a. Type-I Area--High Economic Values and High Noneconomic Qualities	77
b. Type-II Area--Low Economic Values and High Noneconomic Qualities	77
5. Water Quality	78
a. Turbidity	78
b. Dissolved Oxygen	79
c. Trace Metals	79
d. Hydrocarbons	79
6. Air Quality	80

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. Physical Characteristics of the Beaufort Sea Planning Area: The description of the physical characteristics of the Beaufort Sea Planning Area as contained in Section III.A of the Sale 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference; a summary of this description, augmented by additional material, as cited, follows.

1. Geology:

a. Petroleum Geology: The petroleum provinces into which the Beaufort Sea Planning Area have been divided are based on the classification used by Craig, Sherwood, and Johnson (1985) to describe the geological framework and hydrocarbon potential of the area. The locations of the provinces are shown in Figure III-1. The geologic ages and names of stratigraphic sequences are shown in Figure III-2.

As shown in Figure III-1, the petroleum provinces of the Beaufort Sea shelf can be incorporated into two major provinces separated by a highly faulted boundary called the Hinge Line. The Arctic Platform provinces lie south of the Hinge Line, and the Brookian Basin provinces lie north.

The Arctic Platform provinces are more prospective for petroleum in the southern part, south of the Zero Ellesmerian line (Fig. III-1), than they are in the northern part. Thick, wedge-shaped layers of Ellesmerian Sequence formations are present in the southern part of the province, but they become thinner in the northerly direction and are absent in the northern part. As shown in Figure III-2, all of the oil produced from North Slope reservoirs comes from the Ellesmerian Sequence formations. Known accumulations of petroleum are trapped by a variety of stratigraphic and structural features. Grabens are present in the northern part of the Arctic Platform, and they may contain reservoir rocks deposited as part of the Rift Sequences, Figure III-2. Throughout the Beaufort shelf, source beds are thought to be present at levels of thermal maturity adequate for petroleum generation and expulsion.

The Brookian Basin provinces contain many structural and stratigraphic traps in the thick wedge of clastic sediments north of the Hinge Line. Petroleum reservoirs are most likely to occur in sands deposited in a deltaic or prodelta environment: individual accumulations may be small because of the lense-shaped characteristics of the deposits.

b. Other Geological and Environmental Considerations:

(1) Physiography and Bathymetry: The Beaufort Sea Sale 97 area includes the continental shelves and upper part of the continental slopes of the northeastern Chukchi Sea and the Alaskan Beaufort Sea. Water depths within the Chukchi Sea part of the sale area range from about 20 meters to slightly more than 200 meters and in the Beaufort Sea part from about 2 meters to slightly more than 1,000 meters. Most of the Chukchi shelf is characterized as being broad and flat-lying. The major bathymetric features are the Barrow Sea Valley and the eastern flank of Hanna Shoal. 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. 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 and landward 3 to 7 meters per year. Shoals that rise 5 to 10 meters above the surrounding seafloor have been observed in water depths of 10 to 20 meters.

(2) Surficial Sediments: The surficial sediments of the Alaskan Beaufort Sea continental shelf consist predominantly of mud (clay- and silt-size particles) (Fig. III-3). The seafloor out to a depth of at least 20 meters is an area where sediment erosion is more dominant than deposition (Reimnitz, Granes, and Barnes, 1985). Coarser 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.

Only a relatively thin layer of unconsolidated sediment overlies the bedrock throughout much of the Chukchi continental shelf. The thickness of this layer averages about 2 to 5 meters; exposed bedrock is frequently found in areas where the water depth is greater than 30 meters. The sediments consist predominantly of silt- and clay-size particles. Sand and gravel deposits are found along the coast, in the Barrow Sea Valley, and on Hanna Shoal.

(3) Mudslides: Most of the Beaufort and Chukchi shelves seaward of the 50- to 65-meter isobath and the upper part of the slopes consist 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 kilometers long and from 20 to 230 meters thick have been observed. Estimates of the downslope movement ranges from 0.2 to 2.3 kilometers. 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 et al., 1982). However, if fine-grained sediments are presently 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 upon 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. Excluding the Colville River Delta, the coastline between Drew Point and Prudhoe Bay eroded at an average rate of 2.5 meters per year between 1950 and 1980; in places, local long-term erosion rates were as high as 18 meters per year (Reimnitz, Granes, and Barnes, 1985). However, for the same period, the coastline of the Colville River Delta advanced seaward at an average rate of 0.4 meters per year; near the active mouths of the Colville River, accretion rates may be as high as 20 meters per year. Coastal erosion rates of other locations along the coast adjacent to the sale area are shown in Figure III-4.

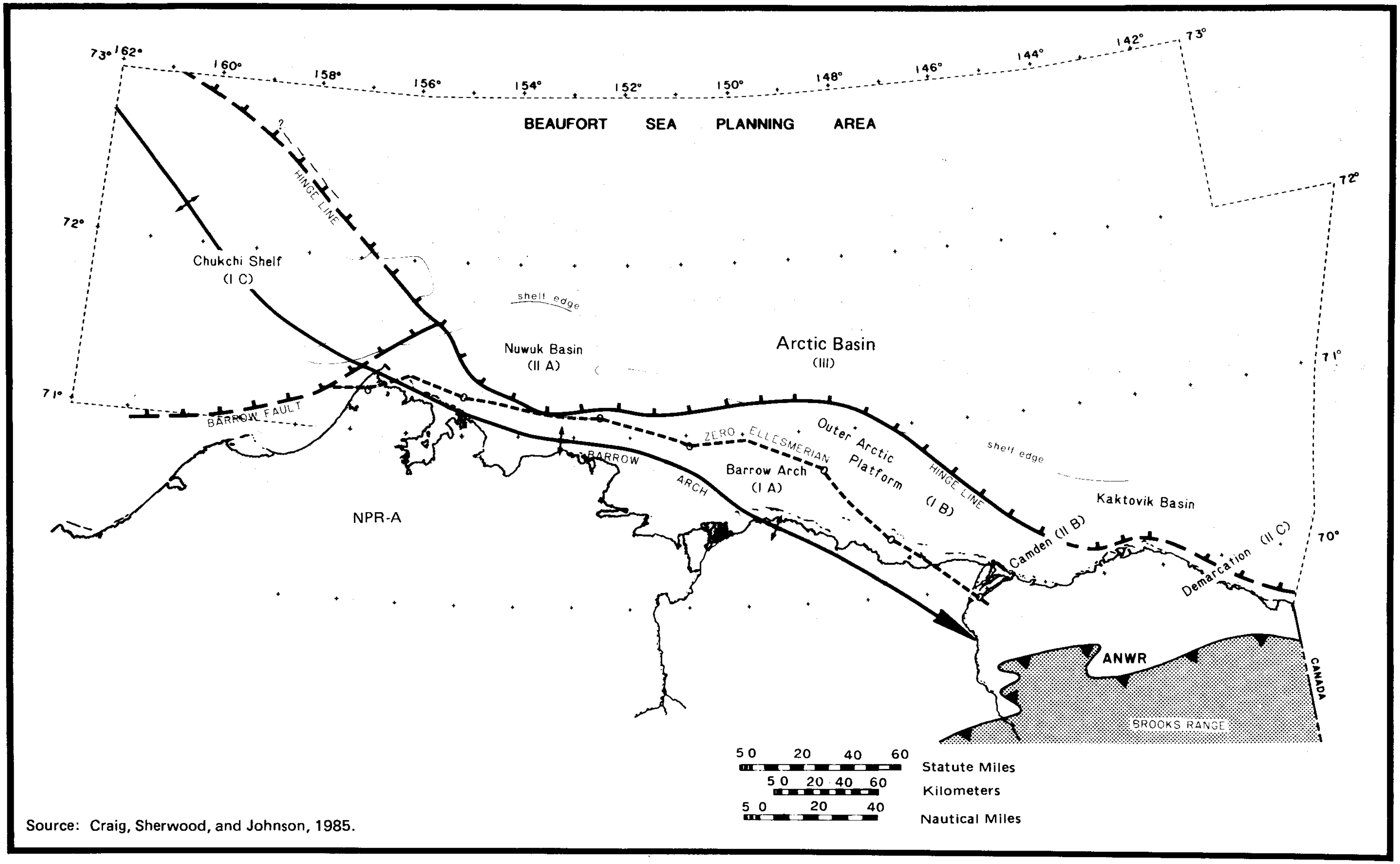


FIGURE III-1. REGIONAL TECTONIC FEATURES AND PETROLEUM PROVINCES IN THE BEAUFORT SEA PLANNING AREA

Arctic Platform provinces (Chukchi shelf, Barrow Arch, and Outer Arctic Platform--province I) are geologic basins formed in mid-Paleozoic to mid-Mesozoic time on a continental basement complex. The Hinge Line is the crustal flexure along the continental margin formed after mid-Mesozoic rifting. Post-breakup basins along the subsiding continental margin (Nuwuk and Kaktovik Basins-- province II) contain thick sections of Cretaceous to Tertiary clastic sediments beneath the present Beaufort shelf. The Arctic Basin (province III) is an oceanic basin north of the Beaufort shelf edge.

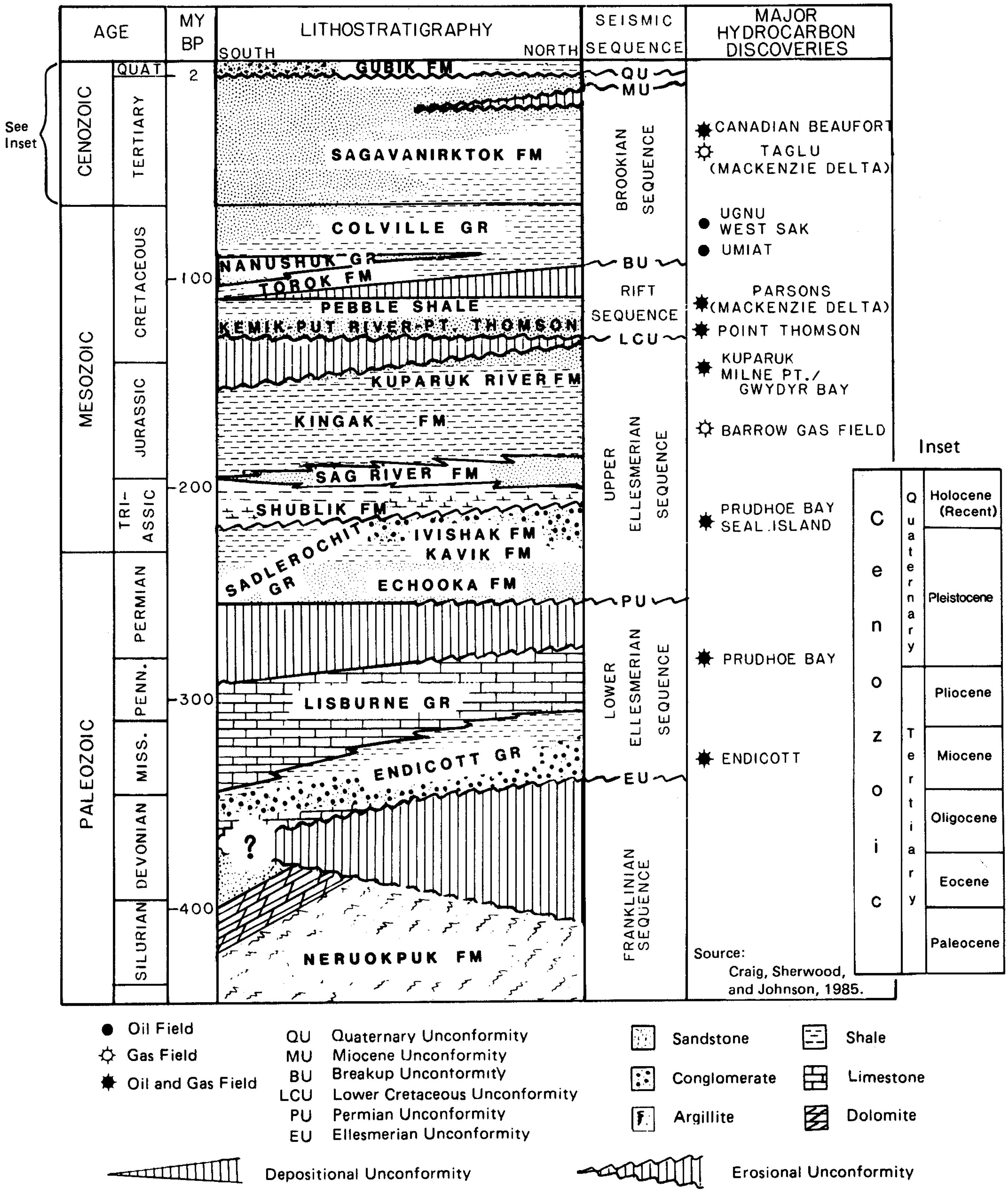


FIGURE III-2. GENERALIZED LITHOSTRATIGRAPHIC COLUMN SHOWING THE RELATIONSHIP OF ONSHORE ROCK UNITS IN NORTHERN ALASKA TO OFFSHORE SEISMIC SEQUENCES IN THE BEAUFORT SEA PLANNING AREA

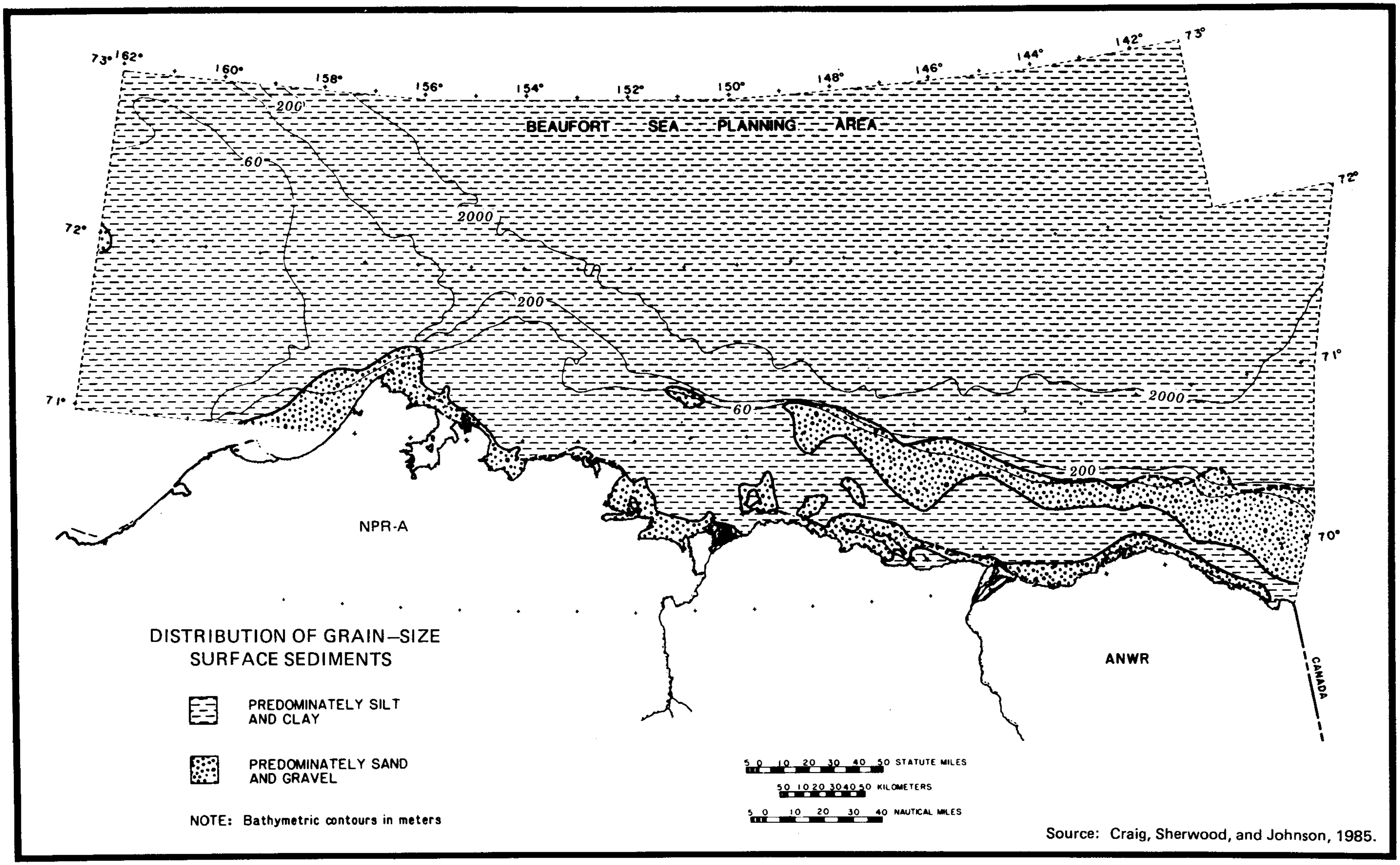


FIGURE III-3. GENERALIZED DISTRIBUTION OF COARSE–GRAINED (SAND AND GRAVEL) AND FINE–GRAINED (SILT AND CLAY) SURFACE SEDIMENTS IN THE BEAUFORT SEA PLANNING AREA

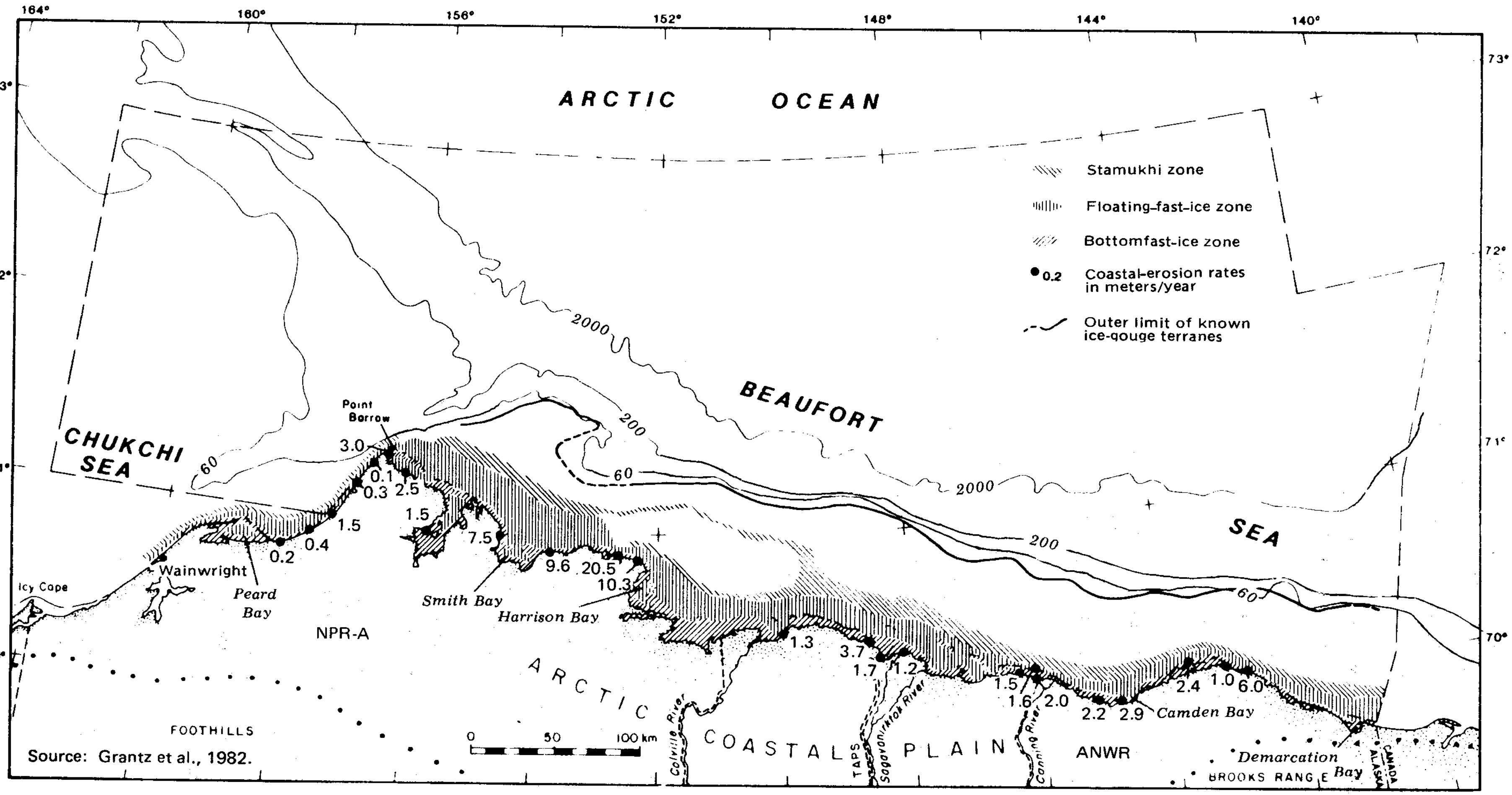


FIGURE III-4. COASTAL HAZARDS AND ICE ZONATION ON THE ALASKAN BEAUFORT AND NORTHEAST CHUKCHI SHELVES

(5) Faults and Earthquakes: Subsurface faults have been mapped in (1) the Harrison Bay area, (2) along the middle part of the shelf of the western Beaufort Sea, (3) along the outer shelf and upper slope of the western Beaufort, and (4) in the Camden Bay area (Fig. III-5).

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 meters. 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.

Earthquakes indicate active movement along the faults in the Camden Bay area and tend to occur along the axes of anticlines and synclines. The earthquakes are part of the central Alaska seismic system. The magnitudes of the earthquakes measured in this region range 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.

(6) Permafrost: The permafrost that underlies the present-day Beaufort Sea continental shelf shoreward of the 90-meter 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 Saganvanirktok (Sag) River, where ice-bonded sediments are commonly found less than 10 meters 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-meter 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 may also exist on the Beaufort Shelf at depths that range from 100 to 1,900 meters.

(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 meters, the upper 300 to 700 meters 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-6.

(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-6). 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 are also 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 due to incomplete dewatering of the shale and is an indication of overpressuring within the shale section. The occurrence of abnormal pressure is probably confined to areas of thick Cenozoic strata as in the Kaktovik, Camden, and Nuwuk Basins.

2. Meteorological Conditions and Physical Oceanography:

a. Climate: The region is in the Arctic climate zone. Mean annual temperature is about -12 °C. Precipitation ranges from 13 centimeters at Barrow to 18 centimeters at Barter Island and 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 speed is 5 meters per second at Barrow and 6 meters per second at Barter Island. Winds are usually 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 kilometers offshore.

b. Physical Oceanography: The nearshore area of the Beaufort Sea includes the semienclosed lagoons, such as Simpson Lagoon, and the open embayments, such as Harrison Bay. Circulation in the nearshore area appears to be strongly wind-driven, with currents and flushing rates closely related to local winds. The prevailing winds are from the east; the currents generally flow to the west. However, major flow reversals occur when strong westerly winds develop over the Beaufort and Chukchi Seas. In Simpson Lagoon, currents range from about 15 to 45 centimeters per second. In Harrison Bay, summer current velocities range from 5 to 50 centimeters per second. Bottom topography and ice modify nearshore currents. From May through mid-July, currents are on the order of 2 centimeters per second. They are often less but seldom higher. After breakup, nearshore wind-driven currents commonly reach 15 centimeters per second or more.

In winter, Beaufort Sea nearshore currents are generally westerly; and under thick ice cover, prism effects can cause 10- to 15-centimeter-per-second tidal currents along the 2-meter isobath. Velocities drop to 2 centimeters per second in deeper water, although a tidal current on the order of 5 to 10 centimeters per second at the 59-meter isobath has been observed.

The inner-shelf regime generally overlies the area between the 10- and 50-meter isobaths. The general circulation is also from east to west in response to the prevailing winds. The movement of seabed drifters also shows a net westerly transport of bottom water. There appears to be a rapid response to

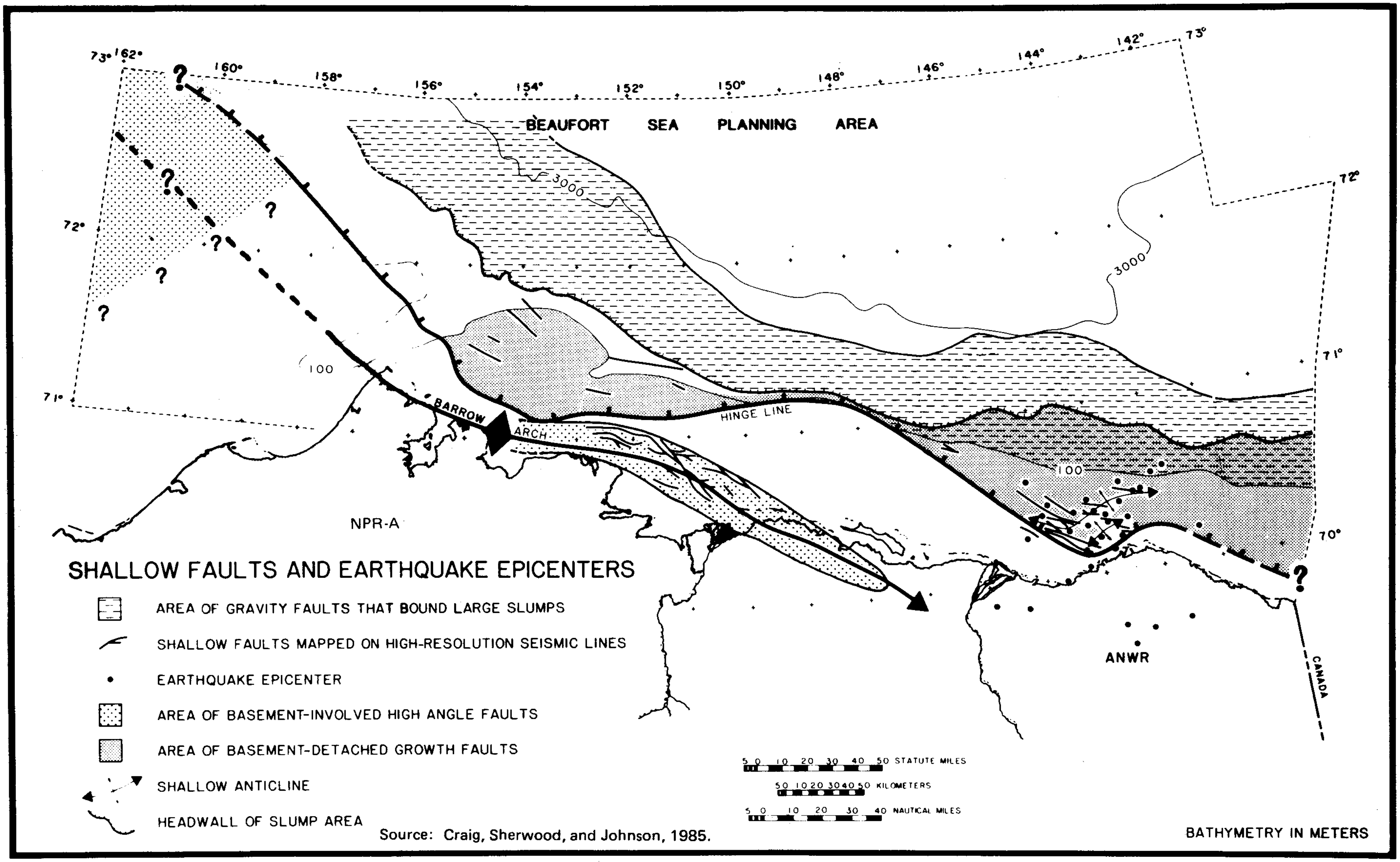


FIGURE III-5. SHALLOW FAULTS AND EARTHQUAKE EPICENTERS IN THE BEAUFORT SEA PLANNING AREA

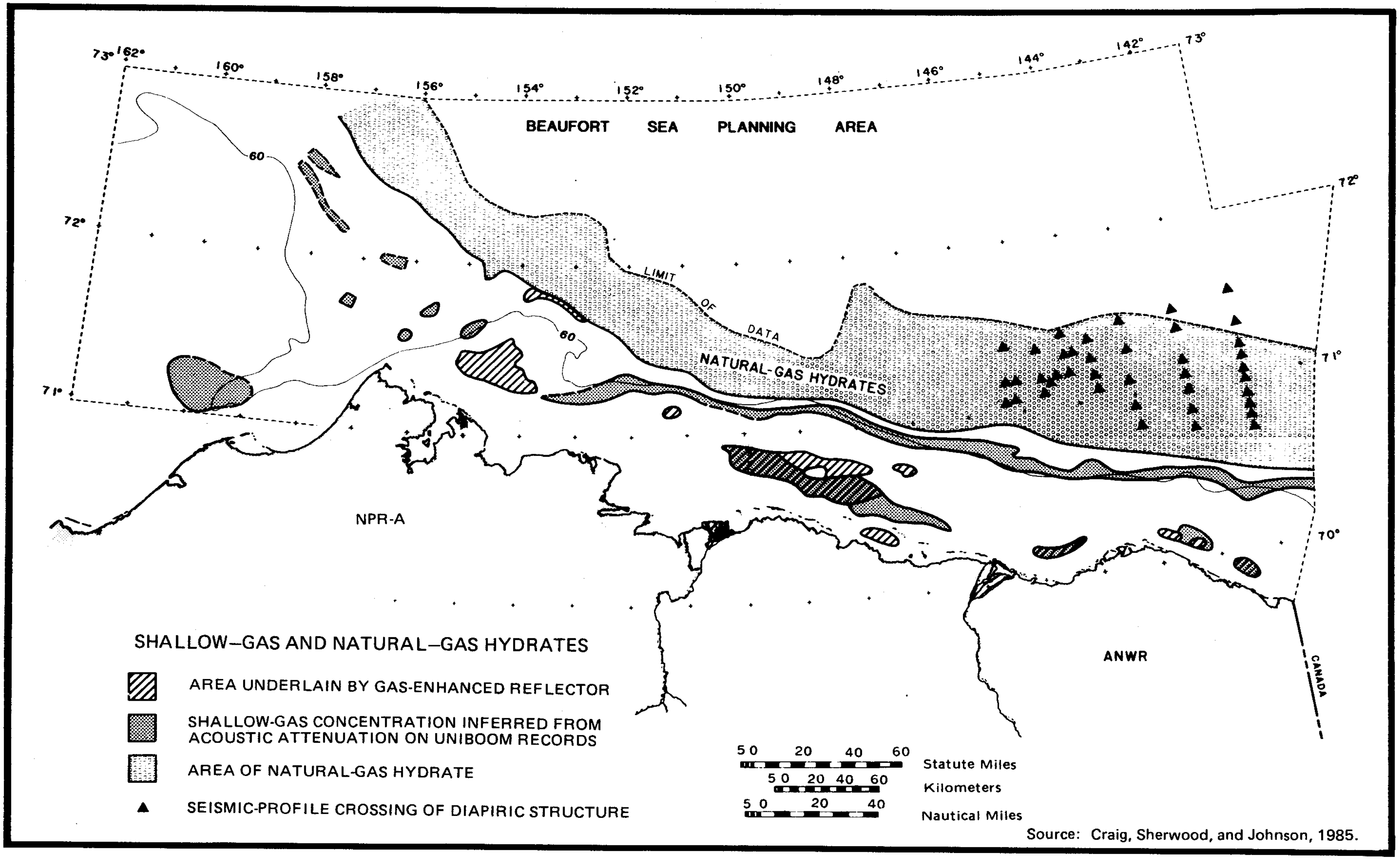


FIGURE III-6. DISTRIBUTION OF SHALLOW–GAS CONCENTRATIONS, THE MINIMUM AREA INFERRED TO BE UNDERLAIN BY NATURAL–GAS HYDRATES, AND THE DISTRIBUTION OF DIAPIRIC STRUCTURES IN THE BEAUFORT SEA PLANNING AREA changing wind conditions. Locally strong currents, apparently with velocities of 100 centimeters per second, are indicated by sediment bedforms. During the summer, the temperatures and salinities of the surface water show very large temporal variations. In wintertime, currents are generally less than 5 centimeters per second and may not exceed 10 centimeters per second.

The circulation of surface water seaward of the 50-meter isobath is primarily to the west. Circulation seaward of the continental shelf is part of the anticyclonic (clockwise) circulation of the Canadian Basin of the Arctic Ocean. The mean flow along the outer edge of this gyre, north of Point Barrow, is about 5 to 10 centimeters per second. The water lying between the surface layer and the 50- to 2,500-meter isobaths generally flows to the east (Aagaard, 1984).

In the Chukchi Sea portion of the sale area, the general flow of water is to the northeast (Lewbel and Gallaway, 1984). Water that comes through the Bering Strait and follows the Alaska coast around Barrow dominates the circulation pattern over most of the Chukchi Shelf beyond depths of 20 to 30 meters. The water from the Bering Sea consists of two water masses--the Alaskan Coastal Water and the Bering Sea Water. Near Barrow, the Alaskan Coastal Water has temperatures of 5 to 10 °C and salinities that are generally less than 31.5 parts per thousand. The Bering Sea Water is colder, near 0 °C, and more saline, 32.2-33 parts per thousand, than the Alaskan Coastal Water. In the Chukchi Sea, the core of the Alaskan Coastal Water lies about 20 to 30 kilometers offshore (Lewbel and Gallaway, 1984). The Bering Sea Water occurs at depths and lies west of the Alaskan Coastal Water. The Alaskan Coastal Water mixes rapidly with the surface water in the Beaufort Sea and is not clearly identifiable east of 147° to 148° W. longitude. However, the Bering Sea water has been traced as far east as Barter Island. Southerly flow in the Chukchi Sea is episodic, but there is some indication that it is more common in the fall and winter than in the spring and summer.

Current speeds of 20 to 30 centimeters per second are characteristic of the eastern Chukchi Sea. The predominant northeasterly winds of the summer generate nearshore currents with velocities of 4 to 20 centimeters per second. During storms, longshore surface-current velocities of 50 to 80 centimeters per second seem to be typical but may range up to 200 centimeters per second. Subsurface-current velocities of about 60 to 75 centimeters per second have been recorded at depths of 10 to 54 meters off Point Franklin.

Upwelling has been observed in the vicinity of Point Franklin in the summer (Hachmeister, 1983). During strong northeasterly winds, the warm, brackish nearshore water moves offshore and colder, more-saline water upwells along the coast.

(1) <u>Waves and Swells</u>: The entire coastline adjacent to the planning area is a low-wave-energy environment. Waves, which are generally 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 would otherwise be expected in summer. Wave heights greater than 0.5 meters occur only in 22 percent of the observations summarized by Brower, Diaz, and Prechtel (1977). Wave heights greater than 5.5 meters are not reported within the Brower et al. limited Beaufort Sea database of 2,570 observations.

(2) Storm Surges: Summer and fall storms frequently generate storm surges along the Beaufort and Chukchi Sea coasts. Sea-level increases of 1 to 3 meters have been observed along the Beaufort 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 are generally less than in summer and fall. Decreases in sea-level elevation also occur and appear to be more frequent in the winter months.

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

(4) River Discharge: The Colville River is the major river entering the Alaskan Beaufort Sea. Annual discharge of the Colville River is 12 cubic kilometers; 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 (Sec. III.D.4 of this EIS). The Chukchi Sea coast adjacent to the planning area has no major rivers, and the nearshore waters of the Chukchi Sea are much less affected by riverine discharges.

3. Sea Ice:

a. Winter Conditions: Wintertime conditions in the Beaufort and Chukchi Seas begin with freezeup and an increase in the concentration of sea ice. Although there are considerable spatial and temporal variations, the edge of the Arctic pack ice in September of an "average year" is from about 20 to 110 kilometers offshore (LaBelle et al., 1983). In October, the edge has moved 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 winter sea-ice regime in the planning area can be divided into the landfast-ice zone, the stamukhi (or shear) zone, and the pack-ice zone (Figs. III-4 and III-7).

(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 meters of water but by the late winter may extend beyond the 20-meter isobath. During the early part of freezeup in October and November, the ice is thin, susceptible to displacement by only modest wind and water stresses, and easily deformed. Displacements of the ice sheets may be up to several kilometers per day. Deformations take the form of pileups and rideups on the coastal and island beaches and rubble fields and small ridges offshore. Extensive deformation within the landfast-ice zone generally decreases as the winter progresses. As the ice in the landfast zone thickens and strengthens, it becomes more resistant to deformation.

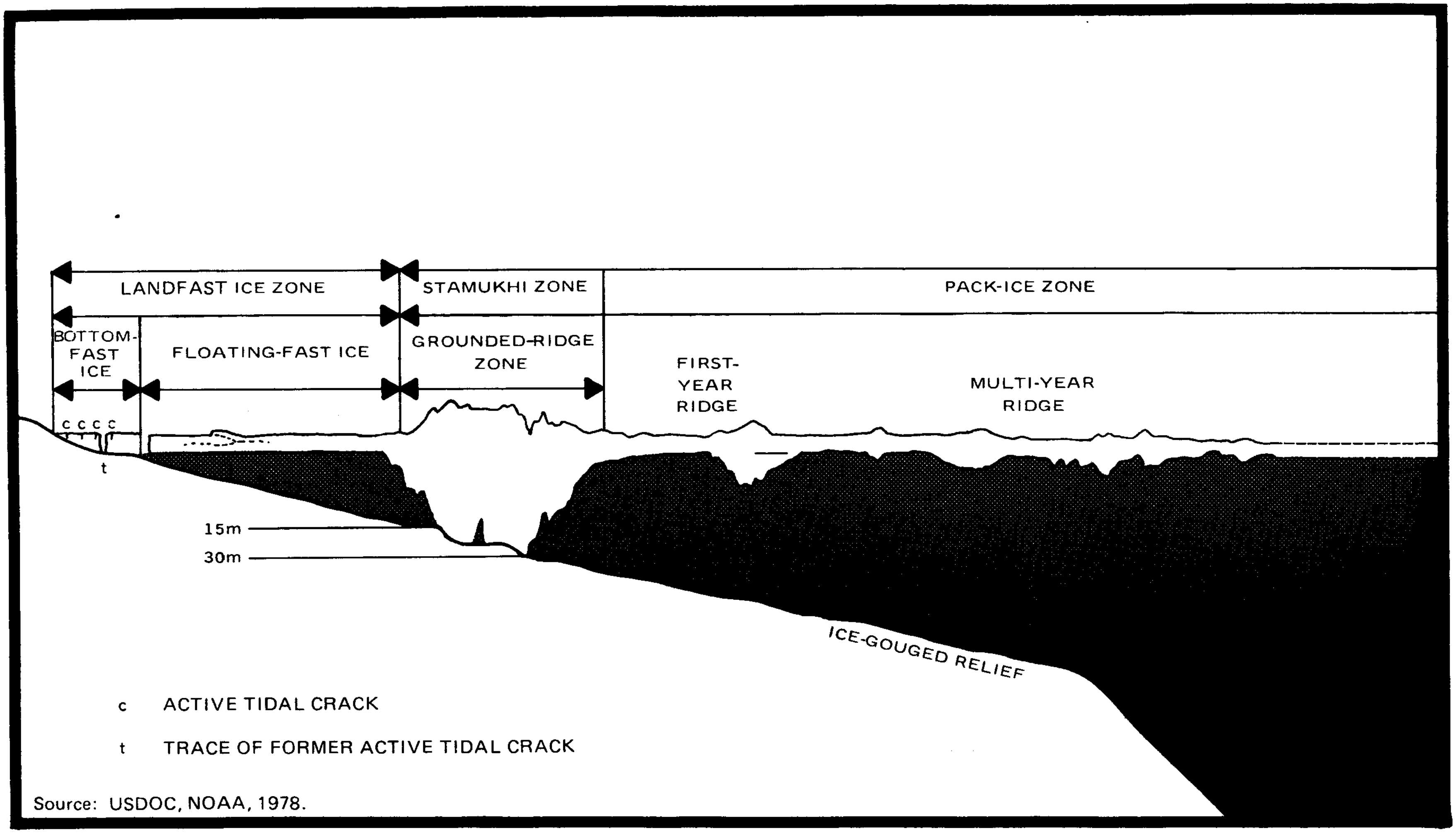


FIGURE III-7. WINTER-ICE ZONATION OF THE BEAUFORT SEA COAST

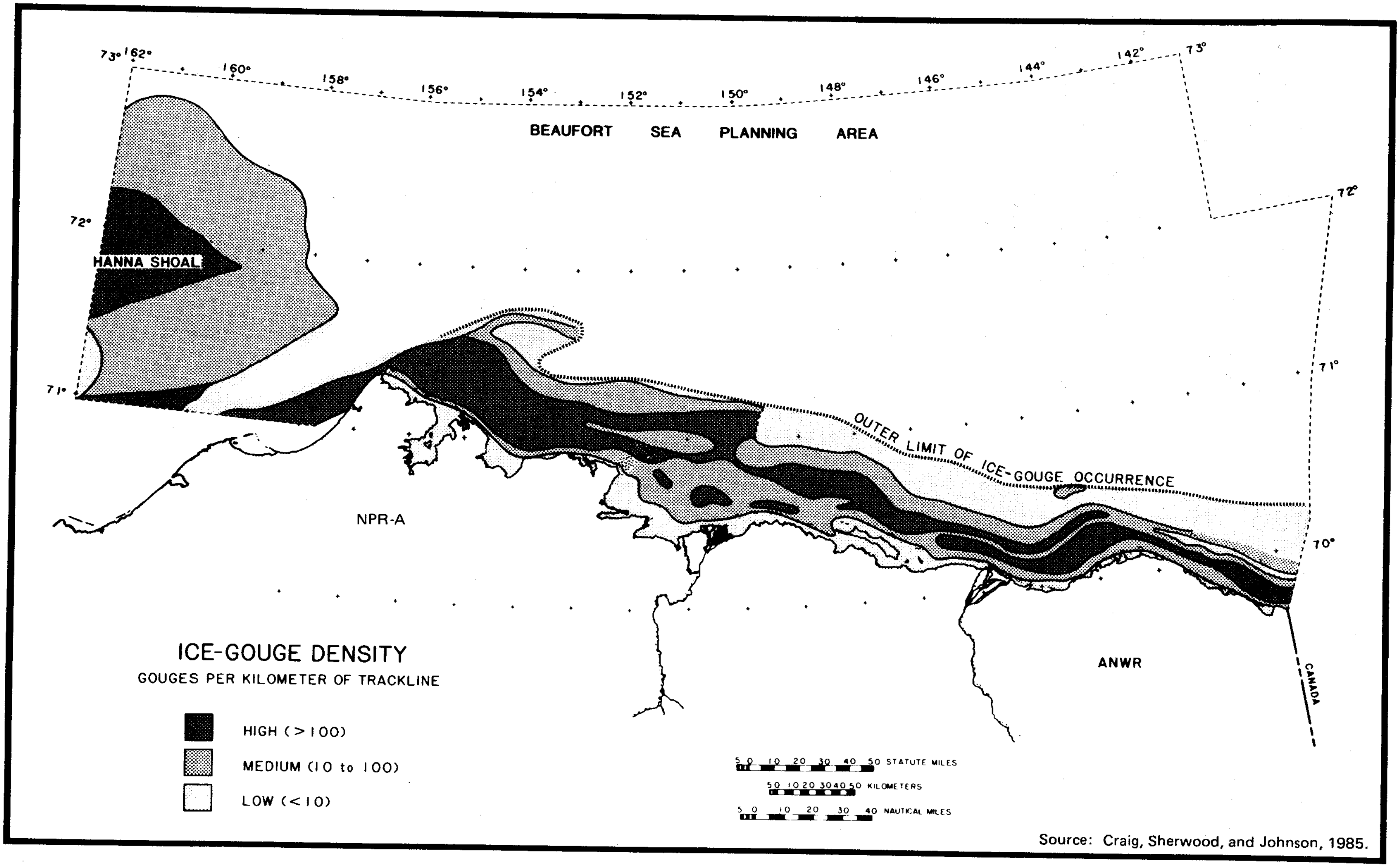


FIGURE III-8. GENERALIZED DISTRIBUTION OF ICE-GOUGE DENSITY IN THE BEAUFORT SEA PLANNING AREA

By late winter, first-year sea ice in the Beaufort Sea landfast-ice zone is generally about 2 meters thick; out to a depth of about 2 meters, 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. Movement of the floating-fast ice is usually on the order of tens of meters, but larger displacements up to several hundred meters have been observed. In the Chukchi Sea, the landfast ice usually thickens to about 1.3 to 2.0 meters 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 meters 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 meters, are not very frequent; rideups that extend more than 100 meters are relatively infrequent.

(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 meters deep (Barnes, Rearic, and Reimnitz, 1983).

As shown in Figure III-7, 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.

Shoreward of the 60-meter 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 meters deep is within 20° of being parallel to the coast. In waters shallower than 10 meters and deeper than 50 meters, individual gouge orientation may deviate from being parallel to the coast by as much as 50° (Barnes, Rearic, and Reimnitz, 1983). In general, the highest average (mean) values of those features--such as individual gouge density, depth, and width--occur within the stamukhi zone.

Gouge densities of more than 100 gouges per square kilometer are found in waters 20 to 40 meters deep (Barnes, Rearic, and Reimnitz, 1983) (Fig. III-8). Dense gouging also occurs on the seaward side of bathymetric highs such as the shoals. The lowest gouge densities are located in waters that are less than 5 meters deep and greater than 45 meters deep.

Gouges with average depths of greater than 1 meter are generally found in waters between 20 and 55 meters deep (Barnes, Rearic, and Reimnitz, 1983). There is a greater likelihood that the keels of drifting ice masses will cut deeper gouges in the seafloor of the deeper water than in that of the shallower water. The maximum measured draft of sea ice in the Arctic Ocean is only 47 meters. Thus, the gouges observed seaward of about 47 meters 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 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 per kilometer in water depths of 20 to 35 meters 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; and on the north flank, at depths of 40 to 52 meters, there is a zone of gouges that has a general east-west trend.

(3) Pack-Ice Zone: The pack-ice zone lies seaward of the stamukhi zone and includes (1) first-year ice; (2) multiyear floes, ridges, and floebergs; and (3) 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. Ice islands are tabular icebergs that have calved (broken away) from ice shelves on Ellesmere and Axel Heiberg Islands.

During the winter, movement in the pack-ice zone of the Beaufort Sea is generally 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 kilometers per day and (2) an actual rate of 2.2 to 7.4 kilometers per day, with extreme events up to 32 kilometers 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 is usually 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 or more kilometers wide and extends from the Bering Strait northward along the Alaska coast past Point Barrow to move southward.

(a) Floes: Undeformed multiyear ice in the Arctic Ocean is believed to reach a steady-state thickness of 3 to 5 meters (Weeks and Mellor, 1983). Based principally on aerial reconnaissance, more than 60 percent of the sale area is covered by ice floes greater than 500 meters in diameter from mid-October through June (Labelle et al., 1983). Through July, the number of large floes decreases and, by August 1 to 15, the estimated pack-ice edge is well offshore. The edge of the pack ice remains offshore until about October 1st. As the pack ice moves south, the number of large floes advancing into the sale area increases and, by the end of October, more than 60 percent of the sale area is covered by large floes. Floes with diameters of up to 10 kilometers have also been observed.

(b) Ridges: About one-quarter and, in places, up to one-half of the area seaward of the stamukhi zone consists of deformed ice. Data obtained from late winter and early spring laser profilometer flights in the Beaufort and Chukchi Seas showed that (1) over 85 percent of the ridges were between 0.9 and 2.1 meters high--the average height was about 1.6 meters; (2) the highest ridge observed had a sail height of 6.4 meters (measured 100 km northeast of Barter Island), and (3) the average number of ridges in the Beaufort Sea was about 5.5 per kilometer and in the Chukchi Sea about 3.3 per kilometer (Tucker, Weeks, and Frank, 1979). 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 (Barnes, Rearic, and Reimnitz, 1983).

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-meter isobath; and (3) in the eastern Beaufort Sea 30 to 40 kilometers from the coast, there is an increase in ridging from east to west.

(c) Floebergs: Floebergs are massive pieces of sea ice that consist of hummocks, groups of hummocks, or rubble fields that are frozen together and separated from any surrounding ice. They form primarily in the shear zone between the drifting ice pack and the landfast ice. Large, coherent ice masses consisting of continuous ridges and multiyear hummock fields (floebergs) also form off the southwest coast of Prince Patrick Island in the western entrance to M'Clure Strait; the hummock fields eventually break out and drift into the southern Beaufort Sea.

(d) Ice Islands: Ice islands are large, tabular icebergs with areal sizes ranging up to 1,000 or more square kilometers and thicknesses up to 60 meters (Sackinger et al., 1985). They calve from the ice shelves located along the northern coasts of Ellesmere and Axel Heiberg Islands and drift into the Arctic Ocean, where they slowly circulate in a clockwise direction for many years. In 1972, 433 ice islands or fragments were observed along the Beaufort Sea coast. The large number of fragments may have been the result of the breakup of a very large island that went aground near Barter Island. In 1973, 299 ice islands or fragments were sighted; in 1974, 27; in 1975, no ice islands or fragments were seen along the same part of the coast. During the observation period from 1963 through 1986, 1,053 square kilometers of ice were lost from the Ellesmere and Axel Heiberg ice shelves. The amount of ice lost in any year varied from 0 to 569 square kilometers. The ice-shelf observations and ice-island sightings indicate that it may take 10 or more years for ice islands to reach locations within the Beaufort Sea Planning Area.

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

(e) 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 Alaska 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 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 less than 1 kilometer (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-meter 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. Due to Coriolis forces, these winds drive the ice offshore; westerly winds move the ice onshore.

B. Biological Resources

1. Lower-Tropic-Level Organisms: This discussion summarizes and incorporates by reference the description of lower-trophic levels contained in the Sale 87 FEIS (USDOI, MMS, 1984a), with augmentation by additional information as cited. Various other references that discuss or summarize information on these organisms or their communities include Barnes, Schell, and Reimnitz (1984); Dunton (1984); Dunton, Reimnitz, and Schonberg (1982); Horner (1984); Schell et al. (1982); Dome Petroleum, Ltd. et al. (1982); Schell and Horner (1981); Horner (1981); Broad, Griffiths, and Carey (1981); the BF FEIS (USDOI, BLM, 1979); and Carey, ed. (1978).

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 these organisms are strongly influenced by the extreme physical conditions described earlier (Sec. III.A).

a. Planktonic Communities: The planktonic communities in this region are comprised of both phytoplankton and zooplankton.

(1) Phytoplankton: Ninety-four species and eighteen additional taxonomic categories (e.g., unidentified species and groups of species) of phytoplankton have been identified from the Beaufort Sea; however, not all of these species or groups were found each year sampled (Horner, 1984). The species and species-groups were divided by Horner into four major categories: the diatom genus *Chaetoceros* (greater than 20 species), all other diatoms, dinoflagellates, and flagellates. The geographical and vertical

depth distributions of these organisms were described from Point Barrow in the west to Barter Island in the east, and were correlated with vertical profiles of cell density and chlorophyll a concentration. The most abundant species had broad distributions, but the relative abundances of species groups varied spatially. Near Point Barrow and Pitt Point, flagellates were most abundant; at the more easterly stations (Harrison Bay, Prudhoe Bay, and Barter Island), Chaetoceros species and dinoflagellates were more abundant. Microflagellates were abundant in all years sampled, being especially common in surface waters. Horner (1984) suggests that they may be more tolerant of high light intensity and low salinity. Diatoms were most numerous in deeper waters. Primary productivity generally was highest at depths where Chaetoceros species or other diatoms predominated. A similar pattern in the distribution of species types and productivity was found in earlier studies conducted in the shallow (less than 20 m) depths of Harrison and Prudhoe Bays (Alexander, 1974; Horner, Coyle, and Redburn, 1974).

Abundance of phytoplankton appears to be greatest in nearshore waters with decreasing numbers farther offshore. Although observations of vertical distribution of phytoplankton vary, most reports show that phytoplankton abundance is greatest in depths less than 5 meters (Alexander, 1974). Horner, Coyle, and Redburn (1974), however, found phytoplankton abundance to be greater below 5 meters near Prudhoe Bay. Peak abundance occurs in late July and early August due to increased light intensity during this period.

Schell et al. (1982), based on their own data plus that of Alexander (1974) and Horner (1981),

> "conclude that seasonal primary productivity in the coastal Beaufort Sea is typically between 0-2 g C/m^2-yr (grams carbon per meter squared per year) for ice algae and 5-20 g C/m^2-yr for phytoplankton for the nearshore areas such as Stefansson Sound, inner Harrison Bay, and Simpson Lagoon. Outside of the barrier islands and further offshore, ice-algal productivity increases to 2-6 g C/m^2-yr and phytoplankton productivity increases to over 40 g C/m^2-yr. These increases reflect the clearer ice cover and the deeper water column which, when integrated over the euphotic zone, yield higher total primary productivity values. It is assumed that far offshore (beyond about 200 km) where pack ice is perennial, phytoplankton productivity decreases to very low annual totals of less than 1 g C/m^2-yr (Apollonio, 1959; English, 1959)."

Levels of primary productivity are positively correlated with light levels. Horner (1984) found rates of primary production to vary 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.

Variation also seems to exist in the presence or absence of a spring phytoplankton bloom. A spring bloom apparently occurs in the nearshore Chukchi Sea at Barrow during and just after ice breakup when light levels increase and high nutrient concentrations exist (Horner, 1969). However, 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. It is not clear why a spring bloom does not occur, but factors involved may include light levels, nutrient concentrations, zooplankton grazing, or a bias resulting from the time of year that areas were sampled.

(2) Zooplankton: The greater than 100 species of zooplankton identified from the Beaufort and northeastern Chukchi Seas can be divided into four groups: (1) species that occur throughout the Arctic Basin; (2) species that are swept into the Beaufort Sea to varying extents 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).

Hydrographic conditions can greatly influence the abundance, distribution, and diversity of these zooplankton groups. Based on collections made in 1950 and 1951, Johnson (1956) has concluded that in the Beaufort Sea, those animals spending their entire lives in the plankton comprised the most important part of the zooplankton. By contrast, in the Chukchi Sea, the meroplankton were also an important component of the plankton, perhaps reflecting the more shallow, nearshore nature of the water (see Table III-B-1 and Johnson, 1956).

Table III-B-1
Average Number of Larvae per Station

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

Source: Johnson, 1956.

More recently, zooplankton in the western part of the Beaufort Sea was found to contain a large component of meroplankton (USDOC, NOAA, 1978). Larvae of barnacles, bivalves, polychaetes, hydrozoans, gastropods, and echinoderms comprised a large part of the meroplankton.

Zooplankton communities found by Johnson (1956) were richer in the Chukchi Sea and the western part of the Beaufort Sea than in the eastern Beaufort (east of approximately Barter Island), again possibly reflective of greater extents of shallower depths in the west. Copepods were the predominant zooplankton group, both in numbers and biomass. Horner (1979, 1981), in another 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 were generally 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 meters across), but usually only 5 to 10 meters 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 are primarily herbivorous, so copepods form an important link between phytoplankton and larger, carnivorous species. Other components of the zooplankton include amphipods, mysids, euphausiids, arrow worms, ostracods, decapods, pteropods, comb jellies, jellyfish, fish larvae, larvaceans, and larval stages of benthic organisms (Johnson, 1956; Hopkins, 1969; Sekerak et al., 1976, 1979; Horner, 1979; Griffiths and Buchanan, 1982; and Richardson, 1986).

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 may also 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 more than 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). One possibility is that those species that eventually thrive in the ice may be present in low numbers in the water column and may be incorporated into the ice as it forms (Horner and Schrader, 1982).

Light appears to be the major factor controlling the distribution, development, and production of the ice-algal assemblage. 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.

Algal biomass in the spring bloom off Narwhal Island showed a bimodal pattern similar to that found by Alexander, Horner, and Clasby (1974) for the Chukchi Sea near Barrow. Near Narwhal Island, an early peak occurred in late April-early May, with a later maximum peak at the end of May-early June. Although the pattern of the bloom was similar, primary production levels near Barrow (5 g C/m^2 for the bloom period) were about seven times greater than for offshore Narwhal Island (0.7 g C/m^2), perhaps reflecting differing light conditions.

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. Other sources of primary production include phytoplankton; benthic microalgae; and, in some areas, benthic macroalgae.

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.

Attenuation of light by turbid ice (ice with incorporated sediments) or by snow cover can greatly reduce or eliminate the productivity of the ice algae (Alexander, Horner, and Clasby, 1974; Schell, 1980a,b; Horner and Schrader, 1982; and Dunton, 1984).

Although the contribution of ice algae to annual productivity may be relatively small, its importance lies in its input during early spring when food is presumably in short supply.

c. Benthic Communities: The benthic communities in the Alaskan Beaufort and Chukchi Seas can contain macrophytic algae (large seaweeds), benthic microalgae and bacteria, and benthic invertebrates.

(1) Marine Plants and Bacteria:

(a) Macrophytic Algae: Although most substrates in the Beaufort Sea are silty sediments that are generally unsuitable for settlement and growth of large algae, hard substrates in the form of cobbles and boulders occur sporadically. The occurrence of such substrates is not perfectly coincidental with the presence of large seaweeds, since ice gouging can prevent the establishment or growth of algae on suitable substrates. Dunton, Reimnitz, and Schonberg (1982) have also found algae in areas where significant quantities of rock substata were lacking. But, in general, macrophytes are most likely to occur in areas not subjected to ice gouging or landfast ice, and where hard substrates occur (see Dunton et al., 1982, and the Sale 87 FEIS, USDOI, MMS, 1984a, for notes about locations of other kelp beds). The largest kelp community thus far described occurs in Stefansson Sound and is appropriately entitled, the Boulder Patch (see Dunton and Schonberg, 1981; Dunton, Reimnitz, and Schonberg, 1982; and Dunton, 1984). The locations of other kelp beds in the eastern Beaufort Sea are portrayed in Figure 5 of Dunton, Reimnitz, and Schonberg (1982). Basically, these other beds occur near the Stockton Islands, Flaxman Island, northwest of Kangigivik Point in western Camden Bay in Nuvagapak Lagoon, and Demarcation Bay. Dunton et al. state that: "In two cases, algae were present in the absence of significant concentrations of rock substrata. However, none of the algal beds were large, not all contained kelp, and none possessed the diverse epilithic fauna that characterizes the Boulder Patch in Stefansson Sound." MacGinitie (1955) noted the occurrence of algal growths (possibly, *Laminaria*) at Elson Lagoon near Point Barrow. Some kelp and other macroscopic algae also occur somewhat south or southeast of the sale area in the Chukchi Sea (Phillips et al., 1982; Schell, personal communication).

The Boulder Patch community, although predominated by the brown alga, Laminaria solidungula, also contains red algae and a diverse assemblage of 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 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). This input may be quite important to the numerous filter feeders found in the community.

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 noticeably 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.

(b) Benthic Microalgae and Bacteria: 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 $C/m^2/yr$.

Bacterial communities in the western Beaufort Sea have been studied by Atlas and Griffiths (1984). Seasonal changes in the abundance of bacterial populations occurred, with a decline evident during winter, especially in surface waters. As in other marine ecosystems studied, the numbers of bacteria were highest in sediments, lower in water, and lowest in ice. Beaufort Sea bacterial communities were also taxonomically diverse, with taxonomic diversity significantly greater in sediment than in water assemblages and significantly greater in summer than in winter. Geographic trends in diversity also occurred: during the summer, diversity was greatest in the western Beaufort Sea, while during the winter, it was lowest there. Relative microbial activity was greatest in waters and sediments associated with the major river plumes. Microbial biomass production may be very high in river-plume waters and may represent a significant food source for higher-trophic-level organisms (Atlas and Griffiths, 1984). Information from nutritional studies showing that large numbers of carbohydrates can be used by bacteria suggest that the ecosystem is supported by phytoplankton, especially during the summer (Atlas and Griffiths, 1984).

(2) Benthic Invertebrates: Benthic invertebrates in the Alaskan Beaufort and Chukchi Seas can generally be divided into two main categories, epifauna and infauna, based on their relationship with the bottom substrate. Infaunal organisms live within the substrate and, as a result, are often rather 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 Sale 87 FEIS (USDOI, MMS, 1984a) and Sale 109 DEIS (USDOI, MMS, 1987). Major studies examining these groups in the Alaskan Beaufort and Chukchi Seas include those of Broad (1979) and Broad, Griffiths, and Carey (1981); Carey (1978); Stoker (1981); Frost and Lowry (1983a); Griffiths and Dillinger (1981); Craig and Griffiths (1981); Envirosphere (1985); and Moulton, Fawcett, and Carpenter (1985). Wacasey (1975) has described the infauna of the Canadian Beaufort Sea.

Patterns in the distribution and relative abundance of species in the Beaufort Sea appear to be correlated with meter physical factors. In nearshore waters with depths less than or equal to 2 meters, relatively few species are found, sampled biomass is low (although divers have reported densities of epibenthic organisms approximately 10^2 to 10^3 times greater than those obtained by otter trawls or epibenthic trawls; see Carey, ed., 1978; Griffiths and Craig, 1978; and Crane and Cooney, 1975), and the abundance of groups is highly variable from year to year. Since this is the zone of shorefast ice, the distribution and abundance of most species is probably dependent on annual (or more frequent) colonization. Abundant groups (of benthic organisms and zooplankton) include amphipods, mysids, isopods, copepods, oligochaete worms, and midge (chironomid) larvae. The fourhorn sculpin is also abundant in this zone. Of the invertebrates, only the oligochaetes and chironomid larvae appear to be restricted to this zone.

In the inshore environment, which ranges from 2- to 20-meter depths, the diversity and biomass of infauna increase and species composition changes (Carey, ed., 1978). The principal groups of species found include polychaete worms, amphipods, an isopod, bivalve mollusks, and a priapulid. Some of these organisms, primarily the amphipods and the isopods, also figure importantly in the nearshore environment and in the epibenthos. Species composition of the epibenthos is similar in the nearshore and inshore environments, with mysids and amphipods generally predominating. Epibenthic organisms, in general, and the mysids and amphipods, in particular, are important prey of anadromous fishes that seasonally frequent nearshore waters. Several recent studies have examined the patterns of distribution and abundance of these epibenthic organisms (Craig and Griffiths, 1981; Envirosphere, 1985; Moulton, Fawcett, and Carpenter, 1985), primarily as they relate to fish movements and feeding behavior. In general, the two major mysid species, Mysis relicta and M. litoralis, have somewhat different distributions, with the distribution of M. litoralis apparently indicating a lesser tolerance of low-salinity water. Amphipods were exceptionally abundant on the inside of barrier islands, and their distributions also showed more fluctuations in Prudhoe Bay than in the lagoonal system to the west (Gwydyr Bay Lagoon). Hypersaline waters also apparently affected distributions, leading to reduced biomass of mysids and amphipods in offshore or central areas of Prudhoe Bay during late summer (Envirosphere, 1985; Moulton, Fawcett, and Carpenter, 1985).

Biomass and diversity in the inshore zone generally increase with depth, except in the shear zone at approximately 15 to 25 meters in depth. Intensive ice gouging occurs in this zone between the landfast ice and the moving polar pack ice, which greatly disturbs the sediments in which infaunal organisms exist, thereby presumably minimizing their abundance. Ice gouging continues out to about 40 meters with decreasing intensity. Diversity and biomass of infauna increase beyond this minimum-abundance zone with distance offshore (Carey, ed., 1978), at least as far as the continental shelf (200 m).

In a study of the nearshore and littoral areas of the Beaufort and Chukchi Seas, Broad et al. (1978) concluded that the fauna of the Beaufort littoral and nearshore (0-20-m depths) and the northeastern Chukchi littoral (0-2-m depths) are similar in species, diversity, and biomass. Principal invertebrates sampled in the northeastern Chukchi littoral include oligochaete worms, isopods, mysids, amphipods, bivalves, priapulids, chironomid larvae, dipterans, and hermit crabs (Broad et al., 1978).

Offshore epifauna have been sampled on several cruises (Carey et al., 1974; Carey and Ruff, 1977; and Frost and Lowry, 1983a; see Carey, ed., 1978, for descriptions). The most extensive sampling of epifaunal invertebrates was by Frost and Lowry (1983a). Their trawls were made in the northeastern Chukchi and western Beaufort Seas at depths of 40 to 400 meters. Many of the tows were made near the southern edge of the pack ice. Frost and Lowry

> "identified 238 species or species groups of invertebrates including 49 gastropods, 34 amphipods, 28 polychaetes, 27 echinoderms, 25 bivalves, 16 ectoprocts, and 14 shrimps. Only 14 species occurred in more than 20 trawls. All except the scallop Delectopecten groenlandicus (which was caught only east of long. 154° W), were found throughout the study area. Forty-one species occurred in 10 or more trawls and almost half of the 238 species occurred in fewer than 5 trawls. At 26 of 33 stations, echinoderms, mainly brittle stars and crinoids, were the most abundant invertebrate group. In most cases, they composed more than 75 percent of the total trawl biomass.
>
> "At least two major community types seemed to exist. West of long. 154° W, brittle stars (usually Ophiura sarsi) were predominant. Associated species included soft corals (Eunephthya spp.) and sea cucumbers (Psolus sp. and Cucumaria sp.). At all stations where this brittle star community was found, the bottom was muddy. East of long. 150° W, the invertebrate community was characterized by the scallop Delectopecten groenlandicus and the crinoid Heliometra glacialis. Sea cucumbers (Psolus sp.), sea urchins (Stronglyocentrotus droebachiensis), several species of brittle stars (not Ophiura sarsi), and the shrimp Sabinea septemcarinata were usually among the most abundant species. Most trawls in which this species assemblage occurred were in rocky (cobble) areas.
>
> "Some trawls fell into neither of the above community types. Those trawls were generally in rocky areas between long. 158° and 162° W, and between long. 150° and 154° W."

d. Trophic Interactions: In a highly seasonal environment like that of the Beaufort and Chukchi Seas, extremes and patterns in the physical environment affect the interaction of organisms with the environment and interactions among organisms. Physical parameters may limit when and how much primary productivity occurs, thus influencing the availability of food to other organisms. Thus, shifting patterns of physical processes may limit or determine biological processes and resultant interactions among organisms.

In the Alaskan Beaufort and Chukchi Seas, sources of primary production include epontic algae, phytoplankton, benthic microalgae, benthic macroalgae, and peat entering into the system from terrestrial environs. 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 may be relatively small (see earlier discussion), but its importance probably lies in its input during early spring when food is presumably in short supply. Another peak in production by ice algae may occur in the fall (Schell, 1982). Open-water phytoplankton generally have the greatest input to primary production (but see comments related to macroscopic algae and peat input), but the contribution varies considerably spatially, increasing in offshore areas except where the pack ice is perennial (Schell et al., 1982; Alexander, 1974; Horner, 1981; Apollonio, 1959; English, 1959). 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).

Benthic microalgae, on the other hand, generally appear to contribute relatively little to annual primary production (Horner and Schrader, 1982; Dunton, 1984), although Matheke and Horner (1974) reported high productivities for benthic microalgae over the summer. The input of carbon from terrestrially-derived peat to the shallow, nearshore zone (less than 10 m in depth, but extending to 10 km offshore) was found to be approximately equal to that of annual primary production (30 $g/m^2/yr$ from peat versus 20 $g/m^2/yr$ from phytoplankton; Schell, 1982, 1983).

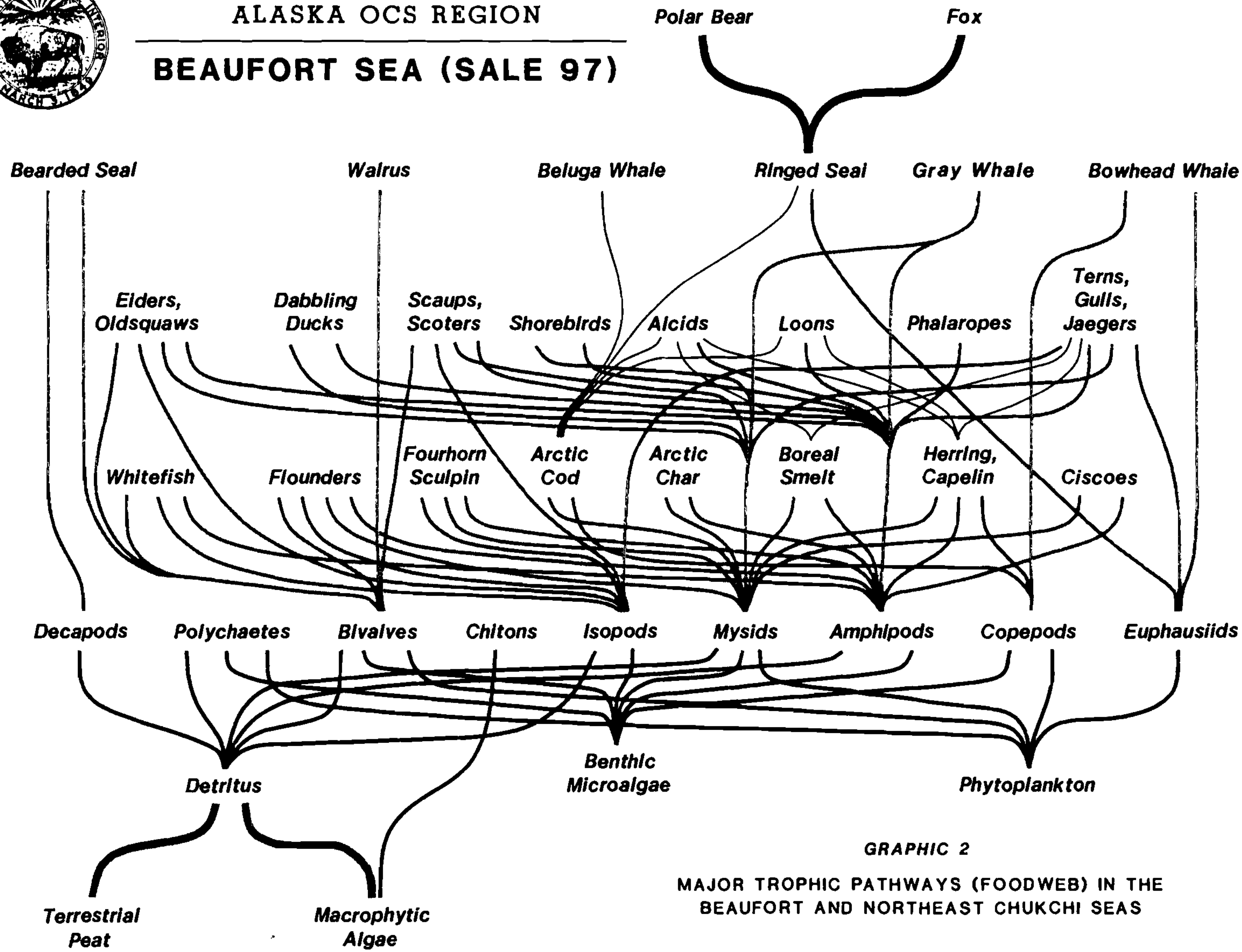
The production or input of carbon into the ecosystem is important, but the methods and degrees to which these potential food sources are used are also critical and form the basis for further interaction among organisms. Knowledge of trophic interactions is in some respects quite rudimentary; most information revolves around who eats what or whom. Relatively little information exists concerning preferences, feeding behavior, likelihood of choosing alternative prey, etc.

Although terrestrially-derived peat contributes substantially to available carbon in the nearshore marine environment, it is little-used by strictly marine organisms and thus does not enter in large degree into the marine food webs (Schell, 1983). Top carnivores of the pelagic food webs (seals, whales, and polar bears) have large energy-storing capabilities, which may enable them to persist in the face of large annual and seasonal fluctuations in food. Peat carbon does seem to be important seasonally for freshwater and anadromous arctic fishes and oldsquaw ducks utilizing insect larvae. The insect larvae appear to be the link with peat carbon for these organisms (Schell, 1983). Bacterial production in river plumes based on the use of soluble organic material leaching from vegetation may provide another link between terrestrial vegetation and marine food webs. Marine organisms, however, are basically dependent on food webs based on marine algae (see Graphic 2), although peat and peat detritus have some input.

The food habits of marine invertebrates vary depending on habitat, season, preferences, etc., but in general they may rely on marine plants, other invertebrates, detritus, or carrion. Certain invertebrates--primarily mysids, amphipods, copepods, isopods, and euphausiids--comprise major portions of the diets of some fishes, birds, and marine mammals (Lowry and Frost, 1981b, 1984; Frost and Lowry, 1983a, 1984; Craig, 1984a; Craig et al., 1984; Connors,

MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION

BEAUFORT SEA (SALE 97)



GRAPHIC 2

MAJOR TROPHIC PATHWAYS (FOODWEB) IN THE BEAUFORT AND NORTHEAST CHUKCHI SEAS

Feeds on Marine Mammals and Products
Feeds on Fishes
Feeds on Invertebrates
Feeds on Primary Producers
Sources of Detritus

SOURCE: Dome Petroleum, LTD., 1982.

1984; Divoky, 1984; Moulton, Fawcett, and Carpenter, 1985; and Envirosphere, 1985). Other invertebrates, such as bivalves, snails, crabs, and shrimp may comprise the diets of some marine mammals (e.g., walrus, bearded seals, and ringed seals; see Frost and Lowry, 1983a).

Areas with high primary productivity or with concentrations of certain larval forms may also be areas where organisms dependent on that productivity, either directly or indirectly, also concentrate (Johnson, 1956; Schell, 1985, personal communication). Schell (1985, personal communication) has found a positive correlation between patterns of high primary productivity in the Alaskan Beaufort Sea and areas where whales historically have been killed. Areas in the eastern Beaufort Sea where bowhead whales feed contain concentrations of their zooplankton prey (Griffiths, Thomson, and Johnson, 1987). Thus, patterns in physical parameters can be linked to patterns of primary and secondary productivity.

2. Fishes: This discussion summarizes and incorporates by reference the description of fish resources contained in Section III.B.2 of the Sale 87 FEIS (USDOI, MMS, 1984a) and Sale 109 DEIS (USDOI MMS, 1987), with augmentation by additional information as cited. Recent reviews include those of Craig (1984a) and Dome, Esso, and Gulf (1982). Nearshore areas of the Alaskan Beaufort Sea have received more attention (see (Craig [1984a] for references, plus Craig et al. [1984]; Envirosphere [1985]; Cannon and Hachmeister [1987]; and Moulton, Fawcett, and Carpenter [1985]) and appear to have greater abundance of fishes than offshore areas, although the lower sampling effort offshore may bias the strength of this generalization.

The fishes occurring in the Beaufort Sea fall into three basic categories: (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 life cycle in the marine environment. They are typical of the "Inuit fauna" (McAllister, 1962), a fairly distinct assemblage of marine or anadromous fishes that extends from the central Canadian Arctic through the Chukchi Sea and into Siberian coastal waters. Sixty-two fish species have been reported from the Alaskan Beaufort Sea (Craig, 1984a) and 72 from the northeastern Chukchi Sea (Craig, 1984b). By comparison, over 300 fish species occur in the Bering Sea and Gulf of Alaska. The low variety of fish in the region has been attributed to low temperature, low productivity, and harsh ice conditions that preclude extensive use of shoreline habitats during the winter period.

Of the 62 Alaskan Beaufort species reported, 37 were collected in nearshore, brackish waters and 40 in offshore marine waters, indicating that some species occur in both habitats. The areas of greatest species diversity tend to be the delta regions of large rivers draining into the Beaufort Sea.

Some characteristics of the physical environment greatly influence the distribution and abundance, both spatially and temporally, of Beaufort Sea fishes. In particular, the formation of a narrow band of warm, brackish water nearshore affects the movements and activities of anadromous fishes. The formation of this watermass is described in the Sale 87 FEIS (USDOI, MMS, 1984a). This warm, brackish water, with its riverine origin, has its greatest extent off the mouths of rivers, with a plume sometimes extending 20 to 25 kilometers offshore (Craig, 1984a). During winter, most of the nearshore water less than 2 meters deep freezes to the bottom.

Aspects of the general biology of freshwater, anadromous, and marine fish species occupying the Alaskan Beaufort Sea follow.

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 is generally sporadic and brief with a peak occurrence probably during or immediately following spring breakup. Such freshwater species include arctic grayling, round whitefish, and burbot.

Anadromous Species: Anadromous species found in the nearshore waters of the Beaufort Sea include arctic char, arctic cisco, least cisco, Bering cisco, rainbow smelt, humpback whitefish, and broad whitefish. Pink and chum salmon have been reported from Simpson Lagoon (Craig and Haldorson, 1981) and along the western Beaufort (Schmidt, McMillan, and Gallaway, 1983); however, their occurrence is thought to be occasional and their abundance relatively low. Other anadromous species recorded from the Alaskan Beaufort include arctic lamprey; chinook, sockeye, and coho salmon; inconnu; and ninespine and threespine stickleback.

The two largest river drainage systems, the Mackenzie and the Colville, contain the most anadromous species. Both rivers have spawning populations of arctic char, ciscoes, whitefishes, and smelt, plus relatively small runs of salmon (Craig, 1984a). Between these two drainage systems are numbers of mountain streams containing perennial springs that are associated with the spawning and overwintering grounds of arctic char (Craig, 1984a; see Fig. III-9).

During the open-water season, anadromous fishes appear to widely use the nearshore, brackish-water habitats as feeding and rearing areas. With the first signs of spring breakup (June 5-20), 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.

Anadromous fishes using the Beaufort Sea coastal region as summer-feeding habitat have been hypothesized to prefer the warmer, less saline waters around river deltas rather than the cooler, more saline waters offshore or removed from drainages. Support for this hypothesis has come from Craig and Haldorson (1981); Moulton, Tarbox, and Thorne (1980); Griffiths and Gallaway (1982); Critchlow (1983); Dew (1983); Griffiths et al. (1983); Woodward-Clyde Consultants (1983); Moulton and Fawcett (1984); and Moulton, Fawcett, and Carpenter (1985). Moulton, Fawcett, and Carpenter (1985) also have found that the large fish of some anadromous species (char, arctic cisco, and least cisco) are less restricted by low temperature and high salinity than are smaller fish. Among the abundant anadromous fishes found in the nearshore zone, arctic char have the broadest salinity tolerance, followed--in decreasing order--by arctic cisco, least cisco, and broad whitefish.

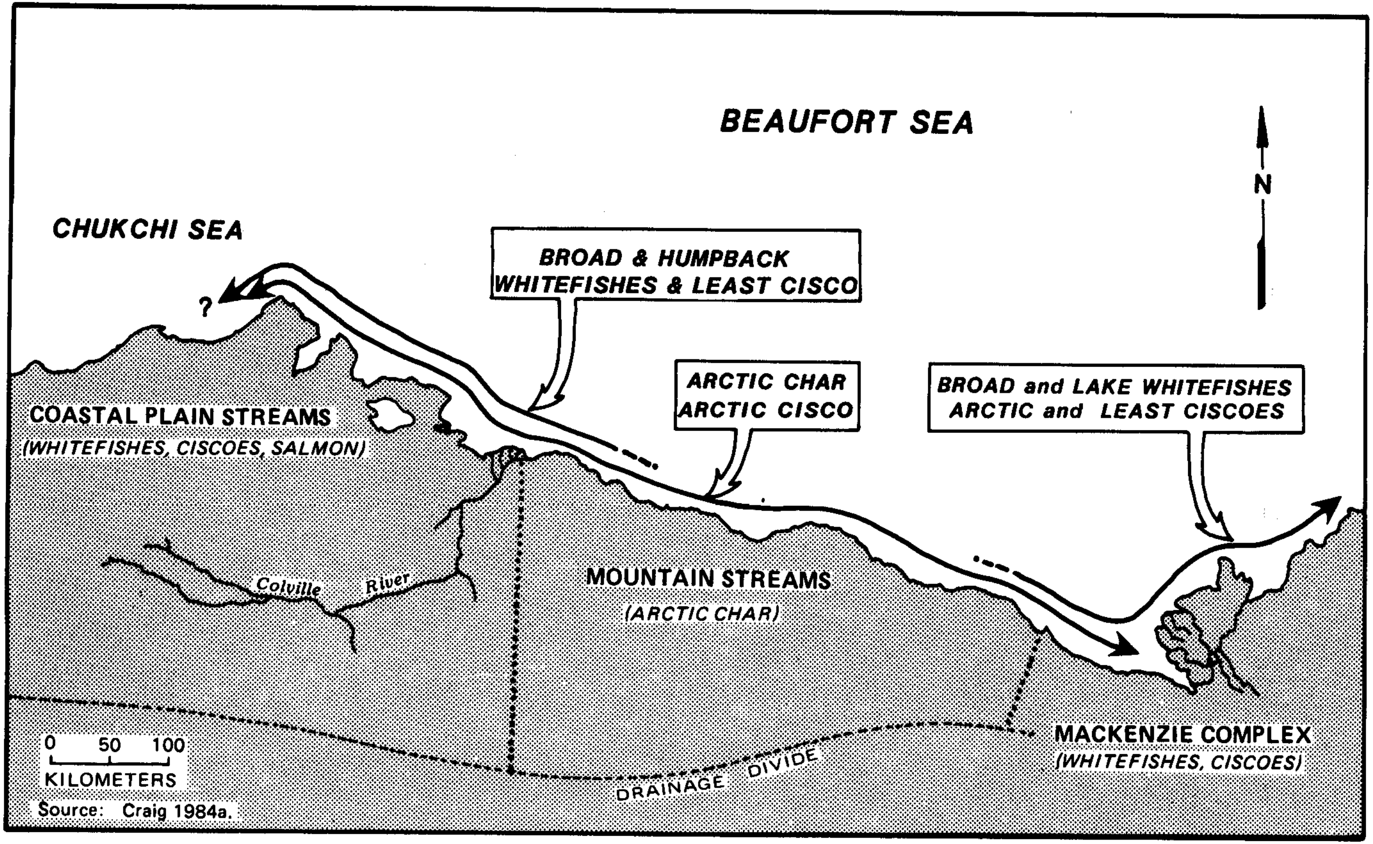


FIGURE III-9. FRESHWATER SOURCES AND COASTAL DISPERSAL PATTERNS OF THE PRINCIPAL ANADROMOUS FISHES OCCURRING ALONG THE BEAUFORT SEA COASTLINE

The concentration of movement and feeding activities of anadromous fishes in the band of warm, brackish water nearshore has been postulated to be related most to (1) temperature and salinity regimes or (2) the concentration of prey in this area. Recent investigations and correlation analysis (Moulton, Fawcett, and Carpenter, 1985) suggest that fish distribution is most strongly correlated with temperature and/or salinity parameters; prey density seems to have little effect. Food does not appear to be a limiting factor for the anadromous fishes studied (Craig and Haldorson, 1981, and Moulton, Fawcett, and Carpenter, 1985, but see comments about arctic cisco). Within the nearshore-brackish zone, fish tend to be concentrated along the mainland and island shorelines rather than in lagoon centers or offshore. The important fishes in nearshore waters, based on numerical abundance or use by humans, are arctic and least aisco, arctic char, arctic cod, and fourhorn sculpin (the latter two are marine species). These species constitute over 90 percent of the fish caught along the Alaskan Beaufort and western Yukon Territory coastlines (Craig, 1984a). Recent catch statistics also indicate that broad whitefish is an important and preferred species in subsistence harvests (George and Nageak, 1986; Moulton, Field, and Brotherton, 1986).

The coastal distribution of some anadromous species (e.g., the broad and humpback whitefishes and arctic char) reflect major geographical differences in the locations of anadromous fish stocks in North Slope rivers (see Fig. III-9). Details of distributions of the Alaskan Beaufort anadromous fishes are found in the Sale 87 FEIS (USDOI, MMS, 1984a); Morrow (1980); Craig (1984a); and Moulton, Fawcett, and Carpenter (1985). Brief descriptions of the distributions of the four 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. Arctic char in Alaskan waters are generally found east of the Colville River and are known to spawn and overwinter in mountain streams. Anadromous least cisco are common west of the Colville River (in rivers from near Wainwright to the Colville) and in rivers on the northern coat of the Yukon and Northwest Territories, but are absent in lakes and rivers of the central Beaufort Sea (between the Colville River and the Babbage River in Canada). In the Alaskan Beaufort Sea, broad whitefish occur in association with the freshwater discharges of larger rivers from Point Barrow east to the Sagavanirkok River Delta, and also have been reported from the Canning River.

Because some fishes, notably whitefishes and least ciscoes, do not disperse far from their rivers of origin, they show a somewhat disjunct distribution pattern with greatest abundances near the Mackenzie River and west of the Sagavanirktok River. In contrast, those fishes that disperse widely from their streams of origin (arctic ciscoes and some arctic char) usually are common along the entire Alaskan Beaufort Sea coastline. An extreme example of a fish showing this latter pattern of dispersal is the arctic cisco. Gallaway et al. (1983) suggest that all the arctic cisco in the Alaskan Beaufort Sea are derived from a single stock that reproduces in the Mackenzie River system. Waves of fishes disperse into Alaskan waters at irregular intervals (Gallaway et al., 1983; Envirosphere, 1985) and juvenile fishes use Alaskan rivers (in particular, the Colville and adjacent environs) and their delta areas as overwintering habitat. Presumably, when they attain sexual maturity, they return to the Mackenzie River to spawn.

Recent genetic studies of arctic char have demonstrated that separate stocks with distinctive genetic makeups occur in different river drainages (Everett and Wilmot, 1987). This suggests that despite what may be wide-ranging movements by adults, char show high fidelity to a particular drainage (Johnson, 1980).

Other distributional patterns also occur. Onshore-offshore distribution or segregation of species varies, presumably due to affinity or tolerance for various salinity-temperature regimes.

Seasonal shifts in distribution take place, with most anadromous species returning to North Slope rivers and lakes in late summer or fall. Some return later, in early winter, while others overwinter in brackish waters off or within the major river deltas (Mackenzie and Colville). One anadromous species, the rainbow smelt, shows a distinctly different pattern by overwintering in marine environments. Large concentrations occur off the mouths of the Mackenzie and Colville Rivers in winter. Then, in spring, the smelt migrate into the rivers to spawn (Haldorson and Craig, 1984).

The nearshore, brackish waters, which are used by these anadromous fishes primarily as a feeding ground, contain an abundant supply of food organisms. The food habits of both anadromous and marine fishes using this zone are quite similar. Epibenthic mysids and amphipods usually constitute over 90 percent of the diets of arctic and least ciscoes, arctic char, and arctic cod (Craig and Haldorson, 1981; Craig et al., 1984). Other fishes may also extensively use these prey while showing preferences for other types of prey. For example, rainbow smelt and sometimes arctic char eat fish; fourhorn sculpin and arctic flounder eat isopods. Infaunal organisms are not abundant in areas where water depths are less than 2 meters and are not commonly eaten by nearshore fishes (Craig, 1984a).

Additional diet and selectivity information was gathered by Moulton, Fawcett, and Carpenter (1985). During the period of greatest fish abundance, in early and midsummer, there was little dietary overlap among the fish species taken in Prudhoe Bay. In late summer, as fish declined in abundance and prey increased, significant dietary overlap was noted between arctic and least cisco, arctic cisco and char, and arctic cisco and broad whitefish. The various fish species showed somewhat different sets of preferences for two mysid species, amphipods, isopods, and other prey (Moulton, Fawcett, and Carpenter, 1985). Although most anadromous fishes feed in nearshore waters during the summer, both arctic and least cisco are known to continue feeding through the winter in Colville Delta habitats (Craig and Haldorson, 1981).

Marine Species: Marine species in the Beaufort Sea have been studied much less than anadromous species have been. In general, they appear to be widely distributed but in fairly low densities, with schooling species such as arctic cod displaying a rather patchy distribution. 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, 1984a). The most widespread and abundant species are the arctic cod, saffron cod, twohorn and fourhorn sculpins, the Canadian eelpout, and the arctic flounder (Craig, 1984a). Trawl surveys conducted by Frost and Lowry (1983a) in the northeastern Chukchi and western Beaufort Seas, at depths of 40 to 400 meters, sampled 19 species of fishes.

Three of these species (arctic cod, Canadian eelpout, and twohorn sculpin) accounted for 65 percent of the catch. Catch rates were low in their trawls. In more-nearshore waters, the fourhorn sculpin is also important numerically. Some marine species, arctic cod and capelin, sporadically enter the nearshore areas to feed on the abundant epibenthic fauna or to spawn. Others, like 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. 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 marine mammals, birds, and other fishes (Andriyashev, 1954; Quast, 1974; Bain and Sekerak, 1978; Craig et al., 1982; Sekerak, 1982; Craig, 1984a). It has been calculated to be the most important consumer of secondary production in the Alaskan Beaufort Sea (Frost and Lowry, 1983) and may influence the distribution and movements of marine mammals and seabirds (Craig, 1984a, citing Klumov, 1937; Bradstreet, 1980; Davis, Finley, and Richardson, 1980; and Finley and Gibb, 1982).

Fourhorn sculpin are among the most widespread and numerous species along the Beaufort Sea coastline. This demersal fish is found in virtually all nearshore habitats including deeper waters not frequented by anadromous fishes (Craig and Haldorson, 1981). Saffron cod, arctic flounder, and starry flounder have similar distributions; however, their occurrence is sporadic and variable and in much lower numbers. Snailfish, which appear to be closely associated with hard, rocky substrates or kelp, have been collected in Simpson Lagoon (Craig and Haldorson, 1981) and Prudhoe Bay and have been observed in association with the Stefansson Sound "Boulder Patch" (Dunton, Reimnitz, and Schonberg, 1982).

Canadian eelpout is a benthic fish species that is common on muddy bottoms (Andriyashev, 1954). After arctic cod, it was the most abundant species found by Frost and Lowry (1983a). Twohorn sculpin, an offshore marine fish (Frost and Lowry, 1983a), is abundant but patchy in its distribution. Capelin is a widely distributed species that has been reported in areas west of the Mackenzie Delta; it usually is not abundant except in August when it spawns in coastal habitats.

Most other marine species spawn during the winter period. 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. Snailfish are also winter spawners, attaching their adhesive eggs to rock or kelp substate.

Feeding habits of marine species are similar to those of anadromous species in nearshore waters. Almost all of the marine species discussed rely heavily on epibenthic and planktonic crustacea such as amphipods, mysids, isopods, and copepods. Flounders also feed heavily on bivalve mollusks, while fourhorn sculpins supplement their diets with juvenile arctic cod.

<u>Sport and Commercial Use of Fish Resources</u>: Anadromous fishes, particularly ciscoes, whitefishes, and char are the focal point of several fisheries along the Alaskan Beaufort Sea coastline. Subsistence harvest of fishes is described in Section III.C.3. Fish are also taken by a commercial fishery in

the Colville River Delta and by sport fishing at villages, DEW-line stations, and oil camps.

The only continuous commercial fishing operation on Alaska's North Slope is operated by a single family (Helmericks) during the summer and fall months in the Colville Delta. Of the four species taken, arctic cisco is the most important cash product. This species, along with broad and humpback whitefish, is sold for human consumption in Fairbanks and Barrow. Least cisco also are taken in large numbers and are sold for dog food. Average annual catch statistics (1964-1984; Alaska Dept. of Fish and Game, 1984) for these species are as follows:

Species	Number	Percent	Total Weight (lbs.)
Arctic Cisco	30,615	55	30,615
Least Cisco	21,602	39	19,441
Broad Whitefish	2,183	4	11,133
Humpback Whitefish	1,351	2	--

It is estimated that about 9 percent of the arctic ciscoes and 5 percent of the least ciscoes are exploited by commercial fisheries every year.

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 87 FEIS (USDOI, MMS, 1984a) 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 adjacent to the area of Sale 97 in the Beaufort Sea. Nearly all of these species are found in the Arctic, seasonally, from May through September. The most abundant marine and coastal species include red phalarope, oldsquaw, glaucous gull, and common eider.

Within the proposed sale area, major concentrations of birds occur near shore (in waters less than 20 m in depth) and in coastal areas such as Peard Bay, Plover Islands-Barrow Spit, Pitt Point-Cape Halkett, Fish Creek Delta, Colville River Delta, Simpson Lagoon, Beaufort Lagoon, and Demarcation Bay (Graphic 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. 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.

Shortly after spring migration, most shorebirds 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 (Graphic 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 Graphic 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 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.

4. Pinnipeds, Polar Bears, and Beluga Whales: The description of these nonendangered marine mammals in the Beaufort Sea Planning Area as contained in Section III.B.4 of the 87 FEIS (USDOI, MMS, 1984a) 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 proposal. Species covered include the ringed seal, bearded seal, spotted seal, walrus, polar bear, and beluga whale. The trophic relationships of these species to other organisms of the marine ecosystem are portrayed on Graphic 2. Other species that are uncommon or rare in the sale area but that occasionally occur in small numbers include harbor porpoise, killer whale, narwhal, and hooded seal. Due to the relative numerical insignificance of the latter species in the Beaufort Sea, they are not discussed further.

All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. In the Act, 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 Graphic 4.

a. Pinnipeds:

Ringed Seal: This species is the most abundant seal in the Beaufort Sea. It is widely distributed throughout the Arctic, with an estimated population of


MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION
BEAUFORT SEA (Sale 97)
GRAPHIC 3
MARINE AND COASTAL BIRDS
Bird Colonies
> 100,000
> 10,000
> 1,000
< 1,000
Major Feeding and/or Molting Concentration Areas and High Sensitivity Areas:
Coastal
Offshore*
Tundra Swan Concentration Area
Coastal
* as represented by short-tailed shearwater sitings along the 'Bering Sea Intrusion' (Divoky, 1983)
BEAUFORT SEA PLANNING AREA
PROPOSED SALE 97 AREA
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
MACKENZIE BAY
Blocks Previously Leased
Point Barrow
Barrow
Pt. Belcher
Wainwright
Peard Bay
Skull Cliff
Cape Simpson
Alaktak
Atqasuk
Teshekpuk Lake
Cape Halkett
Nuiqsut
Prudhoe Bay
Deadhorse
Pt. Bullen
Kaktovik
Demarcation Point
Herschel I
Richards Island
Pt Lay
Point Hope
Cape Thompson
Kivalina
Umiat
NATIONAL PETROLEUM RESERVE – ALASKA
ARCTIC NATIONAL WILDLIFE REFUGE
NORTH SLOPE BOROUGH
ALASKA
CANADA
USA
SCALE 1:2,050,000
50 0 50 100 MILES
50 0 50 100 KILOMETERS
MODIFIED TRANSVERSE MERCATOR PROJECTION
NATIONAL GEODETIC VERTICAL DATUM OF 1929
WATER DEPTH IN METERS
SOURCE: Barry et al., 1981; Bartels and Doyle, 1984; Divoky, 1978, 1983; Koski, 1977; Maynard and Partch/Woodward Clyde Consultants, 1983a; Norton and Sackinger, 1981; Sowls et al., 1978; U.S. Dept. of Commerce, NOAA, 1978; USDI, 1978a.


MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION
BEAUFORT SEA (Sale 97)
GRAPHIC 4
MARINE MAMMAL HABITATS
SPOTTED SEAL SUMMER CONCENTRATION AREAS
WALRUS COASTAL HAULOUT AREA
BELUGA WHALE SUMMER CONCENTRATION AREAS
POLAR BEAR COASTAL CONCENTRATION AREAS
GREY WHALE CONCENTRATION AREAS
APPROXIMATE FLOATING FAST ICE ZONE
(Ringed seal pupping habitat)
ACTIVE ICE (flaw) ZONE
(important winter or spring use area for marine mammals; particularly polar bear, bearded seal, beluga whale near Pt. Barrow, and nonbreeding ringed seal)
BEAUFORT SEA PLANNING AREA
PROPOSED SALE 97 AREA
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
MACKENZIE BAY
NATIONAL PETROLEUM RESERVE - ALASKA
ARCTIC NATIONAL WILDLIFE REFUGE
NORTH SLOPE BOROUGH
ALASKA
CANADA
USA
Blocks Previously Leased
Point Barrow
Barrow
Wainwright
Pt. Belcher
Skull Cliff
Atqasuk
Alaktak
Cape Simpson
Cape Halkett
TESHEKPUK LAKE
Nuiqsut
PRUDHOE BAY
DEADHORSE
Pt. Bullen
Kaktovik
Herschel I.
Richards Island
Pt. Lay
Point Hope
Kivalina
Umiat
COLVILLE
SCALE 1:2,050,000
50 0 50 100 MILES
50 0 50 100 KILOMETERS
MODIFIED TRANSVERSE MERCATOR PROJECTION
NATIONAL GEODETIC VERTICAL DATUM OF 1929
WATER DEPTH IN METERS
SOURCE: Fraker, M., D.Sergeant, and W. Hoek, 1978; Grantz et al., 1982; U.S. Dept. of Commerce, NOAA, 1978,1984; Ljungblad, 1981; Ljungblad et al., 1982, 1983, 1984a, 1985c, 1986.

80,000 seals during the summer and 40,000 seals during the winter in the Beaufort Sea. 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. 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 are generally less mobile than individuals in other habitats; they depend on a small relative number of holes and cracks in the ice for breathing and foraging. During nursing (4-6 weeks), pups are generally 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).

Bearded Seal: This species is found throughout the Arctic and generally prefers areas where seasonal broken sea ice occurs over waters less than 200 meters deep. The majority of the bearded seal population in Alaskan OCS areas are in the Bering and Chukchi Seas, where an estimated 300,000 to 450,000 individuals occur. 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 and lowest during the winter.

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.

Spotted Seal: This species is a seasonal visitor to the Beaufort Sea. Spotted seals appear along the coast in July in low numbers (about 1,000), hauling out on beaches, barrier islands, and remote sand bars on the river deltas. Traditional 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 (Graphic 4). Recently, these seals have also 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.

Walrus: The walrus population of the north Pacific is in the range of 170,000 to 250,000 animals, comprising about 80 percent of the world population. In general, most of this population is associated with the moving pack ice year-round. Walrus spend the winter in the Bering Sea, and the majority of the population summer throughout the Chukchi Sea including the westernmost part of the proposed sale area (Graphic 4). Although a few walrus 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).

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 walrus move 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 Wrangel Island and along the northwest coast of Alaska from about Point Hope to north of Point Barrow (Graphic 4). 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 walrus is considerably lower than that of seals. At best, females produce one calf every 2 years rather than every year as with other pinnipeds. Walrus are a very important cultural and subsistence resource. Alaskan annual harvest catches have ranged from 1,000 to about 3,000 animals in the past 15 years (ADF&G, as cited by Fay, 1982).

b. Polar Bears: Polar bears are found throughout the Arctic. The Beaufort Sea population (from Point Barrow to Tuktoyaktuk Peninsula) is estimated to be 2,000 bears, while the total Alaskan population is estimated at 3,000 to 5,000 bears. 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 square miles, with much lower densities occurring farther than 100 miles offshore. 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 the subadult seals in this habitat. 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.

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 kilometers inland. 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. Insufficient data exist to accurately quantify polar bear denning along the Alaskan Beaufort Sea coast. However, dens appear to be less concentrated than in many denning areas in Canada and on Wrangel Island and elsewhere in the Arctic. Polar bears have been reported to bear young in maternity dens far offshore on the pack ice (Amstrup, 1985). The majority of polar bear maternity dens located recently in the Sale 97 area were found on sea ice scattered throughout the planning area (Amstrup, 1985).

Besides being covered by the Marine Mammal Protection Act 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. Beluga Whales: The beluga whale, a subarctic and Arctic species, is a summer seasonal vistor throughout offshore habitats of the Alaska portion of the Beaufort Sea. The North American Arctic population is estimated to be at least 30,000, while an estimated 11,500 whales migrate to the eastern Beaufort Sea. 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, personal communication). 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 (Graphic 4). An estimated 3,000 to 4,000 belugas summer in the northwestern Beaufort and Chukchi Seas, with some utilizing coastal areas such as Peard Bay and Kasegaluk Lagoon (Frost, 1985, personal communication).

Fall migration through the western Beaufort Sea and the Sale 97 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 belugas migrate offshore along the pack-ice front (Frost, 1985, personal communication). Beluga 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: Endangered species likely to occur within the proposed Sale 97 area include the bowhead and gray whale. The threatened arctic peregrine falcon may be present adjacent to the sale area. The following descriptive section summarizes the biology of these species. An endangered species is defined by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531, et seq.), as a species that is in danger of extinction throughout all or a significant portion of its range. Threatened species are those likely to become endangered within the foreseeable future. Information on endangered and threatened species in Sections III and IV of this EIS also serves as the Biological Assessment referred to in Section 7(c) of the Endangered Species Act of 1973, as amended. Whales protected under the Endangered Species Act also are protected under the International Convention for the Regulation of Whaling (1946) and the Marine Mammal Protection Act of 1976.

a. Bowhead Whale: Several sources (Ljungblad, Moore, and Van Schoik, 1984a, and Ljungblad et al., 1985b; Braham Krogman, and Carroll, 1984; and Fraker, 1984) summarize current knowledge about the bowhead whale. Included here is a brief summary of information regarding the population status, seasonal migration, and preferred habitats of the bowhead as related to the proposed sale area.

At least four stocks of bowhead whales occur in the northern latitudes. The largest of these, the western Arctic stock, is estimated to number at least 4,417 individuals (International Whaling Commission, 1986). Individuals from this stock pass through or near the sale area semiannually as they migrate between wintering areas in the Bering Sea and summer-feeding grounds in the Canadian Beaufort Sea (Figs. III-10 and III-11). Bowheads can be expected to be present in or near the sale area from April through mid-June and August through October (USDOI, MMS, 1984a).

Though not well-defined, the bowheads' winter range appears to be in the central and western Bering Sea, from south and west of St. Lawrence Island to the ice front (Brueggeman, 1982; Brueggeman, Grotefendt, and Erickson, 1984). The bowheads' northward spring migration appears to be timed with the ice breakup, usually beginning in April (Braham, Krogman, and Carroll, 1984). Most bowheads travel north between St. Lawrence Island and the Chukotsk Peninsula and north by northeast through the Bering Strait. Once in the Chukchi Sea, they follow leads in the flaw zone from outer Kotzebue Sound to Barrow. Bowheads pass Barrow from April through mid-June and then move through offshore leads in an easterly direction (Fig. III-10). East of Point Barrow, lead systems further divide into numerous branches that vary in location and extent from year to year. Here, the overall migration corridor widens as the whales use multiple lead systems (Ljungblad, 1982), but generally the spring migration appears to center around 71°30'N. latitude, at least as far east as Barter Island (Ljungblad et al., 1984a).

After summer feeding in the Canadian Beaufort Sea, bowheads begin moving westward in August into Alaskan waters in or near the proposed sale area (Fig. III-11). Conditions can vary during the fall migration from open water to over 9/10 ice coverage. Bowheads have been observed in waters ranging from several meters to over 2,000 meters in depth. The depth regime over which the greatest number of whales appears to migrate is from 10 to 50 meters (Ljungblad et al., 1984a).

The major portion of the bowhead fall migration passes through the sale area between mid-September and mid-October, but the timing and nature of the migration can vary and may be related to whether heavy- or light-ice conditions are present and the effect of these conditions on bowhead prey productivity and feeding opportunities (Ljungblad, Moore, and Van Schoik, 1984a, and Ljungblad et al., 1985b). Light-ice conditions are created when winter ice melts or is blown offshore, resulting in an extensive open-water condition (0/10 - 1/10 ice coverage). Much more bowhead feeding was observed during the light-ice years of 1979, 1981, 1982, and 1984 than during the heavy-ice years of 1980 and 1983. Also during light-ice years, bowheads were more often seen in groups or aggregations. There have been relatively few bowhead sightings in Alaskan waters during August, and most of these sightings have been in offshore waters deeper than 50 meters. Nearshore sightings have been sparse until ice coverage has melted to less than 2/10. Peak sighting rates have occurred just before or during freezeup in late September or early October, but many bowheads have been seen even after the ice coverage reached 9/10 or as late as mid-October. All periods of high-sighting rates have occurred in

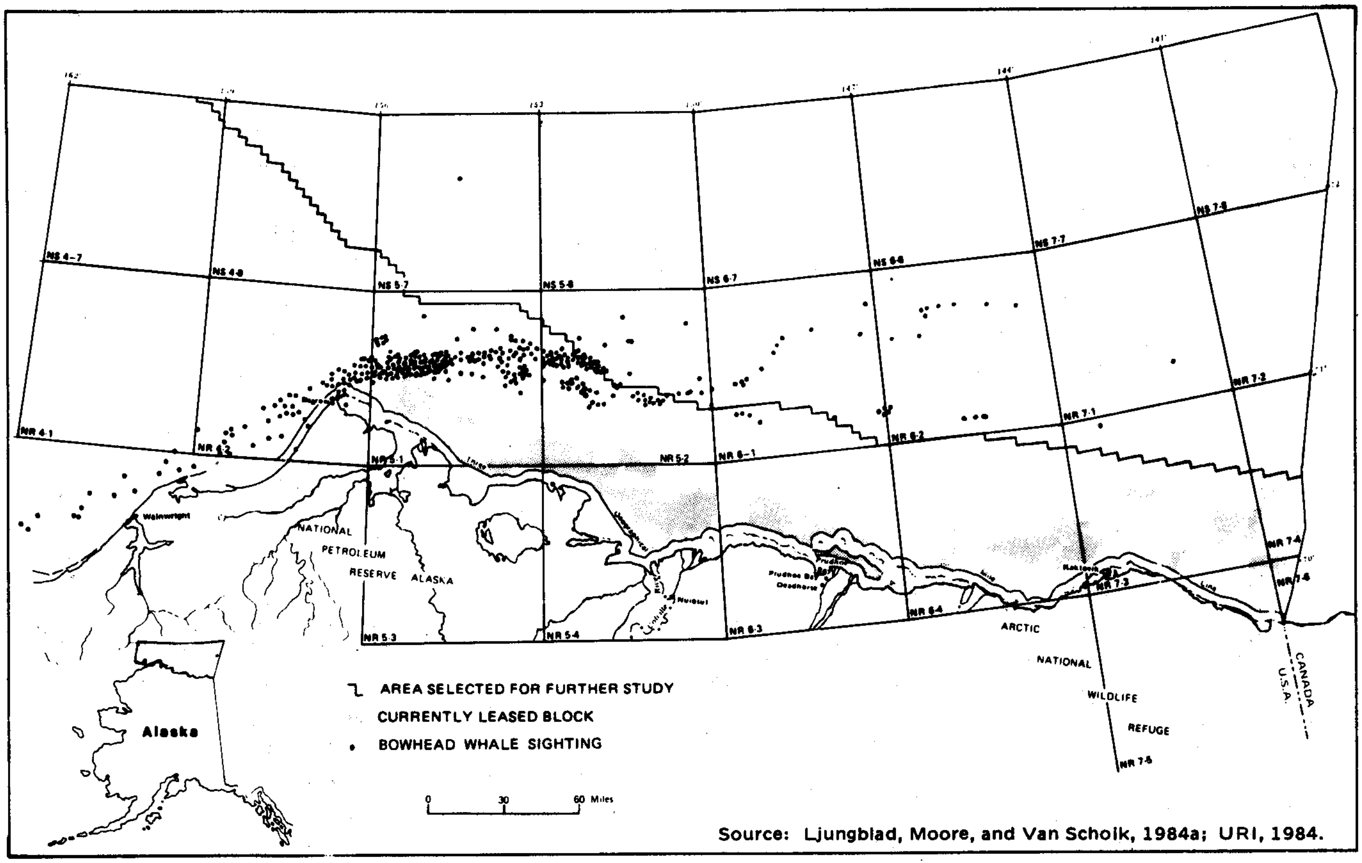


FIGURE III-10. COMBINED DISTRIBUTION OF BOWHEAD WHALE SIGHTINGS. SPRING 1979–1984

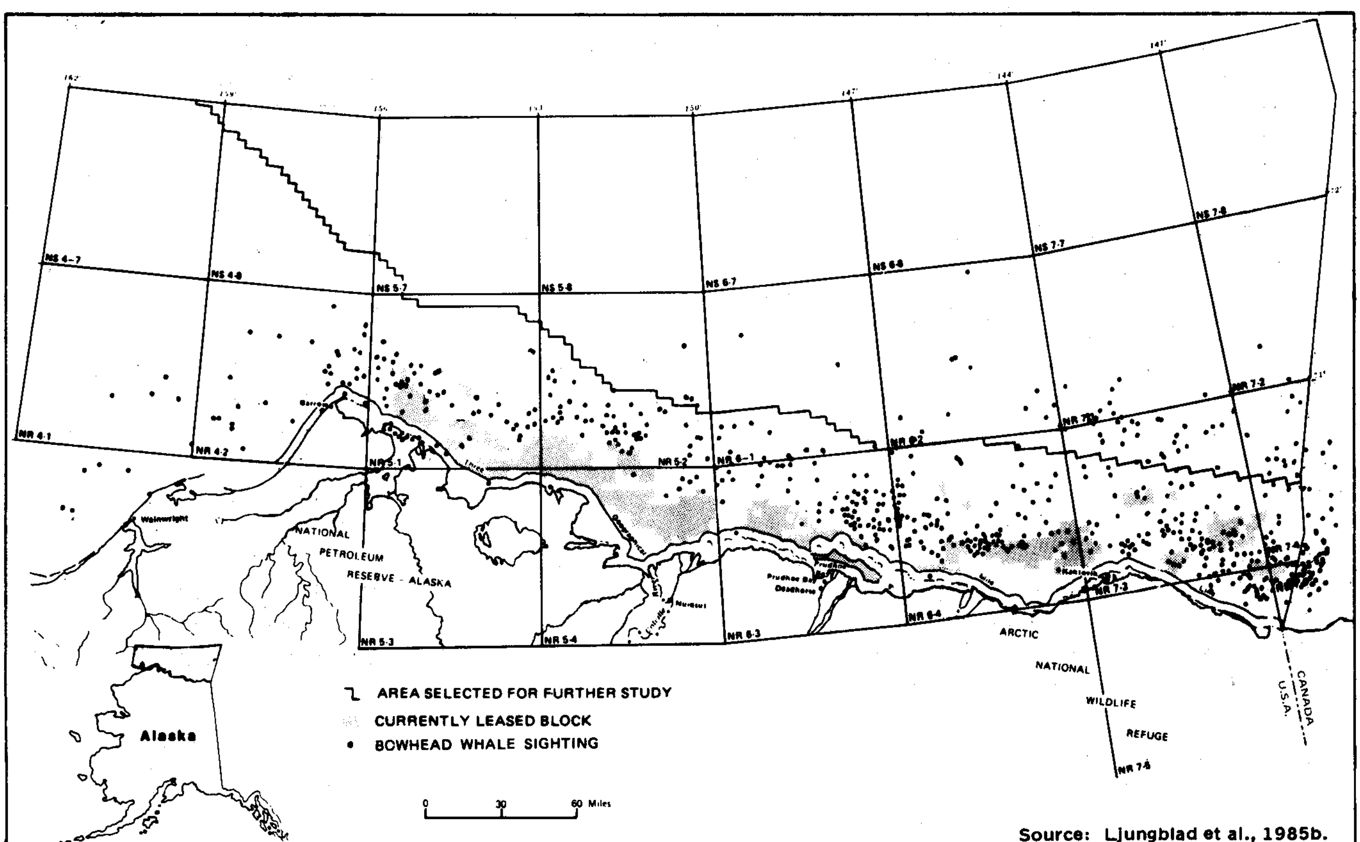


FIGURE III-11. COMBINED DISTRIBUTION OF BOWHEAD WHALE SIGHTINGS FALL 1979–1984 light-ice years when large groups of bowheads have been observed feeding and socializing near the 20- to 30-meter isobath or near Point Barrow (Ljungblad, Moore, and Van Schoik, 1984b, and Ljungblad et al., 1985b).

During the heavy-ice years of 1980 and 1983, the sea ice never melted into a completely open-water condition. Typical conditions consisted of an average ice cover of about 5/10 with holes and leads in patches of 9/10 coverage. Bowheads migrated in a more direct manner at greater speeds and in smaller groups in heavy-ice conditions. There were few occasions of feeding or socializing, and most whales were solitary and surfaced only briefly between relatively long dives (Ljungblad, Moore, and Van Schoik, 1984b).

Data on the bowhead fall migration through the Chukchi Sea is limited; however, most bowheads sighted west of Point Barrow in recent years were headed offshore in a southwesterly direction. This information--coupled with the fact that many bowheads have been seen in the fall along the northern coast of the Chukotsk Peninsula--has led researchers to believe that before they move south into the Bering Sea, most bowheads cross the Chukchi Sea in a broad front from Point Barrow to the northern coast of the Chukotsk Peninsula (Ljungblad, Moore, and Van Schoik, 1984b).

Bowheads apparently feed throughout the water column (Wursig et al., 1984), and they have been observed during their spring and fall migration feeding in portions of the proposed sale area. Food items most commonly found in harvested bowheads include euphausiids, mysids, copepods, and amphipods (Lowry and Frost, 1984). Areas to the east of Barter Island appear to be used regularly for feeding (Sec. III.B.5.a, 87 FEIS, USDOI, MMS, 1984a). In 1984, large numbers of bowheads (groups of up to 45 to 50) were observed feeding east of Point Barrow near the Plover Islands (Ljungblad et al., 1985b). Bowheads were observed feeding in this same area in 1974, 1975, 1976, and 1978 (Braham, Krogman, and Carroll, 1984), indicating that in certain years this may be a significant feeding area. Bowheads were also observed feeding in the vicinity of Point Barrow during 1985 and 1986, indicating that bowheads will opportunistically feed in this area when food is available (Carroll and George, 1985; George et al., 1987).

Some bowhead mating or calving may occur in or near the sale area during the spring migration. Late winter is the most probable mating season, at the time when most of the population is located in the Bering Sea. (Nerini et al., 1983). However, mating behavior has also been reported north of Point Barrow (Everitt and Krogman, 1979). The peak of calving probably occurs in May, although the calving season could extend in some years from late March until early August (Nerini et al., 1983).

b. Gray Whale: The gray whale is present in the sale area from June through October. During 1984, gray whales were most commonly observed in the Chukchi Sea within 30 miles of the Alaskan coast. Occasionally, they occupy waters east of Barrow (Rugh and Fraker, 1981; Ljungblad et al., 1985b). The eastern Pacific stock, which represents most of the world's population, migrates annually from the coast of Baja California to Alaskan and Soviet waters. In 1980, this stock was estimated to number 15,647 individuals, which represented an average annual increase of 2.5 percent over the 13-year period from 1967-1968 through 1979-1980 (Reilly, Rice, and Wolman, 1983). The steadily increasing population estimates indicate that the eastern Pacific stock is recovering well from severe overexploitation (Reilly, 1981).

The gray whale's northward migration begins in February off the Baja California coast (Rice and Wolman, 1971). Most of the gray whale population enters the Bering Sea through Unimak Pass from March through June. The whales arrive near St. Lawrence Island in May and June and subsequently at other summer-feeding areas in the northern Bering and Chukchi Seas (Braham, 1984). Gray whales present within the sale area primarily engage in summer feeding. Of the 112 gray whales spotted during aerial surveys of the Chukchi Sea in 1984, 91 whales (79%) were observed feeding north of 71° N. latitude (Ljungblad et al., 1985). About 40 percent of the gray whales seen during aerial surveys of nearshore waters in the Chukchi Sea during 1982 and 1983 were bottom feeding as indicated by mud plumes. As in the Chirikov Basin, a prime feeding area for gray whales, the nearshore waters of the Chukchi Sea also are important for gray whale feeding (Davis and Thompson, 1984). The distribution of gray whales near or in the sale area probably is primarily dictated by prey availability, although there is little data available on the distribution of food organisms (benthic invertebrates) in the northeastern Chukchi Sea. In the northern Bering and western Chukchi Seas, gray whales feed extensively on bottom-dwelling amphipods (Nerini, 1984), and it is likely that they feed on similar species in the sale area.

Gray whales seen in or near the sale area from August to mid-October 1984 seemed to alternate feeding and migrating to the southwest (Ljungblad et al., 1985b). Late migrants probably leave the sale area in the latter portion of October.

c. Arctic Peregrine Falcon: The Arctic Peregrine Falcon Recovery Team (APFRT) has reported 44 recently active peregrine falcon nests (1960-1981) and 72 known historical nest sites on the Colville, Sagavanirktok, and other river drainages east and west of the Sagavanirktok River (USDOI, FWS, Region 7, 1982). Two of the recently active sites were indicated as "coastal" and possibly included sites south of Barrow. The Colville River drainage was identified by the APFRT as the center of the peregrine distribution on the North Slope, and populations apparently have been increasing in the last decade (USDOI, FWS, Region 7, 1982).

There are no known active nest sites along the coast between Barrow and Demarcation Point. Nest sites or possible nest sites nearest to the coast include those on the Colville River at Ocean Point (approximately 25 mi. inland), at Franklin Bluff on the Sagavanirktok River (approximately 25 mi. inland), and at Red Hill on the Canning River (approximately 40 mi. inland) (Sec. III.B.5.d, 87 FEIS, USDOI, MMS, 1984a). Roseneau et al. (1976) estimate that 8 to 10 pairs nested from the Shaviovik River to the Canadian boundary.

According to the FWS Section 7 Biological Opinion (November 9, 1981), peregrines usually are present in Alaska from mid-April to mid-September; and egg-laying on the North Slope begins in the middle of May (See Vol. 2, Appendix D, 87 FEIS, USDOI, MMS, 1984a). Young fledge from about the end of July to mid-August (USDOI, FWS, 1982). The most frequent occurrence of peregrines in coastal habitats of the northern Alaskan coast is east of the mouth of the Colville River. Most probably, immature birds use this area on a transient basis from mid-August to mid-September (Sec. III.B.5.d, 87 FEIS, USDOI, MMS, 1984a).

d. Candidate Plant Species: Two species of plants currently designated as candidates for listing as threatened or endangered occur within the Beaufort Sea coastal region. *Salix ovalifolia* var. *glacialis*, a low-growing willow, is found in sandy soils at Barrow, Collinson Point, and Camden Bay. The other species, *Thlaspi arcticum*, is a mustard known from northeastern Alaska where it occurs on well-drained sites on alpine slopes, dry ridges, and low river terraces (Murray, 1980). After examining the known distribution of these species, MMS has determined it is unlikely that onshore developments or other activities associated with the OCS program will affect these species.

6. Caribou: The description of caribou in the Beaufort Sea Planning Area as contained in Section III.B.6 of the 87 FEIS (USDOI, MMS, 1984a) 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 97 area.

Two major 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. The Western Arctic herd, estimated to be 200,000 animals (James, 1985), 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 Porcupine caribou herd, estimated to be approximately 135,000 animals (Whitten, as cited by Carruthers, Jakimchuk, and Ferguson, 1984), 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 (Graphic 5). The Central Arctic herd, estimated at about 13,000 animals (Cameron, 1984, as cited by Murphy, 1984), 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 Teshekpuk Lake herd, comprising 4,000 to 5,000 animals (USDOI, BLM, 1983), is around Teshekpuk Lake and near Cape Halkett adjacent to Harrison Bay (see Graphic 5). The Western Arctic herd's major calving area is inland on the NPR-A. The Porcupine caribou herd calving range encompasses an area along the Beaufort Sea coast from the Canning River in Alaska to the Babbage River in Canada south to the northern foothills of the Brooks Range. 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 Central Arctic herd have calved within 30 kilometers of the Beaufort Sea, including the Prudhoe Bay area (see Graphic 5). 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 excess of 50,000. Cow/calf groups are most sensitive to human disturbance


MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION
BEAUFORT SEA (Sale 97)
GRAPHIC 5
CARIBOU CALVING AREAS AND MOVEMENT PATTERNS
MOVEMENT PATTERNS:
SPRING
SUMMER
FALL
CALVING AREA
BEAUFORT SEA PLANNING AREA
PROPOSED SALE 97 AREA
Blocks Previously Leased
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
MACKENZIE BAY
NATIONAL PETROLEUM RESERVE - ALASKA
ARCTIC NATIONAL WILDLIFE REFUGE
NORTH SLOPE BOROUGH
ALASKA
CANADA
USA
Barrow
Point Barrow
Wainwright
Pt. Belcher
Skull Cliff
Atqasuk
Alaktak
Cape Simpson
Cape Halkett
TESHEKPUK LAKE
Nuiqsut
PRUDHOE BAY
DEADHORSE
Pt Bullen
Kaktovik
Demarcation Point
Herschel I
Richards Island
Pt Lay
Point Hope
Kivalina
Umiat
COLVILLE RIVER
SCALE 1:2,050,000
50 0 50 100 MILES
50 0 50 100 KILOMETERS
MODIFIED TRANSVERSE MERCATOR PROJECTION
NATIONAL GEODETIC VERTICAL DATUM OF 1929
ATTENTION USER: THIS GRAPHIC HAS BEEN PREPARED FOR AN ENVIRONMENTAL IMPACT STATEMENT FROM EXISTING SOURCES AND IS NOT A PRODUCT OF ORIGINAL SCIENTIFIC RESEARCH. THIS IS A SPECIAL GRAPHIC OVERPRINT AND IS NOT TO BE USED FOR NAVIGATION PURPOSES, NOR IS THIS GRAPHIC A LEGAL DOCUMENT FOR FEDERAL LEASING PURPOSES. MINERALS MANAGEMENT SERVICE, U.S. DEPARTMENT OF THE INTERIOR, DOES NOT GUARANTEE THE ACCURACY TO THE EXTENT OF RESPONSIBILITY OR LIABILITY FOR RELIANCE THEREON. PREPARED BY THE ALASKA OUTER CONTINENTAL SHELF REGION.
SOURCE: Banfield, Jakimchuk, and Cameron, 1981; Jingfors, 1980; USDI, 1978b; USDI, Fish and Wildlife Service, 1982.
WATER DEPTH IN METERS

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.

C. Social Systems

1. Population:

a. 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 (see Sec. III.C.3, Fig. III-14). 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 (see Sec. III.C.3, Fig. III-14). Naturally, the population of these camps is directly determined by the ebb and flow of oil developments. Thus far, most North Slope work camps have been developed as industrial enclaves separated by rules and distance from the traditional communities. For this reason, the sociocultural effects of the oil industry remain, in large measure, indirect. Social, economic, and population dynamics of the villages are distinct from those of the work camps.

Table III-C-1 presents 1980 and 1981 population figures for villages and work camps in the region. The 1980 figures are given by village and camp. They are totaled by census subarea, as well as for the entire North Slope Borough (NSB). While these numbers present an adequate picture of North Slope village population, they are of limited value in assessing the work camps. The 1982 figures are broken down only for villages. Totals are given for the traditional villages, for oil-related work camps, and for the NSB as a whole. The work-camp total is from a special census that represents an accurate picture of camp size at one point in time. According to Table III-C-1, of the 11,234 people counted on the North Slope in 1982, 43.9 percent resided in traditional villages and 56.1 percent were found in oil-related work camps.

b. Traditional Communities: The same census figures for the eight villages in Table III-C-1 are restated in Table III-C-2, which also includes available census data going back to 1929. Figure III-12 depicts this information for total North Slope village population and for Barrow. All villages grew between 1980 and 1982, and these villages increased by a total

Table III-C-1
Population of the North Slope Region
1980, 1982, and 1985

		1980 1/	1982 2/	1985 3/
	Anaktuvuk Pass	203	250	234
	Atqasuk	107	210	214
	Barrow	2,267	2,882	3,075
	Cape Lisburne	36	--	--
	Kaktovik	165	214	206
	Nuiqsut	208	287	337
	Point Hope	464	544	570
	Point Lay	68	105	129 4/
	Wainwright	405	436	507
SUBTOTAL	Traditional Inupiat Villages	3,923	4,928	5,272
SUBTOTAL	Oil-Related Enclaves, Military Stations, and Others	276 5/	6,306	3,036 6/
TOTAL	NORTH SLOPE BOROUGH	4,199	11,234	8,308

Sources: As indicated in the footnotes below.

1/ Source: USDOC, Bureau of the Census, 1981.
2/ Alaska Consultants, Inc., 1984.
3/ Source: FY 1986 Revenue Sharing Program, State of Alaska, Dept. of Regional and Community Affairs.
4/ 1984 household census conducted by NSB.
5/ This figure from the 1980 U.S. Census underrepresents the actual number of workers employed in petroleum-related enclaves.
6/ This number was calculated by 2/ using a different methodology from that used in the 1980 Census. In 1982, the military stations contained around 200 people. The remainder of this subtotal consists of 39.1 percent of the latest average annual employment of the Prudhoe Bay, Kuparuk, and Pipeline areas.

Table III-C-2
North Slope Population Trends
1929 to 1982

Village	1929	% Total	1939	% Total	1950	% Total	1960	% Total	1970	% Total	1980	% Total	1982	% Total
Anaktuvuk Pass	a/		a/		66	3.9	35	1.7	99	3.3	203	5.3	250	5.1
Atqasuk			78	6.2	49	2.9	30	1.4	c/		107	2.8	210	4.3
Barrow	330	32.4	363	28.9	951	56.7	1,314	63.3	2,098	69.4	2,207	57.7	2,882	58.5
Kaktovik	b/		13	1.0	46	2.7	120	5.8	123	4.1	165	4.3	214	4.3
Nuiqsut	b/		89	7.1	c/		c/		c/		208	5.4	287	5.8
Point Hope	139	13.7	257	20.4	264	15.7	324	15.6	386	12.8	464	12.1	544	11.0
Point Lay	351	34.5	117	9.3	75	4.5	c/		c/		68	1.8	105	2.1
Wainwright	197	19.4	341	27.1	227	13.5	253	12.2	315	10.4	405	10.6	436	8.9
TOTALS	1,017		1,258		1,678		2,076		3,021		3,827		4,928	

Sources: USDOC, Bureau of the Census, 1981; Alaska Consultants, Inc., 1981.

a/ Anaktuvuk Pass was not a village site in 1929 and 1939. It functioned as a seasonal camp.
b/ Figures are not available. Size is assumed to be small.
c/ Settlement abandoned, used as a seasonal camp, or too small to be censused.

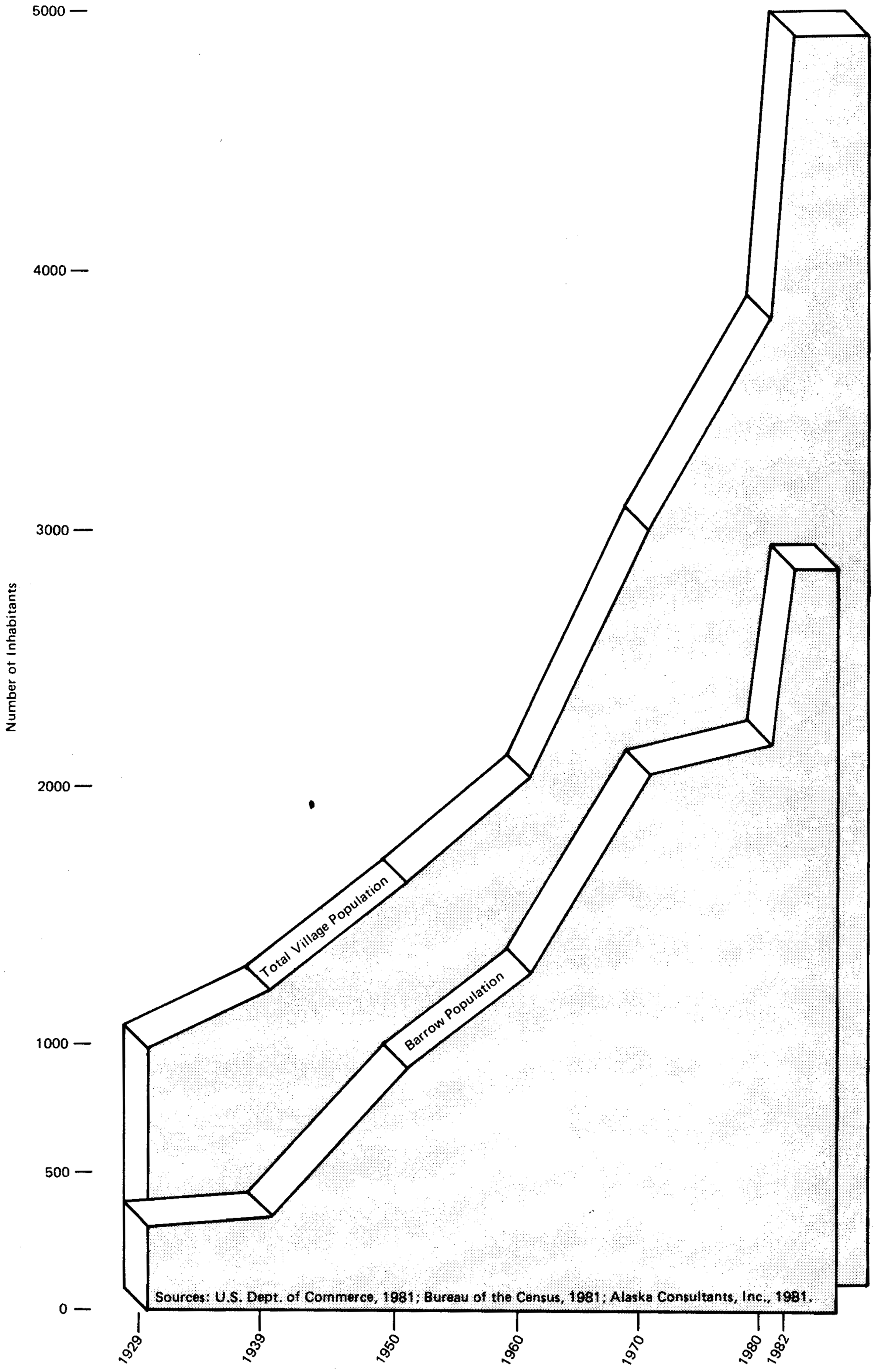


FIGURE III-12. NORTH SLOPE POPULATION TRENDS: 1929–1982 TOTAL VILLAGE POPULATION, BARROW of 1,101 people--a phenomenal 28.8 percent in 2 years, or a growth rate of 13.5 percent per annum. Wainwright's population increased the least--7.7 percent. The "new" villages of Atqasuk, Nuiqsut, and Point Lay grew most rapidly--96.3, 38.0, and 54.4 percent, respectively. Barrow's population increased rapidly as well. In 2 years, this regional center grew by 675 people, or 14.3 percent per annum. While Barrow's 1982 population reached 2,882, other North Slope villages remained relatively small, with an average of 292 inhabitants. The largest of these contained 11 percent of the total North Slope village population, the smallest only 3 percent. Barrow, on the other hand, represented 58.5 percent of the North Slope total.

The future of this 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). In 1939, Barrow's population comprised 56.7 percent of the North Slope total; by 1970, this figure climbed to 69.4 percent. Much of this drift from smaller to larger settlements was inspired by better economic prospects in the latter (see below).

Between 1929 and 1960, the population of the North Slope grew 2.3 percent annually. Barrow, reflecting its role as a regional center, grew at a 4.6-percent rate during these same years. Fueled by improving economic prospects and health care, the growth rate rose in the 1960's. In this decade, the North Slope added 945 people--3.8 percent per annum. Increasingly, economic prospects centered in Barrow; it grew 4.8 percent per year.

The early 1980's population boom is a unique event in the demographic history of the North Slope. It indicates indirectly the economic and social magnitude of the North Slope Borough's (NSB) Capital Improvements Program (CIP). During these years, CIP economic infusions created jobs, housing, and infrastructure in all the North Slope villages (see Sec. III.D.1, Sale 87 FEIS [USDOI, MMS, 1984a]). 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. The newer villages of Atqasuk, Nuiqsut, and Point Lay grew much faster than Anaktuvik Pass, Kaktovik, Point Hope, and Wainwright, with an annual average growth of 7.1 percent and 2.6 percent, respectively. 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 (Galgainitis, 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 in-migration of non-Natives. Between 1970 and 1980, this group grew from 9.5 to 22 percent of Barrow's total population. This group is made up primarily of whites but includes Blacks, Filipinos, Koreans, Mexicans, Yugoslavians, and others (Smythe and Worl, 1985).

Figures for the preceding decade also show the importance of the NSB-CIP program. By the early 1970's, the area's growth rate was slowing. The Alaska Native Claims Settlement Act (ANCSA) settlement in 1971 and NSB incorporation in 1972 opened the way to expanded revenues, as well as to resettlement of Atqasuk, Nuiqsut, and Point Lay. This resettlement, which was financed primarily by the NSB, initially masked the CIP program's role in promoting further centralization in Barrow. By creating construction jobs in the new settlements, other communities--most notably Barrow--lost inhabitants during the initial stages of elevated population growth. For the first time since 1939, Barrow actually lost ground in its share of the total North Slope population.

The effects of the CIP program on composition of North Slope villages can be seen from their non-Native populations. Between 1970 and 1980, the non-Native population grew by 150 percent. This population included teachers and technocrats, with or without their families, as well as skilled laborers required on local CIP projects. It also included other ethnic minorites who moved to Barrow and filled relatively low-paying unskilled and clerical jobs (Smythe and Worl, 1985). In particular, the number of laborers fluctuated rapidly along with construction demands. Nevertheless, in 1980, approximately 30 percent of all village inhabitants were non-Natives. The CIP job-related characteristic of this influx is evident in its distribution among age groups. Only peak working years are well-represented--children are relatively few, the aged almost nonexistent. Figure III-13 depicts non-Native village population by percentage of age group. The age-30 to -34 group represents over 40 percent of all village inhabitants of that group. Actually, the percentage of non-Natives in these active years is under-represented by this graph. Since no age information was given for 19 percent of non-Native inhabitants, they were excluded from this tabulation.

CIP expenditures were $93 million in 1980 and peaked at $302 million in 1983. They dropped to $211 million in 1984 and further to $199 million in 1985. CIP projects face further drastic reduction and may drop to 0 by 1990. This reduction is expected whether or not more OCS or onshore oil developments occur on the North Slope (see Sec. III.D.1). Because recent population growth has been tied to CIP-related opportunities, similar growth is not expected in the foreseeable future. Various population sectors should be differentially affected. Because non-Native residency is tied most directly to CIP projects, this group faces some reduction. This reduction may be heaviest among people in their 20's and 30's in settlements other than Barrow. It should involve people in construction roles more than those in managerial or technocratic roles.

Because Native residency is not as directly tied to CIP projects, it should be affected less directly and less quickly. In recent years, governmental functions have concentrated in Barrow, and its Native residents may be less affected by projected reductions 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.

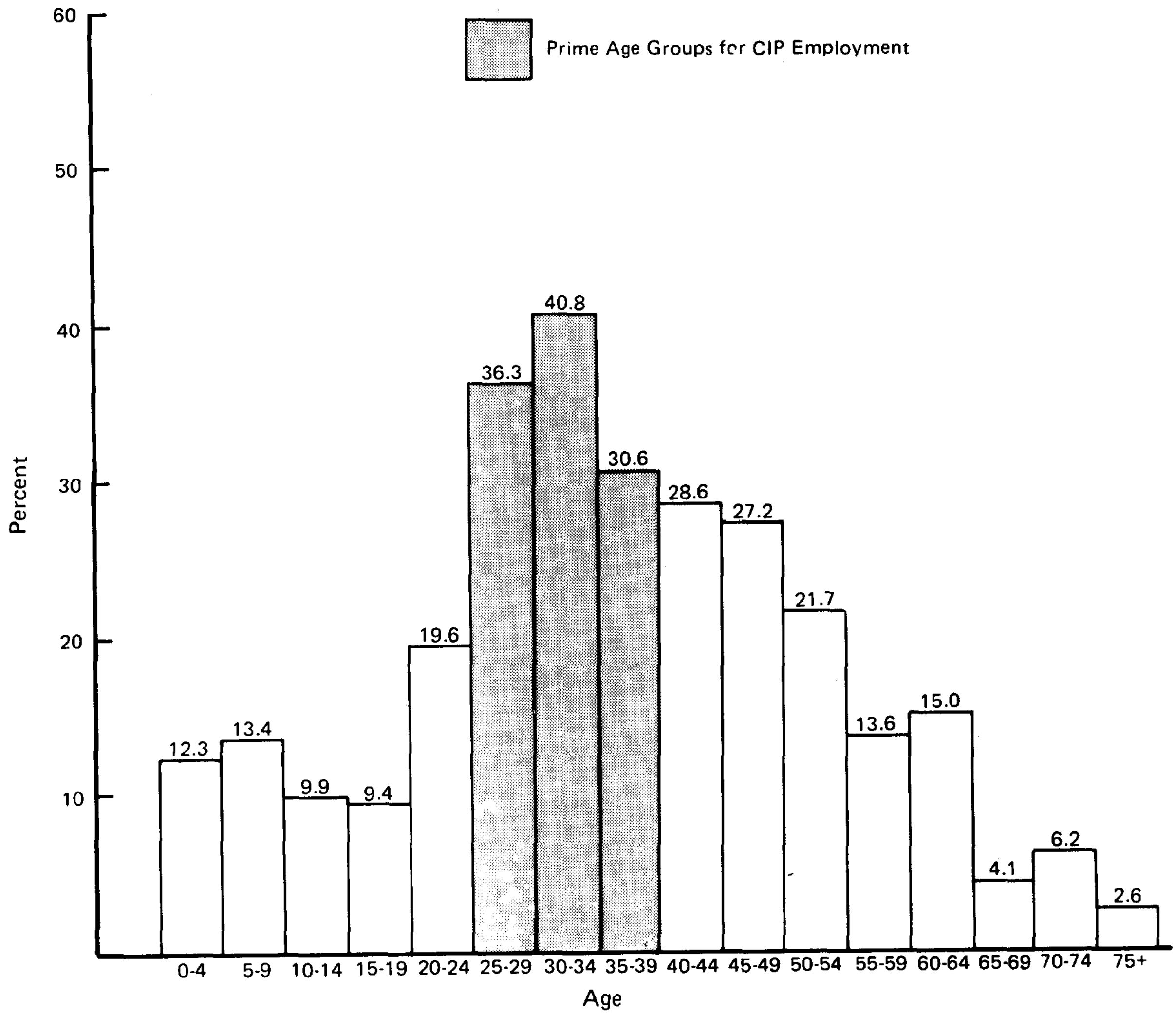


FIGURE III-13. TRADITIONAL VILLAGE POPULATION PERCENT NON–NATIVE BY AGE

Sources: U.S. Dept. of Commerce, 1981; Bureau of Census, 1981; Alaska Consultants, Inc. 1981.

Table III-C-3
Summary of Subjects Mentioned in Inupiat North Slope Public Testimony Since 1970[1/]
(in percent)

1.	Sea or Ice Hazards to Development	16
2.	Damage to Subsistence Species	37
3.	Disruption of Subsistence Migration	19
4.	Loss of Access to Subsistence	0
5.	Loss of Cultural Resource Landmarks	3
6.	Loss of Native Subsistence Foods	11
7.	Cultural and Value Changes	4
8.	Loss of Local Control	6
9.	Social Issue Impacts	2
10.	Other	2
Total		100

Source: Kruse, Baring-Gould, and Schneider, 1983.

1/ Total number of responses surveyed = 522.

2. North Slope Sociocultural Systems:

a. Introduction: North Slope society responded to early contacts with outsiders by successfully changing and adjusting to new demands and opportunities (Burch, 1975; NSB Contract Staff, 1979; Worl, 1978). Since the 1960's, the North Slope has witnessed a period of rapid change brought on by the area's oil developments (Lowenstein, 1981). In 1952, the anthropologist Robert Spencer was dependent upon interpreters for the collection of information during his fieldwork at Barrow. Today, few North Slope residents lack English skills, although elders still prefer to speak Inupiaq during public meetings. Communications have been improved; and all North Slope villages are now tied to the rest of the world via telephone, cable television, and regularly scheduled commercial airline flights. Most homes on the North Slope now have telephones.

Oil-related work camps alter the sea and landscape of Prudhoe Bay and Kuparuk, marking some areas as off-limits to subsistence hunting. Large NSB-CIP projects have dramatically changed the physical appearance of the traditional villages. Blocks of modern houses, new schools, water plants, power plants, and community buildings stand out. Snowmachines, three-wheelers, cars, and pickups are commonplace in many villages.

Recent declines in CIP employment and funding are expected to affect smaller communities prior to any major change in Barrow's economy. Recent research in Nuiqsut, for example, indicates that residents of this village are already feeling the effects of the decline in CIP funding. Some businesses that were operating in 1982-1983 are now closed, and inventories of higher priced items are said to be low (Galginaitis, 1985). Recent reports from Barrow indicate increasing poverty among some families (Worl and Smythe, 1986). Greater reliance on subsistence harvesting is said to be a common expectation in all North Slope villages.

In 1970 and 1977, residents of North Slope villages were asked about their state of well-being in a survey conducted by the Institute for Social and Economic Research (University of Alaska, ISER: see Kruse, Baring-Gould, and Schneider, 1983). Significant increases in complaints about alcohol and drug use were noted in all villages between 1970 and 1977.

Social services have increased dramatically during the 1970-1985 period, with increased NSB budgets and grants acquired by or through the Inupiat Corporation of the Arctic Slope (ICAS). 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.

b. Subsistence Values: See Table III-C-3 for a summary of subjects mentioned in Inupiat North Slope public testimony since 1970. In some respects, the breakdown shown in this table is misleading; many Inupiat social and cultural values can be traced to their relationship with subsistence activities. For example, as the testimony in Kruse, Baring-Gould, and Schneider, (1983) clearly shows:

Inupiat youth must learn, on a continuous basis, about their subsistence livelihood. This will not only allow them to preserve important aspects of

Inupiat culture and to survive in a subsistence-based economy after energy development declines, but will also allow for the continued respect of their elders.

° Direct damage to subsistence species violates Inupiat respect for nature (also see Galginaitis, 1984).

° Damage to subsistence pursuits will influence the ability of Inupiat to cooperate and share in traditional ways.

° Loss of Native foods will be detrimental because: (1) Inupiat prefer the taste of Native foods, (2) sharing Native foods provides reciprocity and support within and between generations, (3) Native foods are more nutritious and are needed for good health, and (4) Native foods are superior to Anglo-American (Anglo) foods and provide endurance against both cold and hunger.

° On a practical level, given their large family sizes and the high cost of store-bought foods, many Inupiat feel subsistence products to be essential for self-reliance and think that total dependence on Anglo food is unwise for many families.

° The ability to hunt, to share, and to consume Native foods is a reaffirmation of cultural identity and well-being.

° In summary, as Kruse, Baring-Gould, and Schneider (1983) note:

The loss of subsistence food, possibly more than any other single factor, threatens the concept of being Inupiat.

Thus, an Inupiat preoccupation with subsistence and a seeming paucity of Inupiat concern with cultural issues may actually represent an assumption that:

> ". . .a basic causal relationship does not need to be stated (i.e., between subsistence activities and cultural values, e.g., sharing). Instead of focusing upon culture, Inupiat place their attention on the focal point of impact: threats to the natural environment and subsistence species from which all Inupiat life emanates. . ." (Kruse, Baring-Gould, and Schneider, 1983).

c. The Important Inupiat Values and Behaviors:

(1) The Importance of Kinship and Sharing in Inupiat Culture:

(a) The Definition of Household, Family, and Domestic Function: Family and household relationships are complex in any society but present a special problem for the Inupiat, who are experiencing rapidly fluctuating economic circumstances.

Households are composed of individuals (or an individual) who occupy a structure (or structures) and share some form of domestic function; usually the use of a common cooking facility. The concept of domestic function is crucial and may include additional activities such as baby sitting, the sharing of income and food, and other reciprocal behaviors. In brief, the concept of household implies residence and domestic function, while the concept of family implies kin relation that may or may not be independent of residence and domestic function. It should be noted that the U.S. Census's definition of a family differs considerably from this by mixing the concepts of kin relationship and residence. Thus, a single individual living alone, or with nonrelatives, can never be part of a "family."

In the case of Inupiat household and family structure, creating useful definitions can be especially perplexing. Jorgensen, writing about a Yupik community in Norton Sound (with "household" structures very similar to those of the Inupiat), notes that:

> "An elderly person may have a house and choose to live alone; a young nuclear family may have a separate residence, and a third family, comprising mother, father, unmarried children, a divorced son or daughter, and a couple of grandchildren, may occupy a third house. Yet the three households may well be the core of a family, i.e., the set of people who most frequently interact in hunting and fishing activities, food preparation, baby sitting, meals and the like. . . .A family, then, is not a house or a household. It is an unbounded organization of bilateral kinspersons that expands at marriage" (Jorgensen, 1984).

A subsidary issue that will be developed in later subsections is that the social organization of Native Alaskan groups 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, in addition, are also embedded in those groups that are responsible for the extraction, distribution, and consumption of naturally occurring, renewable resources.

For the North Slope, a dwelling or structure may contain a single individual or group of individuals related by marriage or ancestry who regularly share a cooking facility. 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 make a round of households where they stay for limited periods on a regular basis. In addition, as Jorgensen delineates in his example above, structures or dwellings next door (or throughout the community) contain households that reciprocated various domestic functions, including the sharing of food preparation and meals. For this analysis, a household is defined as a dwelling or structure inhabited by an individual or individuals related by birth, marriage, or friendship who share some form of domestic function on a regular basis. We make this definition realizing that the persons of an Inupiat household are fluid; that relatives or friends may drop in and share meals and sleeping facilities for extended periods. Additionally, domestic function is not limited to one structure or dwelling; and meals, babysitting, and other reciprocal activities regularly take place with other relatives and friends at their residences.

(b) The Contrast Between Inupiat and Independent Nuclear Households: The interdependences that exist among Inupiat households differ markedly from those found in the U.S. as a whole. In the larger society, the demands of wage work emphasize a mobile and prompt work force. For example, the U.S.

Census indicates that on the average during a 4-year interval, 25 percent of all U.S. households have moved--moves usually related to employment opportunities or job transfers. And while modern transportation and communication technologies allow for continued 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 telephone, or in times of crisis through air transportation. They also know that their extended family might provide income for medical emergencies, help with bills during periods of unemployment, and so forth. However, a key contrast between non-Native and Inupiat cultures occurs in the differing expectations--Native people expect and need support from extended-family members on a day-to-day basis.

Associated with these differences, Native cultures of the North Slope 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.

Two important dimensions of these differing expectations need to be underlined: (1) As the recent huge increases in the service sector of the U.S. economy indicate, the stresses or changes encountered by independent nuclear households are usually coped with within the household by diverting part of the household's cash flow to purchase services. (2) The second dimension involves the important expectation that the U.S. economy will provide a steady and regular income for at least one adult member of a household and some reasonable opportunity for at least part-time employment for a spouse. It also needs to be pointed out that labor's expectation of a steady income is mirrored in management's view of a stable and dependable labor supply.

For a number of economic, historical, and cultural reasons, neither of these underlying dimensions of expectation--that households function as independent units and that sufficient wage opportunities exist to allow households to function as independent units--exist for Native communities on the North Slope.

(c) Inupiat Extended Households as Economic Units: Because a detailed case example of a sharing network is lacking in the North Slope literature and because of the vital importance of the topic, we begin by using a detailed description from the St. Lawrence Island communities of Gambell and Savoonga. Although these communities are composed of Yupik speakers, various Inupiat ethnographers (see Worl, 1979; Galginaitis, 1984; Jorgensen, 1984) attest to the underlying similarity in the nature and structure of sharing between the two cultural groups. And while some differences do exist between the two areas in the nature and amount of subsistence products shared and gifted, the major difference, to be described later, rests with the tremendous tax-based revenues that have entered and are now receding in the North Slope Borough's economy.

Robbins and Little (1984), in their work with Native Alaskan households on St. Lawrence Island, note that: "It is crucial to realize that each household is severely limited in its ability to marshal the human and natural resources, that are indispensable for existence, without the cooperation of other households."

In effect, what must be understood is that while we can appreciate the necessity of sharing between households in aboriginal times (i.e., the vagaries of subsistence resources making "independent" households seem short-sighted and foolish), the introduction of a sporadic and irregular wage economy still does not provide sufficient income for most households to act as independent units--even if they should wish to do so. As Robbins and Little note:

> "Very few households in Gambell and Savoonga are able to function and persist without substantial involvement with several other households in the subsistence rounds and cash economy. Manpower needs for subsistence pursuits, crafts production and the low cash income of most households provide strong motivation for numerous cooperative activities. These activities create mutual aid networks which draw households, families. . .and villages together" (Robbins and Little, 1984).

(d) The Consequences of Energy Development on Inupiat Sharing: A 1977 Institute of Social and Economic Research (Kruse, Kleinfeld, and Travis, 1981) study indicated that: "Only one aspect of community life that North Slope Eskimos recalled as having been among the best in 1970 remained among the best in 1977: villagers still helped each other and shared with each other in 1977."

The ISER report generalizes that:

> Overall village life, while still judged as good by most villagers in 1977; did decline somewhat between 1970 and 1977; likewise, while most Eskimos believed villagers helped each other and shared with each other in 1977, they also believed helping and sharing had been more prevalent among villagers in 1970.

NSB leaders and administrative officials were even more critical in their perspectives on the decrease in sharing. As Table III-C-4 indicates, proportionally, four times as many leaders (when compared to other Borough residents) were dissatisfied with the amount of sharing in their community in 1977. See also Table III-C-5.

All the North Slope coastal communities existent in 1970 show significant decreases in their perception of the amount of sharing between 1970 and 1977.

It is suggestive that a major increase in the amount of wage income from CIP projects began about 1976 (see Sec. IV.B.10, NSB Revenues and Expenditures); however, respondents' attitudes towards sharing cannot be directly linked to these changes in wage employment.

(e) Sharing Among Eskimo Households: Robbins and Little (1984) provide a detailed example of the persistence of sharing and of how widespread and important these interhousehold support networks are. The household used as an illustration consisted of a man, who is a wage-earner several months out of the year; his wife; and their three teenage children. The man's wage job

Table III-C-4
Perceptions of Sharing, NSB Residents and Leaders
1970-1977
(in percent)

	1970	1977
NSB Leaders:		
very satisfied	76	36
satisfied	20	40
not satisfied	4	24
Borough Residents:		
very satisfied	91	67
satisfied	9	27
not satisfied	0	6

Source: Adapted from McBeath, 1981.

Table III-C-5
Percentage of Adult Inupiat Who Rated
Sharing Behavior "Good": 1970 - 1977
(in percent)

	1970	1977
Barrow	88	65
Kaktovik	83	67
Wainwright	90	56

Source: Kruse, Kleinfeld, and Travis, 1981.

prevents him from engaging in extensive hunting and fishing, although he does hunt on weekends by himself, with his son, or with his brothers. He is able to participate in about half the walrus and whale hunts. His brothers and other male kin, who are without wage jobs, hunt at every opportunity. His wife, who is responsible for preparing food and distributing subsistence products, dispenses about 50 percent of the subsistence products that come into her possession. The proportion dispensed is about average for a good hunter's home, whereas the best hunters may distribute 70 percent of their take, and an unmarried excellent hunter may redistribute 90 percent of his annual harvest. Note that the average St. Lawrence household receives a majority of its diet from subsistence products. The first people to receive these subsistence products are the elders of the community, widows, people without hunters in their households, and the ill and the infirm. More often than not the recipients are relatives, but kin affiliation is not a necessary condition to receive subsistence products.

On St. Lawrence, the subsistence products distributed include edible products of the walrus, whale, seal, birds, bird eggs, fish, collected plants, and occasionally marine invertebrates. For the North Slope, caribou, whale, fish, and waterfowl probably have priority in amount and preference. In addition to these subsistence products, the example household also gave tea, bread, sugar, floor, stove oil, and clothes. And while the community is connected by overlapping networks of households that distribute subsistence goods, also shared are store-bought goods, labor, equipment, fuels, and money. In the network of 70 households that receive goods from this one example household, walrus meat (and blubber) and muktuk (the skin and underlying fat of a bowhead whale) were the only items that were given and received in all 70 households.

The wife, in the example household discussed above, ensured that six households received a steady supply of subsistence goods. These six households were headed by elderly women and a widower. More variable amounts of goods were gifted across a wide area including 29 households in Gambell; 23 in Savoonga; and smaller numbers of extended-family members who now live and work in Nome, California, Fairbanks, Oregon, and Sitka.

These gifting and reciprocal relations span lifetimes and are characteristic of small communities originally based on hunting and gathering economies. Gifting during one stage of one's life, usually during the most productive years from young to middle-aged adulthood, is complemented by receiving during other stages--childhood, adolescence, and old age. Note that many aspects of these reciprocal relations between households (e.g., babysitting, care for the elderly) are services now performed by institutions in our society (e.g., day-care centers and nursing homes).

(f) <u>Gifting Versus Reciprocity</u>: Of crucial importance is the realization that not all sharing is reciprocal. With many gifts, there is no implied expectation that a gift of the same value (or of lesser or greater value) will be reciprocated. And while the generous may receive status and esteem from the community, generosity is a value viewed by the culture as an attribute required of all human beings.

In Inupiat society, there is no shame in receiving without an implied or expected return. And while there are exceptions, e.g., elderly individuals who are gifted despite the presence of their able-bodied children who do not provide subsistence products for them, there generally is little resentment for giving without an implied return.

That sharing is a profound cultural value of great strength is reiterated in source after source in the Inupiat literature (Nelson, 1969, 1982; Chance, 1966; Burch, 1975; Spencer, 1959; Worl, 1979; Luton, 1984; Galginaitis, 1984). The complex relationship that obtains between cultural values, subsistence pursuits, and the risk that energy development brings to these activities is clearly illustrated in testimony of NSB community member Horace Ahsogeak:

> "And I cannot fulfill the role of an Inupiat hunter that I have been taught to do . . . that I must always share what I hunt with poor people who cannot hunt. Already the hunting is getting so difficult that it is hard for me to continue the sharing I want and need to do to be a true Inupiat hunter" (Kruse, Baring-Gould, and Schneider, 1983).

Worl also points out that from earliest childhood, youngsters are socialized to believe that sharing and generosity are values to be esteemed. For example, young hunters must distribute all of their first kill--whether it be whale, caribou, or seal--to relatives and friends. No portion of their first kill may be used for individual or "selfish" ends. In addition, and reminiscent of the preceding detailed discussion of sharing on St. Lawrence Island, children are taught to first remember the elderly and the needy (i.e., families without active hunters). Thus, any change in patterns of sharing and generosity not only affect an individual's sense of self-worth but also may interfere with the socialization, i.e., moral teaching, of Inupiat children.

(2) Native-Language Retention: Changes in data-collection procedures between the 1970 Census and the 1980 Census make it difficult to complete detailed comparisons on Native-language retention. In addition, immigration and other factors have distorted population distributions. The return of residents seeking newly available job opportunites may skew the process of language loss on the North Slope, since many of their children may have been brought up in English-speaking areas. Naturally, language retention among families that have previously migrated for job opportunites and the influence of Inupiaq-speaking parents on their children's language acquistion in urban areas is also an important concern; however, lacking reliable data on this topic, this discussion focuses on the census data as if language retention is limited to internal processes now going on within NSB communities. That is, what influences do schools, other institutions (such as social services), and energy development have on the speaking of Inupiaq in primarily Native communities?

The findings concerning North Slope Inupiaq language retention are incomplete. Results from two decennial surveys contained in Table III-C-6 seem to indicate that the North Slope has a high proportion of Native bilingual speakers; a majority of Native NSB residents speak both English and Inupiaq. Nevertheless, using only the census data, one can notice a significant increase from 1970 to 1980 (from 7% to 12%) in the proportion of Natives who speak English only. In addition, the 1980 census by age interval suggests a slight increase in Native-language loss in the 14-to-24 age group. Fourteen percent of the group now speaks English only, while only 12 percent of the total population (excluding 13-to-24-year-olds) are monolingually English. The contribution of

Table III-C-6
Inupiat-Language Retention NSB: 1970 - 1980

	1970[1/]	1980[2/]
Total Native Population	2,567	3,196
Speak English only	7%	13%
Speak Inupiat	93%	87%
Also speak English well	-	94%
Speak English poorly	-	6%
Native Persons 14 to 24 Years of Age	-	927
Speak English only	-	14%
Speak Inupiat	-	86%
Also speak English well	-	97%
Speak English poorly	-	3%

Native population excluding 14- to 24-year-olds who speak English only: 12%.

Source: USDOC, Bureau of the Census, 1971; U.S. Department of Labor, 1982.

1/ U.S. Department of Census General and Social and Economic Characteristics of Alaska, Table 119.

2/ U.S. Department of Labor Report 3: Social Indicators for Planning and Evaluation, 1980 Census, NSB - Alaska.

differential migration to these differences cannot be ascertained. In addition, the census does not provide a description of the critical under-5 age group; thus, Native-language loss might be much higher than one would expect, given the census enumeration.

For example, the decennial census accepts self-ratings of language fluency. It seems reasonable, and this is based on experience and research in other areas, that many individuals do not speak Inupiaq fluently but have enough facility to comprehend at least portions of conversations in which Inupiaq is spoken. Thus, many may, in fact, not be fluent but have a rough comprehension of the language.

More recent work by Michael Krauss (1980, 1982), who is an expert on Alaska Native languages, is more pessimistic about Native-language retention. Krauss's map, "Native People and Languages of Alaska," indicates that in the communities of Kaktovik, Barrow, Point Lay, and Point Hope, very few (if any) of the Native children speak Inupiaq. In the communities of Nuiqsut, Anaktuvuk Pass, Atkasuk (Atqasuk), and Wainwright, some of the children speak Inupiaq.

In a personal communication, Krauss indicated that his data come from personal conversations with key informants on the North Slope. Krauss believes that his estimates are conservative; that is, they probably underestimate the amount of language loss. He points out three major factors contributing to Native-language loss--schools (where most courses are taught in English), demographic pressures, and television. Historically, the parents and grandparents of today's younger Inupiat were removed from the local community and sent to distant high schools where they were punished for speaking their Native language. English was not taught as a second language but as a replacement. More recently (but this is not the present policy), parents were exhorted to speak English to their children because fluency in a Native language would only hold them back in school. Although recent research draws exactly the opposite conclusion, parents were made to feel that speaking English only was a key to their childrens' success in school.

In addition, for numerous demographic and economic reasons, children are now brought up in communities that contain a number of monolingual English speakers. These recent immigrants (including school teachers) do not speak Inupiaq, and, given the difficulties involved, probably do not expect to learn it. Finally, television, a compelling medium, is ubiquitous in its influence. Television sets are turned on most of the time and children, unless they talk with their grandparents, are not likely to hear Inupiaq spoken during the course of an average day.

Other recent research also supports Krauss's analysis. Personal communications from North Slope ethnographers (Galginaitis for Nuiqust [1985] and Luton for Wainwright [1985]) indicate that more young mothers speak to their young children exclusively in English--regardless of public or private context.

In summary, many Inupiat, especially those over the age of 40, speak both Inupiaq and English. However, rapid change has occurred during the last decade, and there are probably a generation of Inupiat in their 20's who have lttle facility with the language but who can comprehend some parts of Inupiaq conversations. Finally, very few of the younger generation, who hear English spoken in schools, in the community, and on television, have little experience with spoken Inupiaq.

(3) Community Governance and Administration: The Sale 87 FEIS (USDOI, MMS, 1984a), in Section III.C.2, considers the NSB's fiscal and institutional growth. In addition, Technical Report 117 (Smythe and Worl, 1985), Monitoring Methodology and North Slope Institutional Change 1979-1983, details the growth and responsibilities of local governments in Wainwright, Kaktovik, and Barrow. The area's governance is complex. Most North Slope villages were, in the 1960's, incorporated as cities under the Alaska State Charter. Before this incorporation, these villages often had city councils operating as Indian Reorganization Act (IRA) governments. In one case (Kaktovik), the city council and IRA government are still joined. Presently, few health and welfare functions are performed by village councils. However, they do provide an important central forum for discussion and are popular links to such NSB services as the Public Safety Office and energy-assistance programs. Village councils also receive and administer certain grants-in-aid.

The Arctic Slope Native Association (ASNA), formed in 1961, is the parent organization for the Inupiat Community of the Arctic Slope (ICAS), founded in 1971; the Arctic Slope Regional Corporation (ASRC), founded early in 1972; and the NSB, founded later in 1972. ASNA was also a Statewide leader in the struggle for Native land claims. ICAS is the only regional (IRA) government in existence. ASRC is the regional corporation formed under the Alaska Native Land Claims Settlement Act of 1971 (ANCSA). The NSB has grown steadily since its founding as a home-rule Borough government headquartered in Barrow.

Currently, the NSB provides most government services for all eight traditional villages. These services include such diverse functions as public safety, public utilities, fire protection, and some public-health services.

Under the terms of ANCSA, each village has formed a for-profit corporation. These corporations run stores, fuel yards, hotels, and construction camps. Many are heavily involved in NSB-CIP-funded construction projects. A group of these organizations operate Pingo Corporation as a subsidiary. ASRC, the regional corporation formed under ANCSA, is headquartered in Barrow and runs several subsidiaries, including Eskimos, Inc. and Tundra Tours. Most villages have IRA as well as city governments. The largest and most active of these is the ICAS, which serves as a regional IRA for the entire North Slope. ICAS is headquartered in Barrow and has administered several areawide social service programs. However, recent problems have led to the curtailment of their service delivery, and many of their former programs are now administered by the Bureau of Indian Affairs (BIA).

An earlier subsection noted the almost universal Inupiat opposition to offshore OCS development. However, with regards to onshore development, a recent monitoring study by Galginaitis (that is, a followup investigation of original research) for the community of Nuiqsut concluded that: "One of the largest attitudinal changes to have taken place in Nuiqsut is this realization that oil development must be accommodated rather than fought tooth and nail" (Galginaitis, 1985).

d. Other Factors Affecting Inupiat Sociocultural Systems:

(1) Household Income: A major current concern in North Slope Inupiat communities has been the NSB's Capital Improvement Program (CIP--see Sec. IV.B.10, NSB Revenues and Expenditures). CIP programs, which build schools, houses, roads, and other infrastructures, have been the major employer (see Sec. IV.B.10, Employment) on the North Slope for the last several years and the major factor in the huge jump in Native-household income. The median yearly Native family income on the Arctic slope jumped from $6,923 in 1970 to $32,515 in 1980 (Smythe and Worl, 1985). Non-Native, Arctic-slope, median family income jumped from $8,882 to $44,130 for the same period (USDOC, Bureau of the Census, 1980).

Wainwright is similar to Nuiqsut in its dependence on CIP employment. In contrast, Barrow has a more diversified economy that includes a number of administrative and service jobs. As Luton (1985) notes: "In 1982, most employment in Wainwright occurred in the public sector. A high percentage of this employment was in North Slope Borough-funded CIP construction projects."

With regard to the crucial public-sector nature of North Slope employment, Luton estimates that: ". . .in the summer of 1982, about 120 of 140 jobs found in Wainwright were Borough related or Borough created. This is 80 percent of all jobs. However, most of this was indirect employment, jobs created by the Borough's CIP program but actually contracted out to other employers."

In addition, Luton (1985) notes that the CIP program has: ". . .created high levels of cash employment and household income that were substantially different from the rates of the recent past. It also created a situation on the North Slope that was significantly different from that found in Native Coastal villages in other regions of Alaska."

(2) Recent Changes in the Quality of Life: Cost-of-Living: The Alaska Geographic Differential Study (AGDS, 1985) provides an objective measure of geographic differences in the cost of living. It should be noted that this approach is significantly different from the well-known Consumer Price Index (CPI), which is an inflation index. As AGDS points out: "The CPI measures inflation over time at each individual location and it is calculated for only one Alaska location--Anchorage--on a bi-monthly basis." AGDS concludes: "Therefore the CPI can tell us that it is more expensive to live in Anchorage today than it was last year but it cannot tell us whether it is more or less expensive to live in Anchorage than in Fairbanks, Juneau, Seattle or Barrow."

Some insight into inflationary pressure for the NSB can be inferred by comparing the current geographic differential study (which does compare the major communities in Alaska with Anchorage) against earlier differential studies, including the Alaskan Division of Personnel household surveys of 1972 and 1976. Note that these comparisons are still valid despite differences in methodology between the three surveys. Using Anchorage as a constant baseline of 1 (regardless of year), changes in the proportion of difference between 1976 and 1985 may be indicative of location-specific inflation that is independent of the absolute dollar amounts involved. For example, the AGDS study notes that there were five districts that show a higher cost of living in the present study (1985) relative to the existing differential adjustments (based on calculations from a 1976 study--see Table III-C-7).

The AGDS (1985) shows that the Barrow/Kotzebue district not only has the highest cost of living differential (at 1.45 with Anchorage being 1.0) but also has the highest proportional increase (13% versus 11% for Bethel) in the differential since 1976. In other words, goods are not only 45-percent higher in Barrow when compared to Anchorage, but their cost has grown at a faster rate than in any other district in Alaska.

It is difficult to ascertain what causes these price differences; certainly transportation adds a significant amount. Lack of competition in some sectors, e.g., fuel oil (see Jorgensen, 1984), adds to the cost of goods. Lack of infrastructural facilities, such as storage, influence management decisions in the provisioning of stores, which also adds to costs (i.e., goods are flown in to meet demand rather than being shipped more cheaply by barge). Other infrastructural deficits such as a lack of housing structures also push prices higher. Fueling all these inflationary pressures is an enormous influx of wage income from CIP employment; many more dollars are chasing a lagged increase in goods and services.

(3) Private-Sector Opportunities for Native Entrepreneurs: With the exception of Galginaitis's work on Nuiqsut (1984, 1985) and Luton's work on Wainwright (1984), little more than anecdotal information exists on private-sector small enterprises on the North Slope. In Barrow, for example, Symthe and Worl (1985) note: "In the late 1970's, Inupiat-owned businesses were limited to small family stores in their homes, a bakery and a taxi company . . . Today in Barrow alone there are nearly 100 businesses, many of which are owned by Inupiat."

Unfortunately, details on the Barrow Inupiat businesses--their economic sector, their volume sales, overhead, profit margins, employment and so forth--are lacking. In addition, some businesses are on the licensing rolls but are no longer in operation, not so much because they have failed (although some have) but because entrepreneurs have left them moribund as they go on to more profitable enterprises. Galginaitis (1984) also found that in Nuiqsut a number of business licenses were taken out in anticipation of future demand, but the businesses themselves never materialized (e.g., two non-Inupiat took out licenses for private security firms but, apparently because of lack of demand, neither followed through).

Some indication of the effect that decreased CIP spending has upon employment (and thus consumer spending) can be ascertained from Galginaitis (1984) and the restudy he completed on his initial Nuiqsut fieldwork (1985). There has been a downturn in the commercial sphere of Nuiqsut's economy, to judge by the fate of the commercial establishments that were in existence in 1982-1983. Three of the five stores have closed (only one because the proprietor left Nuiqsut). One of the others was open only sporadically at that time and maintains that pattern. Only the Kuukpik store (the village corporation store) maintains continuity with the past, and it is apparent that its inventory is not at its 1982-1983 level (Galginaitis, 1984). Overall,

Table III-C-7
Increase in the Consumer Price Differential
1976 - 1985

	1976	1985	Increase in Differences
Ketchikan/Prince of Wales	1.00	1.02	2%
Juneau	1.00	1.03	3%
Bristol Bay	1.25	1.29	4%
Bethel	1.28	1.39	11%
Barrow/Kotzebue	1.32	1.45	13%

Source: Alaska Geographic Differential Study (AGDS), 1985.

Galginaitis (1985) observes that "purchases have tended to decline over the last six months, particularly the higher-cost items, as the economy has begun to slow down."

(4) Health and Social Services: Deaths associated with old age--including cancer, heart disease, and respiratory illnesses--are responsible for about one-half of the deaths reported for the North Slope in 1983. However, a high percentage of the remaining mortality is from accidents, suicides, and homicides. That is, violent deaths account for more than one-third of all deaths on the North Slope.

Table III-C-8 shows the variety of services available in Barrow. Many of these facilities and programs were not available prior to the late 1970's. Some, like the Arctic Women-in-Crisis Program, were started in the 1980's.

Barrow has a variety of health-care and social-service programs that are not available in other NSB villages. However, improvements have occurred in all villages, particularly in the area of health services. Nuiqsut, for example, has a health clinic for all but the most serious health conditions.

Community concern for the welfare of the Inupiat people can be found in non-social-service programs as well. The Barrow Mother's Club, for example, contributed over $127,000 one year to a variety of individuals and groups including the Alaska Native Women-Barrow Chapter, Youth Alternatives program, American Cancer Society, Women-in-Crisis, and other programs for families and children.

(5) Social Pathologies: There has been a long-term concern on the North Slope for the high rate of alcohol-related illnesses and crimes. This problem has caused controversy within NSB communities as research results and different treatment philosophies clash with public opinion (Klausner and Foucks, 1982). However, Kruse's 1977 North Slope survey showed heightened concern among Inupiat for the increased alcohol and drug use in Barrow and the larger villages of the North Slope (Kruse, Baring-Gould, and Schneider, 1983).

Tables III-C-9 and III-C-10 display NSB crime statistics from 1977 to 1984, the latest year for which data are available. These tables show increases in total felony crimes reported to North Slope Public Safety Officers. On an annual basis, felony crimes increased from less than 150 during 1977 and 1978 to between 550 to 650 in 1980-1981, then jumped to over 800 for the years 1982 and 1983. The year 1984 saw a slight decrease to a level below 700. Cases of rape and criminal homicide have more than doubled since 1977. Assaults, larcenies, and motor-vehicle thefts have increased as much as tenfold. Some of these increases since 1980, especially for rapes and assaults, may reflect definitional changes caused by the enactment of the 1980 Alaska Sexual Assault statutes.

Increased staffing capacity also may have added to the increased arrests. During the last 5 years, 14 officers have patrolled the Barrow area and another 16 officers have been assigned to the villages and Prudhoe Bay. Staffing patterns were much lower before 1980. Added incomes have encouraged both alcohol and drug abuse and purchases of cars, trucks, three wheelers, and snowmachines. According to the NSB Deputy Chief Marshall, "joy riding" has

Table III-C-8
Services Provided, by Facility, for
Health and Social Services Programs: Barrow

BARROW PUBLIC HEALTH SERVICE HOSPITAL[1/]

Outpatient Clinic	Hospital
Ambulatory Care	Inpatient Care
Emergency Care	Primary Acute Care
Lab and X-Ray	Emergency
Pharmacy	Internal Medicine
Specialty Clinics	Pediatrics
Pediatrics	Minor Surgery
Medicine	Orthopedics
Gynecology	Gynecology
Orthopedics	Obstetrics, Normal
Surgery	Lab and X-Ray
Ear-Nose-Throat	Social Services
Radiology	Mental Health
Opthalmology	Pharmacy
	Labor/Delivery Health

NSB GREIST CENTER

Eye Care
Dental Care
Mental Health
Environmental Health
Alcohol and Drug Abuse
WIC (Women/Infants/
Children
Public Assistance
Youth Services
Social Service
Public Health Nurse

MATSUTANI BUILDING

Education/Media
Arctic Women-in-Crisis
Elective Surgery
Children's Receiving Home
Community Health Aide
Community Health
Representatives
Infant Learning
Senior Citizens
Emergency Medical Services

Source: Symthe and Worl, 1985; data provided by NSB Health and Social Services Agency.

1/ Services not available: Emergency, Diagnostic, or Therapeutic Procedures.

Table III-C-9
NSB Offenses Known to the Police by Year
1977-1984

Offense	Year							
	1977	1978	1979	1980	1981	1982	1983	1984
Criminal Homicide	2	-	-	4	-	4	4	4
Rape	12	2	18	18	34	37	41	39
Robbery	3	-	-	-	2	5	6	6
Assault	15	33	130	125	264	301	192	168
Burglery	63	24	79	127	99	103	111	91
Larceny	22	22	129	146	202	176	218	208
Motor-Vehicle Theft	22	64	187	227	216	218	276	173
TOTAL	139	145	543	647	817	844	848	689

Source: Edscorn, 1985, personal communication.

Table III-C-10
Barrow, Alaska, Requests for Public Safety Assistance
1978-1985

1978	4,985	1982	4,849
1979	5,338	1983	5,026
1980	6,897	1984	7,080
1981	7,011	1985	6,000 1/

Source: Edscorn, 1985, personal communication.

1/ Approximate figure.

become an increased police problem, especially in summer, and is often accompanied by excessive drinking (NSB Deputy Chief Marshall, 1985, personal communication).

Increased access to and use of cocaine and other drugs has probably encouraged the increase in robberies and larcenies during the 1977-1984 period. However, public-safety officials report that alcohol is related to 90 percent of all crimes committed on the North Slope.

Requests for service in Barrow to public-safety officers show higher totals for the years 1978 to 1984. Public-safety personnel expect lower requests for 1985. In contrast, 650-1,000 requests for service are normally accepted by public-safety officers in all other North Slope communities, including Prudhoe Bay (see Table III-C-10).

3. Subsistence-Harvest Patterns: This section describes the subsistence-harvest patterns of the Inupiat (Eskimo) communities closest to the Sale 97 area--Wainwright, 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.

The residents of North Slope communities that might be affected by Sale 97 participate in a subsistence way of life. Alaska statutes define "subsistence uses" as those customary and traditional uses in Alaska of fish, wildlife, and vegetation for direct personal, family, and community needs (AS Sec. 16.05.940). Residents of the North Slope often refer to hunting as their "lifestyle," and this assertion is echoed by social scientists familiar with the area. For example, a typical assessment states, "Subsistence activities are unquestionably assigned the highest cultural value by North Slope Inupiat." They remain "a focus for maintaining a sense of identity" as well as an important economic activity (Nelson, 1969:35). Subsistence activities also provide a major source of food and other products in communities characterized by low and unstable household incomes. During the late 1970's and early 1980's, the North Slope Borough Capital Improvements Program (NSB CIP) temporarily increased household incomes by creating numerous local construction jobs. However, during the period that the sale activities might take place, the economic and dietary importance of subsistence may increase as the number of jobs related to the NSB CIP continues to decline (see Secs. III.C.2 and IV.B.8).

The possible effect of offshore oil development on subsistence is a major scoping concern. This concern combines past experiences of onshore oil development and industrial accidents with secondary information on the subject, usually gleaned from the media; and it appears within a framework of a long history of use and knowledge of the Arctic environment, of the wildlife species that inhabit this environment, and of its ocean and ice conditions. The local Inupiat view biological effects on wildlife species and habitats as, inevitably, causing subsistence effects as well. Analysis of public hearing testimony (Kruse et al., 1983) indicates that Inupiat concerns may be divided into five categories: (1) direct damage to subsistence resources and habitat, (2) migratory disruptions of subsistence species, (3) disruption of access to subsistence areas, (4) harm to cultural-resource landmarks, and (5) loss of Native food.

Subsistence is a system of production and consumption, a fact that complicates the analysis of subsistence effects. For example, a species might be temporarily eliminated from a village's subsistence spectrum. If that loss could not be offset by increased harvests of other resources, subsistence consumption would decline. However, effects on consumption could be serious even if the net quantity of available food did not decline. For example, some species are important for the role they have in the yearly cycle of subsistence-resource harvests. Waterfowl arrive in early spring before other species become available and at a time when stored subsistence foods are low. During this time, birds may provide the most important source of meat. In the winter, if--as is often the case--caribou are scarce, ringed seal may provide a more reliable source of fresh meat. In addition, some harvestable subsistence species fill specialized nutritional roles in the diet or are especially preferred and sought after. For example, throughout the study area, seal oil is invariably served with frozen fish or meat (kwak). Especially preferred foods include, among others, waterfowl, bowhead and beluga maktak, polar bear, and smelt. Thus, important subsistence-consumption patterns may be significantly affected without comparable effects on total consumption.

Harvestable subsistence resources also provide such materials for personal and family use as furs and skins for clothing, bone for tools, and bearded seal hides for boats. The sharing of harvestable subsistence resources helps maintain traditional family organization (Heinrich, 1960; Burch, 1975; Worl and Smythe, 1986); for example, a boy's semiritualistic gift of his first harvest to an elder reinforces ties between generations (Luton, 1985). Subsistence provides special foods for religious and social occasions. For example, the taking of a bowhead whale gives rise to the nalukataq, a traditional North Slope religious ceremony sponsored by successful whaling captains. Throughout the area, households serve waterfowl for special social occasions such as Thanksgiving and Fourth of July feasts. The sharing, trading, and bartering of harvestable subsistence resources structures relations among communities within the study area, while the giving of such foods helps maintain ties with family members elsewhere in Alaska (Worl, Worl, and Lonner, 1980; ACI-Braund, 1983). In these traditional sharing and exchange networks, preferred and special foods play an especially important role (Luton, 1985).

Finally, subsistence provides a link to the market economy. Households within the region earn income from crafting ivory, baleen, and furs and from the sale of furs. This link may be expected to increase in importance on the North Slope in future years as the availability of wage earnings declines.

These are examples of possible effects on consumption; the productive side of the subsistence system may also be affected. For example, the temporary elimination of a species from a community's subsistence spectrum may impair the overall productivity of hunting without substantially affecting the diet. Many important species, such as bearded seal and polar bear, are normally taken as "targets of opportunity" by hunters in pursuit of other game (Nelson, 1969, 1982; Luton, 1985). If such opportunities were significantly curtailed, overall harvest efficiency might decline. People might have to work harder, hunt longer, travel farther, or spend more money for an equivalent harvest.

a. General Considerations: While subsistence is integrated into all parts of community life, this section and Section IV.B.9 examine its more economic aspects. Unlike western industrial systems, subsistence systems are built directly on naturally occurring renewable resources. On the North Slope, the use of vegetation is limited, while the use of faunal resources, such as marine and terrestrial mammals and fish, is heavily emphasized (Nelson, 1969). The available spectrum of resources is limited when compared to more southerly regions; and it varies, somewhat, from community to community. Generally, on the North Slope, more species are available to coastal than to inland communities; more are available to southern- and western-lying communities than to those that lie to the north and east.

Table III-C-11 presents a list of resources used by community. Point Hope, the southernmost coastal settlement, uses 17, while the inland villages of Atqasuk and Anaktuvuk Pass use only 9 each (Pedersen, 1979:10-15). The availability and usefulness of species, the importance of specific subsistence areas, and the timing of subsistence activities are all qualities of the subsistence system that are determined, in large measure, by ecological and biological factors. In Table III-C-11, caribou, bowhead whale, and fish are listed first to emphasize their predominant role in the area's present-day subsistence economy. In a recent study (ACI-Braund, 1984), households in Point Hope, Wainwright, Barrow, Nuiqsut, and Kaktovik were asked which resource they harvested most often, which provided their largest source of meat, which they consumed most often, and which was their favorite. Table III-C-12 summarizes the results. While responses differed from village to village, taken together, caribou, bowhead whale, and fish accounted for between 71.9 and 97.2 percent of all answers. These percentages are lowest for Point Hope, which uses the greatest variety of biotic resources (ACI-Braund, 1984).

In recent years, data on North Slope subsistence uses, in terms of pounds harvested and/or consumed, have been difficult to obtain. While studies of this type have been made (such as in ACI-Braund, 1984), most of the information is several years old and the accuracy of some studies is questionable (see, however, Pedersen and Coffing, 1985). The available data do, however, provide some idea of subsistence levels and dependency. In a 1983 survey done for the U.S. Department of the Interior (ACI-Braund, 1984, Table 91), two-thirds of the respondents living in the villages in the Beaufort Sea region (Barrow, Nuiqsut, and Kaktovik) stated they got most of their meat from hunting and fishing; 23 percent got all. For the Chukchi Sea region, which includes Wainwright, over three-fourths of the respondents got most or all of their meat from hunting and fishing. The survey also asked other questions that help to measure relative subsistence levels and dependency by species: effort spent hunting, quantity hunted, quantity eaten, and favorite meat from hunting and fishing. While no one of these indicators by itself would be an accurate idea of subsistence dependence and importance by species, taken together they do form a measure of relative subsistence dependence (Table III-C-12).

Caribou is the most important resource in terms of effort spent hunting, quantity of meat hunted, and quantity eaten (effort spent hunting is measured by frequency of hunting trips rather than total pounds consumed). Bowhead whale, however, is the favorite meat of the majority of respondents (although caribou

Table III-C-11
Biotic Resources Used by North Slope Communities[1/]

Resource	Anak- tuvuk Pass IN[2/]	Atqa- suk IN	Nuiq- sut IN/C	Kakto- vik IN/C	Barrow C/IN	Wain- wright C/IN	Point Lay C/IN	Point Hope C/IN
Bowhead			X	X	X	X	3/	X
Caribou	X	X	X	X	X	X	X	X
Fish	X	X	X	X	X	X	X	X
Beluga			X	X	X	X	3/	X
Seal			X	X	X	X	X	X
Ugruk			X	X	X	X	X	X
Walrus					X	X	X	X
Polar bear			X	X	X	X	X	X
Moose	X	X	X	X	X	X	X	X
Sheep	X			X				
Small mammal	X	X	X	X	X	X	X	X
Invertebrate								X
Duck	X	X	X	X	X	X	X	X
Goose[4/]	X	X	X	X	X	X	X	X
Murre								X
Owl		X						
Ptarmigan	X	X	X	X	X	X	X	X
Bird eggs	X	X	X	X	X	X	X	X
TOTAL	9	9	13	14	14	14	13	17

Sources: NSB Contract Staff, 1979:10-14; ACI-Braund, 1983; Tables 96, 97, 98, and 108.

1/ The resources are derived from NSB Contract Staff, 1979:14. For the purposes of this table, "primary" and "secondary" resources (NSB Contract Staff's "1" and "2") are joined and designated with an "X." The "rarely utilized/occurring" and "not available" categories (NSB Contract Staff's "0" and "NA") have been dropped. Following ACI-Braund, 1983 (Tables 96, 97, 98, and 108), bowhead whales, caribou, and fishes are listed first to designate their importance.

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

3/ 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 villages except Point Lay, where they are not available. The beluga whale is very important at Point Lay, however, and plays an equivalent role to the bowhead in the Point Lay economy.

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

Table III-C-12
Indicators of Subsistence Levels and Dependency, by Species

Species Most Often Hunted or Fished, by Community

Species	Beaufort Sea Region: Barrow	Nuiqsut	Kaktovik	Total	Chukchi Sea: Wainwright
Caribou	33.8	76.7	50.0	47.2	62.2
Walrus	5.6	0.0	0.0	3.2	2.7
Bowhead Whale	26.8	0.0	15.4	18.1	21.6
Fish	24.0	16.7	19.2	21.3	10.8
Seal	1.4	0.0	0.0	0.8	0.0
Bearded Seal	4.2	0.0	0.0	2.3	2.7
Game Birds	1.4	3.3	7.7	3.2	0.0
Other	2.8	3.3	7.7	3.9	0.0
Total	100.0	100.0	100.0	100.0	100.0
(Number of respondents)	(71)	(30)	(26)	(127)	(37)

Largest Source of Meat Harvested from Hunting or Fishing, by Community

Species	Beaufort Sea Region: Barrow	Nuiqsut	Kaktovik	Total	Chukchi Sea: Wainwright
Caribou	64.2	75.9	30.8	59.8	55.2
Walrus	4.5	0.0	0.0	2.5	0.0
Bowhead Whale	10.4	0.0	34.6	13.1	20.7
Fish	14.9	20.7	23.1	18.0	10.3
Seal	0.0	0.0	0.0	0.0	0.0
Bearded Seal	1.5	3.4	0.0	1.7	6.9
Game Birds	3.0	0.0	11.5	4.1	6.9
Other	1.5	0.0	0.0	0.8	0.0
Total	100.0	100.0	100.0	100.0	100.0
(Number of respondents)	(67)	(29)	(26)	(122)	(29)

Table III-C-12
Indicators of Subsistence Levels and Dependency, by Species
(Continued)

Meat Most Often Eaten from Hunting and Fishing During the Year, by Community

	Beaufort Sea Region				Chukchi Sea
Meat	Barrow	Nuiqsut	Kaktovik	Total	Wainwright
Caribou	71.4	93.4	44.0	71.2	79.4
Walrus	0.0	0.0	0.0	0.0	0.0
Bowhead Whale	8.6	0.0	40.0	12.8	17.6
Fish	0.0	0.0	8.0	11.2	0.0
Seal	0.0	0.0	0.0	0.0	0.0
Bearded Seal	1.4	0.0	0.0	0.8	3.0
Game Birds	17.2	3.3	4.0	1.6	0.0
Other	1.4	3.3	4.0	2.4	0.0
Total	100.0	100.0	100.0	100.0	100.0
(Number of respondents)	(70)	(30)	(25)	(125)	(34)

Favorite Meat from Hunting and Fishing, by Community

	Beaufort Sea Region				Chukchi Sea
Meat	Barrow	Nuiqsut	Kaktovik	Total	Wainwright
Caribou	17.8	50.0	46.2	30.7	30.5
Walrus	1.4	0.0	0.0	0.8	0.0
Bowhead Whale	72.6	32.1	38.5	56.7	66.7
Fish	5.5	10.7	0.0	5.5	0.0
Seal	0.0	0.0	0.0	0.0	0.0
Bearded Seal	2.7	0.0	0.0	1.6	0.0
Game Birds	0.0	0.0	0.0	0.0	0.0
Sheep	0.0	0.0	11.5	2.3	0.0
Like Them All	0.0	3.6	3.8	1.6	0.0
Other	0.0	3.6	0.0	0.8	2.8
Total	100.0	100.0	100.0	100.0	100.0
(Number of respondents)	(73)	(28)	(26)	(127)	(36)

Source: ACI-Braund, 1983, Tables 94, 96, 98, and 108.

Table III-C-13
Annual Subsistence-Resource Harvests[a]
Averaged for the Period 1962-1982

Source	Wainwright	Barrow	Nuiqsut	Kaktovik
Bowhead Whales	1.50 13,350 8.2%	10.10 89,890 21.3%	0.30 2,670 8.6%	1.00 8,900 27.5%
Caribou	1,200.00 84,000 51.6%	3,500.00 245,000 58.2%	400.00 28,000 90.2%	75.00 5,250 16.2%
Walrus	86.00 30,205 18.5%	55.00 19,260 4.6%	b/ b/ b/	±3.00 1,050 3.2%
Bearded Seals	250.00 20,000 12.3%	150.00 12,000 2.9%	b/ b/ b/	30.00 2,400 7.4%
Hair Seals	375.00 7,125 4.4%	955.00 18,145 4.3%	b/ b/ b/	70.00 1,330 4.1%
Beluga Whales	11.00 4,400 2.7%	5.00 2,000 0.5%	b/ b/ b/	5.00 2,000 6.2%
Polar Bears	7.00 1,575 1.0%	7.00 1,575 0.4%	1.00 225 0.1%	4.00 900 2.8%
Moose	2.00 450 0.3%	5.00 1,125 0.3%	b/ b/ b/	5.00 1,125 3.5%
Dall Sheep	0.00 0 0.0%	0.00 0 0.0%	b/ b/ b/	27.00 1,227 3.8%
Small Game	b/ b/ b/	c/ 455 0.1%	b/ b/ b/	c/ 136 0.4%
Birds	c/ 545 0.3%	c/ 3,636 0.9%	b/ b/ b/	c/ 1,045 3.2%
Fishes	c/ 1,273 0.8%	c/ 27,955 6.6%	b/ b/ b/	c/ 7,045 21.7%
Vegetation	b/ b/ b/	b/ b/ b/	b/ b/ b/	b/ b/ b/
Total Harvest (kilograms)	162,923	421,031	b/	32,408
Per Capita	439	245	b/	219

Source: Stoker, 1983, as cited in ACI-Braund, 1983.

a/ For each resource listed under the "Source" column, results are expressed as follows:
line 1: number of animals landed
line 2: utilizable weight (kg)
line 3: contribution to total village harvest (%)
Note that these results are averaged for the years 1962-1982.
Because of missing data and underestimates of some harvests, the actual per capita harvests may be somewhat higher.

b/ No data.

c/ Data expressed only as utilizable weight (kg) rather than number of animals landed.

is the favorite in Nuiqsut and Kaktovik). Bowhead whale is also the subsistence resource most important as the basis of sharing and community cooperation, which are the foundations of the sociocultural system (see Sec. III.C.2). The 1983 Department of the Interior survey by ACI-Braund also shows the relative importance of fish in the subsistence economy. For all the indicators of subsistence levels and dependency, fish usually ranks second or third after caribou and bowhead whale (Table III-C-11). Bearded seal and game birds are also considered primary subsistence species. Waterfowl are particularly important in the springtime, for they provide variety to the subsistence diet. Seal oil, from ringed and harbor seals as well as bearded seals, is an important staple and necessary complement to other subsistence foods.

The subsistence pursuit of bowhead whales occurs at Point Hope, Wainwright, and Barrow in the study area as well as in Nuiqsut and Kaktovik. Whaling is the single most valued activity in the North Slope subsistence economy today. This is true despite International Whaling Commission quotas, supplies of other subsistence foods, and despite relatively well-stocked community stores. Whaling traditions include kinship-based crews; shoreline preparation for a distribution of the hunt; total community participation and sharing; and, often, the use of skin boats. In spite of rising cash income, these traditions remain as central values and activities for all the Inupiat in these villages (ACI-Braund, 1984). North Slope residents also share whale meat with Inupiats in Fairbanks, Anchorage, Juneau, and other communities. Respondents to this survey of whaling captains, crews, and other village residents mentioned 11 separate occasions during a given year when bowhead whale is regularly shared: Thanksgiving, Christmas, various whaling feasts, birthdays, carnivals, and other holidays. All these occasions strengthen family and village ties and the sense of a common Inupiat heritage, culture, and way of life.

Stoker (1983 as cited in ACI-Braund, 1984) has summarized the best available subsistence-harvest data for Wainwright, Barrow, Nuiqsut, and Kaktovik. (More recent figures for Kaktovik appear in a discussion of that community's subsistence-harvest patterns below.) Bowhead harvests are well known. However, Stoker writes, "In most cases, harvest figures should be regarded as estimates only." While, in the case of walrus, this limitation "is not a major problem," harvest figures for the various seals "are underestimated perhaps to a significant degree." Harvest estimates for other resources "are even less well defined. . . ." Stoker concludes:

> "It is felt, nevertheless, that the figures presented are within reason and that in no case are they apt to be in error by such magnitude as to significantly alter the relative results in terms of percentages. It must also be stressed that these figures represent average values only, and cannot be used for predictive purposes. Harvest returns for any given species are extremely variable from year to year depending on ice and weather conditions, migration patterns and, in some cases, population fluctuations."

Because of the limitations of the available data and because of widely fluctuating yearly harvests, Stoker presents his material in terms of a 20-year average (see Table III-C-13).

Using this data, Stoker has estimated the relative contribution to the Native diet of various harvestable subsistence species for the 20 years between 1962 and 1982. (See Table III-C-14, which is based on the amount of usable meat and fat contributed to the diet rather than on the number of animals harvested. For example, 24.3 walrus, 106.3 bearded seal, 121.4 caribou, or 17,000 marine birds would equal the contribution of one bowhead whale.)

These 20-year averages do not reflect an important shift in North Slope harvest patterns that occurred in the late 1960's. The substitution of snowmachines for dogsleds decreased the importance of ringed seal and walrus (two key dogfoods) and increased the relative importance of waterfowl in the subsistence system (Luton, 1984; ACI-Braund, 1984). While ringed seal and walrus remain significant human foods and walrus still provides important raw materials for Native handicrafts, this shift illustrates that technological or social change may lead to long-term modifications of the subsistence system. For this reason, the averages of the next 20 years of North Slope harvests can be expected to differ from those given by Stoker. Because of a projected decline in NSB CIP projects, village wage work, and household incomes (Sec. III.D.1), subsistence hunting in general may increase. Because of their importance for Native handicrafts, the hunting of walrus and polar bear, particularly, may increase. Because of recent changes in technology and subsistence patterns, the dietary importance of waterfowl may also continue to grow. None of these changes would affect the predominant dietary roles of caribou, whale, or fish, however. These three resources play central and specialized roles in the North Slope subsistence system for which there are no logical substitutes (Stoker, 1983, as cited in ACI-Braund, 1984).

The often-stated "flexibility" of the North Slope hunting patterns is necessitated by the uncertainty of harvests in the Arctic. Not only are the harvests of the species limited by the sustainable-yield levels of the population, the species often are unavailable because of their seasonal presence, changes in their migration patterns or population fluctuations, or because the technology used to harvest them is dependent on weather and ice conditions which, themselves, change unpredictably. Thus, the flexibility of hunting practice reflects the natural limitations of the subsistence system rather than the ability to easily substitute the harvest of one species for another. For example, on this subject Stoker (1983, as cited in ACI-Braund, 1984) writes:

> "Perhaps the most salient point to be considered when assessing the subsistence economy of these villages is that, without exception, they are situated so as to take advantage of the broadest resource base available. Their survival has traditionally depended on flexibility, necessitating shifts in emphasis from one species to another depending on resource availability. . . .For marine mammal species this availability depends primarily on weather and ice conditions during the spring and, to a lesser degree, the fall migrations; for caribou it depends primarily on population levels and migration patterns. As is apparent from the great range in harvest results from year to year, no particular resource can be relied upon in any given year, making it essential that they be able to shift at will from resource to resource, depending on which is most available. The exclusion of any one resource compromises this flexibility and tends to destroy the balance of the overall resource base."

Table III-C-14
Major Subsistence Resources Harvested
Ranked by Percentage and Weight Contribution
to Average Total Community Harvest for the Period 1962-1982

Wainwright	Barrow	Nuiqsut	Kaktovik
Caribou 51.6%	Caribou 58.2%	Caribou a/	Bowhead Whale 27.5%
Walrus 18.5	Bowhead Whale 21.3%	Bowhead Whale a/	Fish 21.7%
Bearded Seal 12.3%	Fish 6.6%	Fish a/	Caribou 16.2%
Bowhead Whale 8.2%	Walrus 4.6%	Seals a/	Bearded Seal 7.4%
Hair Seal 4.4%	Hair Seal 4.3%	Moose a/	Beluga Whale 6.2%
Beluga Whale 2.7%	Bearded Seal 2.9%	Birds a/	Hair Seal 4.1%
Other 2.3%	Other 2.2%	Other a/	Dall Sheep 3.8%
			Moose 3.5%
			Walrus 3.2%
			Birds 3.2%
			Polar Bear 2.8%
			Other 0.4%

Source: Stoker, 1983, as cited in ACI-Braund, 1983.

a/ No data available.

In the Arctic, decreases in the availability of one species may not be offset by increases in the availability of another. For this reason, the elimination of a single important species from the harvest spectrum could compromise the productivity of the subsistence system as a whole (Stoker, 1983, as cited in ACI-Braund, 1984; Luton, 1985).

b. Community Subsistence Patterns: Subsistence-use areas for Wainwright, Barrow, Atqasuk, Nuiqsut, and Kaktovik, the North Slope communities adjacent to the lease-sale area, have been described in the FEIS's for Sales 71 and 87. Figure III-14 summarizes and incorporates by reference this community-level, subsistence-use-area information. This figure presents the broad, current-use areas of these villages. These boundaries are dynamic, and they expand and contract according to the availability of game (Pedersen, 1979). Figures III-15 through III-17 present these broad, current-use areas in terms of species harvested. Figure III-15 indicates where Wainwright, Barrow, Atqasuk, Nuiqsut, and Kaktovik harvest bowhead and beluga whales; Figure III-16 indicates where these communities harvest seals and walruses; and Figure III-17 indicates where they harvest caribou. In all, the subsistence-use areas of the five North Slope communities total 84,436 square miles, although these areas overlap (Pedersen, 1979). Under certain conditions, harvest activities may occur anywhere in this wide expanse, but they tend to be concentrated along rivers and ocean coastlines, near villages, and at particulary productive sites. The size of the area used by each village is as shown in Figure III-14. The subsistence-harvest pattern descriptions for Barrow and Atqasuk have been combined because (1) Atqasuk's subsistence-use area is virtually enclosed in Barrow's, (2) Atqasuk hunters often harvest marine mammals with Barrow hunters, and (3) much of the available literature discusses the two communities together.

(1) Wainwright: For Wainwright, the subsistence resources that might be affected by Sale 97 include bowhead whales, beluga whales, seals, walruses, polar bears, caribou, fishes, and marine and coastal birds. The intensity of effort and preferred harvest periods are indicated by Figure III-18. Harvest data for Wainwright summarized by Stoker (1983, as cited in ACI-Braund, 1984) appears in Table III-C-15.

(a) Bowhead Whales: Since the institutionalization of the IWC quota, bowhead whaling usually occurs between late March and early June; the exact timing depends on ice and weather conditions. Also depending on these conditions, the season may last more than 2 months or less than 2 weeks. Whaling crews generally hunt bowheads in leads within 10 miles of shore, although leads may occur 20 miles or more from the coast. Bowheads provide a large source of meat and maktak, an especially preferred food. The sharing of the bowhead is a central aspect of Wainwright's Thanksgiving and Christmas feasts and the focus of the community's nalukataq. The bowhead is shared extensively with Natives in other North Slope communities and with some as far away as Fairbanks and Anchorage. Its baleen is bartered in traditional networks and is used in the manufacture of traditional arts and crafts.

(b) Beluga Whales: Beluga whales are usually harvested in April through June, incidental to the bowhead harvest. However, beluga are sometimes taken later in the open-water season (July through late August) along the coast in lagoon systems when boating and camping groups are concentrating on the

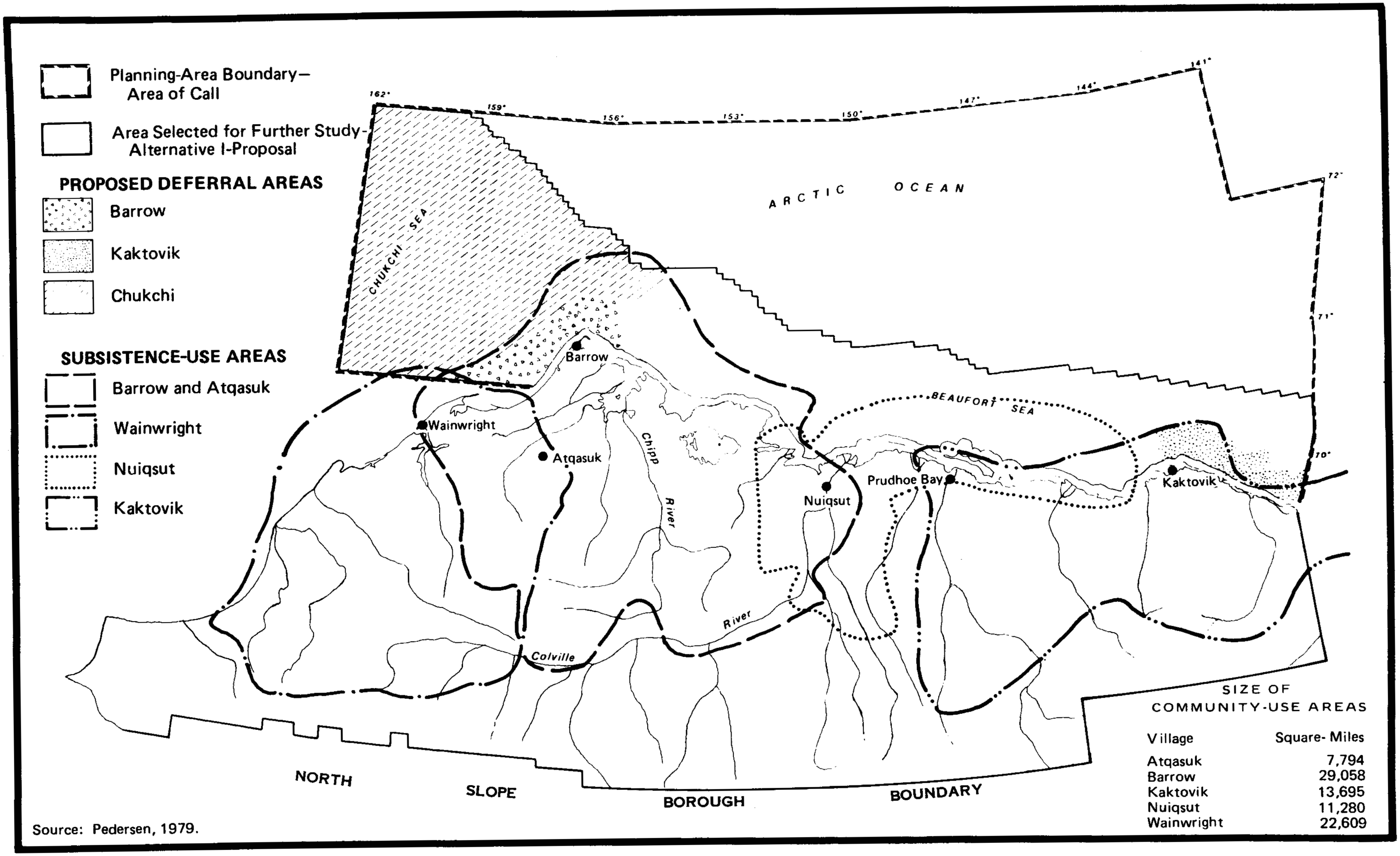
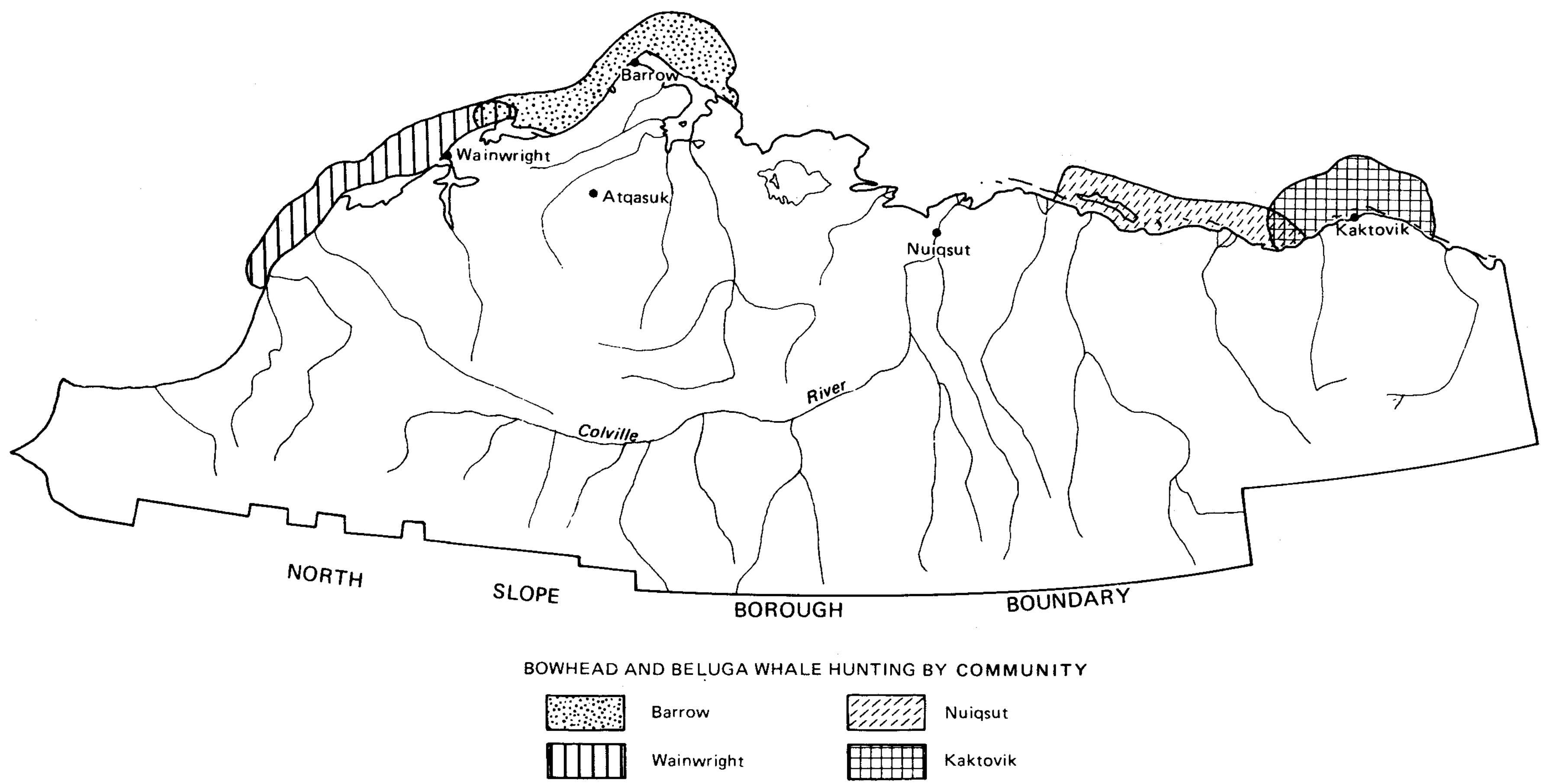
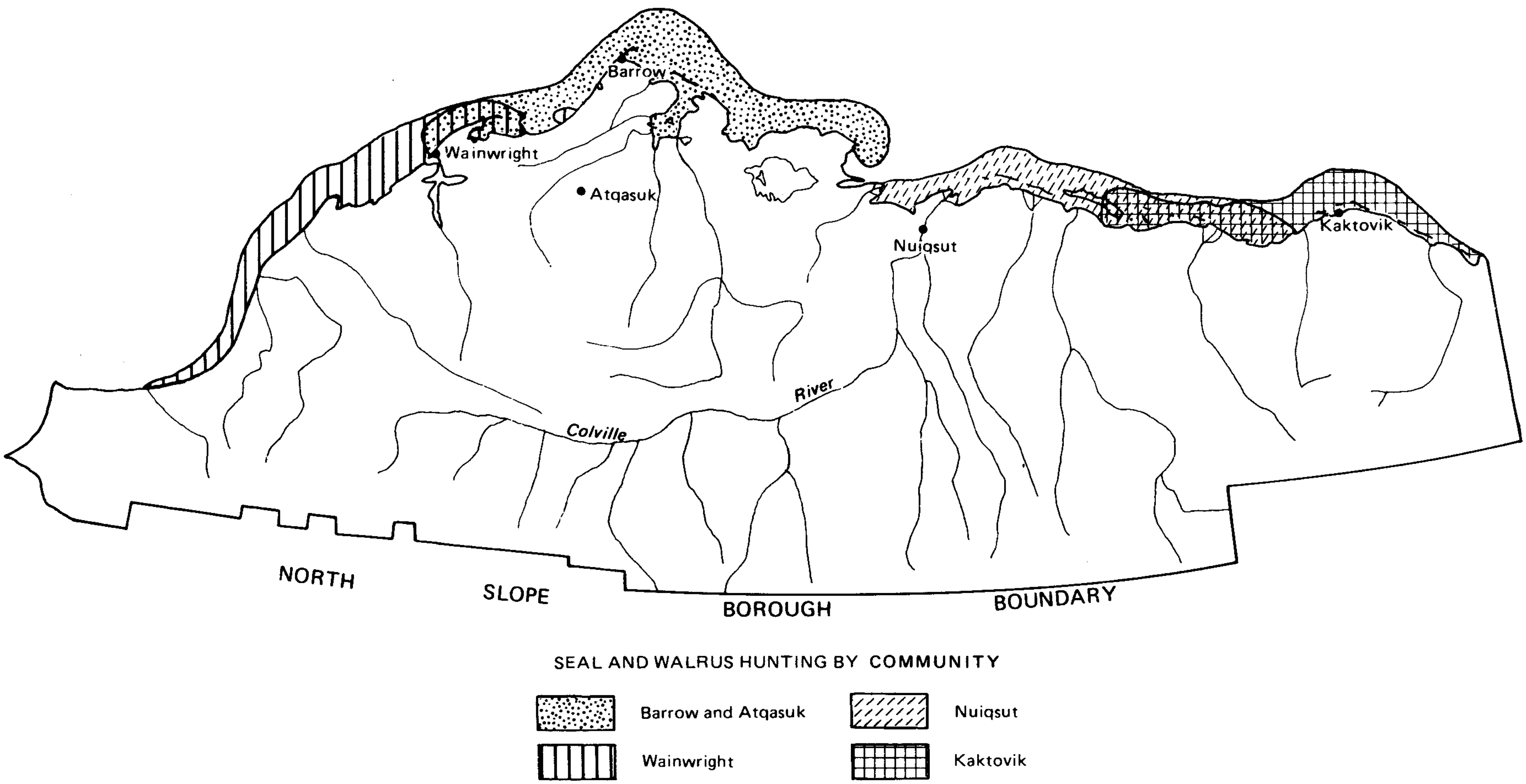


FIGURE III-14. MAP OF THE BEAUFORT SEA AND NORTH SLOPE BOROUGH SHOWING THE SALE 97 PLANNING AREA, ALTERNATIVE I AREA, PROPOSED DEFERRAL AREAS, AND SUBSISTENCE-USE AREAS OF FIVE COMMUNITIES



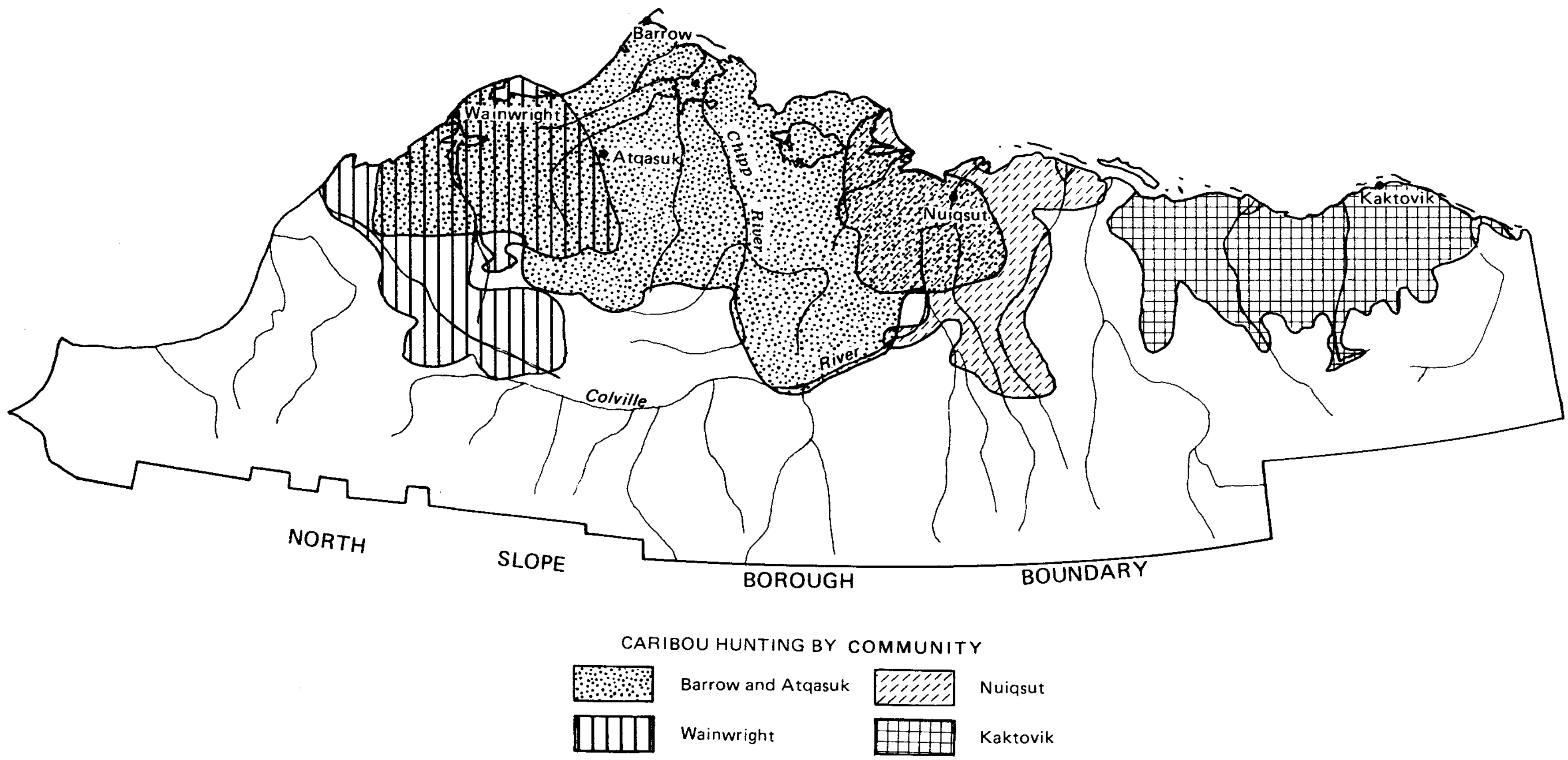
Sources: Original files compiled by Alaska Department of Fish and Game, Division of Subsistence, Arctic Region, North Slope Office, Fairbanks, AK. Map based on North Slope Borough Geographic Information System, December 1985.

FIGURE III-15. NORTH SLOPE BOROUGH SUBSISTENCE-USE AREAS – BOWHEAD AND BELUGA WHALE HUNTING



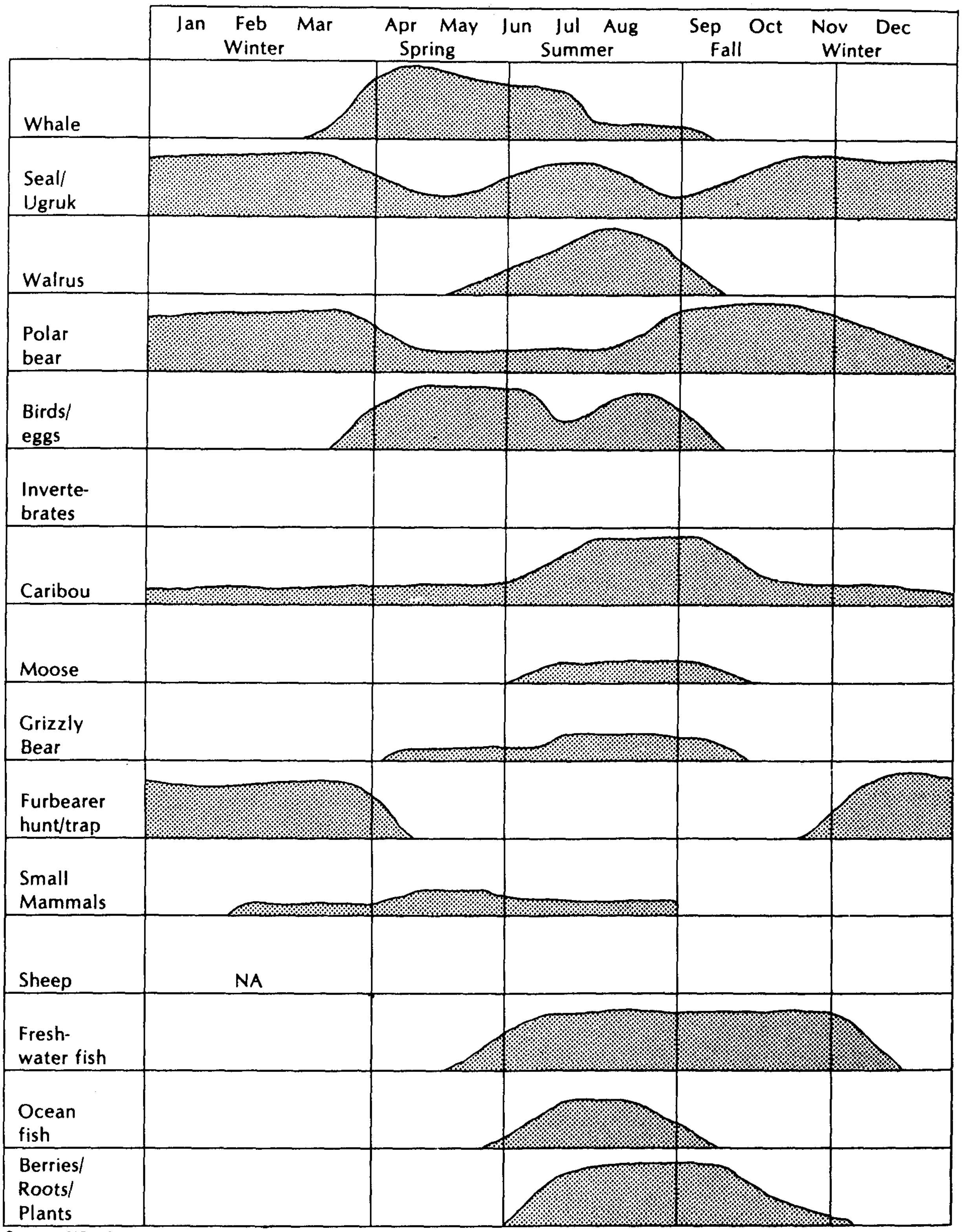
Sources: Original files compiled by Alaska Department of Fish and Game, Division of Subsistence, Arctic Region, North Slope Office, Fairbanks, AK. Map based on North Slope Borough Geographic Information System, December 1985.

FIGURE III-16. NORTH SLOPE BOROUGH SUBSISTENCE–USE AREAS – SEAL AND WALRUS HUNTING



Sources: Original files compiled by Alaska Department of Fish and Game, Division of Subsistence, Arctic Region, North Slope Office, Fairbanks, AK. Map based on North Slope Borough Geographic Information System, December 1985.

FIGURE III-17. NORTH SLOPE BOROUGH SUBSISTENCE-USE AREAS – CARIBOU HUNTING



Source: NSB Contract Staff, 1979.

FIGURE III-18. WAINWRIGHT YEARLY 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.

Table III-C-15
Wainwright's Annual Harvest for the Period 1962-1982
of Species for Which Sufficient Data Are Available

Year	Bowhead Whale	Walrus[1/]	Hair Seal[2/]	Polar Bear[3/]	Total Harvest[4/] (kg)
1962	1	-	328	-	157,580
1963	2	132	573	-	187,130
1964	1	225	-	-	207,018
1965	0	194	345	-	186,698
1966	1	140	69	-	171,454
1967	0	47	277	-	133,956
1968	2	85	40	-	160,553
1969	3	92	450	-	179,693
1970	0	89	480	-	152,513
1971	2	23	250	-	142,843
1972	2	56	1,600	3	179,143
1973	3	31	250+	4	153,968+
1974	1	38	250+	5	138,843+
1975	0	65	250+	4	139,168+
1976	3	257	250+	10	234,318+
1977	2	24	250+	9	143,643+
1978	2	20	-	7	144,265+
1979	1	36	-	0	139,293
1980	1	-	-	9	158,923
1981	3	-	-	13	177,623
1982	2	-	-	-	167,373

Source: Stoker, 1983, as cited in ACI-Braund, 1983.

1/ No data are available for the years 1962 and 1980-1982.

2/ Seal-harvest figures are estimates only and are probably on the low side. No data are available for the years 1964 and 1978-1982.

3/ No subsistence-harvest data are available for the years 1962-1971 and 1982.

4/ Estimated kilograms, includes all species.

harvest of seals, caribou, or fish. While beluga do not have the same religious significance as do bowheads, the distribution of beluga whales has a special, traditional form, which involves many non-kin (Luton, 1985). Beluga meat and maktak are preferred foods that are shared with other communities. Finally, beluga teeth are occasionally used in the production of arts and crafts.

(c) Seals: Seals are hunted year-round, but the bulk of their harvest occurs during the open-water season from June to September. During the winter, these harvests consist exclusively of ringed seals taken along open leads in the ocean ice. These leads are often found many miles offshore. In the summer, boat crews harvest ringed, bearded, and spotted seals. Ribbon seals only occasionally are available during the spring and summer months. Such summer sealing typically occurs 5 to 10 miles offshore but may occur up to 20 miles from shore. Most ringed seals are harvested along the coast from Milliktagvik to Point Franklin, with concentration areas along the shore from Kuk Inlet southward to Milliktagvik and from Nunagiaq to Point Franklin. Migrating seals are most concentrated at Qipuqlaich, just south of Kuk Inlet. The best harvest areas for bearded seal are on the flat ice south of Wainwright, off Qilamittagvik and Milliktagvik and beyond towards Icy Cape (Nelson, 1982). Ribbon and spotted seal meat is eaten; although bearded seal meat is most preferred. However, the dietary significance of seals comes from seal oil, which is served with almost every meal that includes subsistence foods and also is used as a preservative for meats, greens, and berries. Seal skins are important in the manufacture of clothing. Because of their beauty, spotted seal skins are often preferred for making boots, slippers, mitts, and parka trim, but ringed seal skins are used more often because they are more abundant. Bearded seal hides are used to cover umiats (the traditional skin boats used for whaling) and are also necessary for the manufacture of boot soles. Such products as boots, slippers, mitts, and parkas are often sold, given as gifts to relatives and friends, or bartered.

(d) Walruses: Walruses are present only seasonally in Wainwright, with the exception of a few that overwinter in the area. The peak hunting period occurs from July to August as the southern edge of the ice pack retreats. In late August and early September, Wainwright hunters occasionally harvest walruses that are hauled out on beaches. The focal area for hunting walruses is from Milliktagvik north to Point Franklin, although hunters prefer to harvest them south of the community so that the northward-moving pack ice can carry the hunters back home while they butcher their catch on the ice (Nelson, 1982). As in summer sealing, such activities typically occur 5 to 10 miles offshore but may range as far as 20 miles offshore. Walrus meat is eaten and is used as dogfood, and walrus ivory is used in the manufacture of traditional arts and crafts.

(e) Polar Bears: Polar bears are harvested during the winter months on ocean ice and along ocean leads in the Wainwright region, around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island (Nelson, 1982). When discovered, these bears may be pursued 20 miles or more from the coast. Polar bear meat is often consumed. The distribution of polar bear meat has a special, traditional form, which involves non-kin and also plays a special role during Christmas festivities. The polar bear is also important for its fur, which is used to manufacture cold-weather gear such as boots, mitts, and coats. These items are often sold, given as gifts to relatives and friends, or bartered.

(f) Caribou: Wainwright harvests several large land mammals including caribou, moose, and brown bear. Of these, caribou is the most important and is of concern under the proposal. Because of the unpredictable movements of the Western Arctic herd and because of the ice and weather-dependent hunting techniques, Wainwright's annual caribou harvest fluctuates markedly. When available and weather permits, caribou are harvested almost year-round. Wainwright boat crews hunt caribou along the coast beginning in July and lasting usually into September. The open-water season is a period of intense caribou harvesting. Prior to freezeup, caribou hunting is conducted along the inland waterways, particularly along the Kuk River system. Then, usually in late October, snow buildup allows hunter access to inland caribou. From then until breakup, which usually occurs sometime in May, Wainwright hunters take caribou by snowmachine on the coastal plain or inland as far as the foothills of the Brooks Range. During the spring, the herd returns and concentrates near the Utukok and Colville River headwaters (Nelson, 1982).

Caribou--a staple food that is eaten fresh, frozen, and dried--is the most preferred land mammal in Wainwright's diet. During periods of high availability, caribou can provide a source of fresh meat throughout the year. Caribou is often shared with kinsmen, friends, and elders within the community; it is often sent to relatives as far away as Anchorage; and it is occasionally bartered. Caribou plays an important part in holiday feasts. The skins of caribou taken in July and August are used to manufacture such garments as 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: Fishes provide an important subsistence resource at Wainwright. The community's harvests of most subsistence resources fluctuate widely from year to year because of variable migration patterns and because harvesting techniques are extremely dependent on ice and weather conditions. The harvest of fishes is an exception to this rule, which adds to their importance in Wainwright's subsistence system. Moreover, in January and February, fishes may provide the only source of fresh subsistence foods.

Wainwright residents harvest a variety of fishes in most marine and freshwater habitats along the coast and in lagoons, estuaries, and rivers. The most important local fish harvest (char, whitefish, and burbot) occurs from September through November in the freshwater areas of the Kuk but also on the Meade and Utukok River drainages. Fishes are netted before freezeup and jigged after freezeup. In October and November, rainbow smelt and arctic cod (tomcod) are harvested in the estuarine environment by jigging. Ice fishing for smelt and tomcod occurs near the community primarily during January, February, and March. In the summer months, Wainwright residents harvest arctic char, chum and pink salmon, Bering cisco (whitefish), and sculpin along the coast and along the lower portions of Kuk Lagoon (Nelson, 1982; ACI/Courtnage/Braund, 1984). The most common species harvested in the Kuk River system are Bering and least ciscos, grayling, ling cod, and rainbow smelt. Other species harvested less frequently along the coast--in some cases, in estuaries or freshwater--include rainbow smelt, flounder, saffron cod, arctic cod, trout, capelin, and grayling (Nelson, 1982). Marine fishing is conducted from Peard Bay to Icy Cape and in Kuk Lagoon.

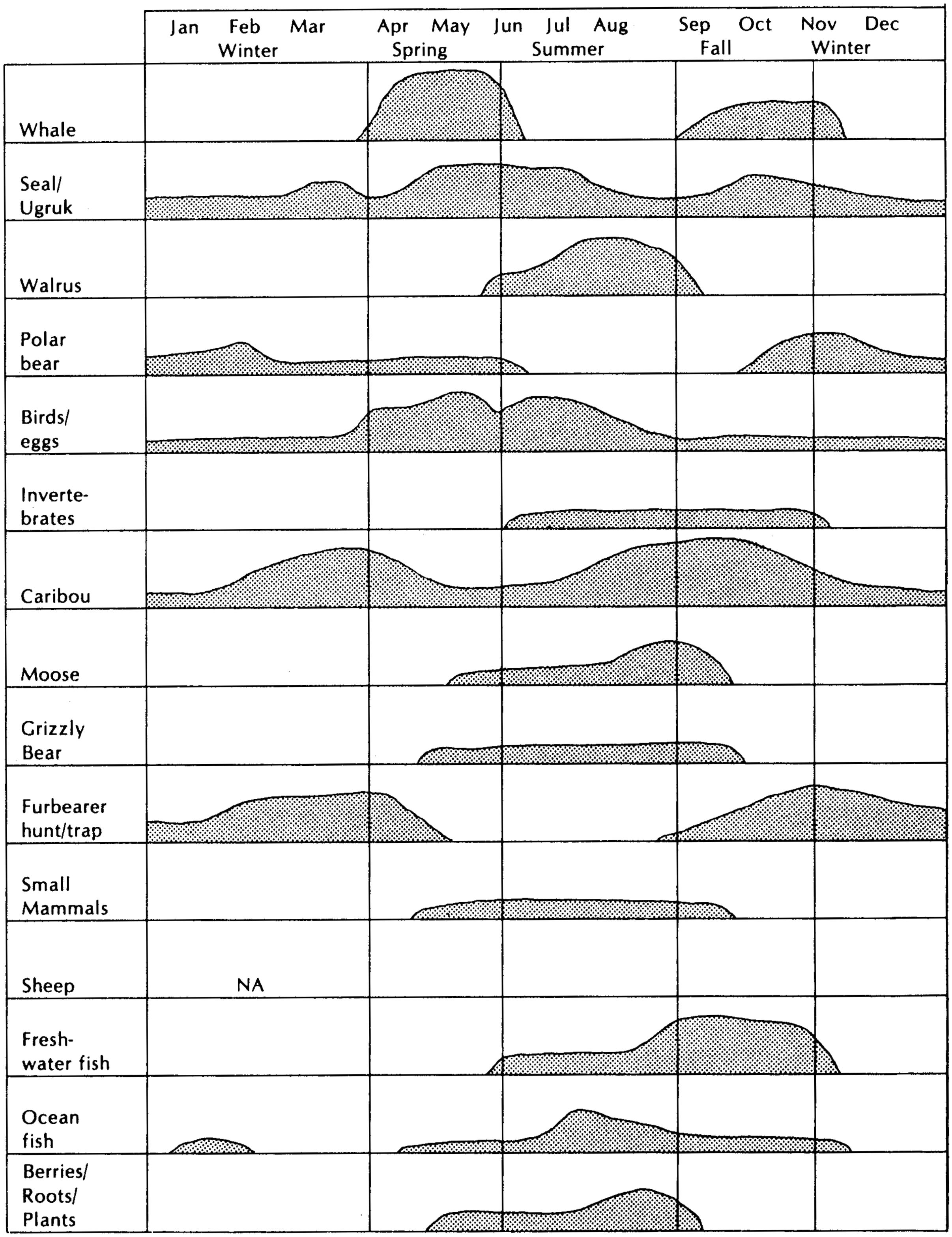
Fishes are eaten fresh or frozen, and salmon also may be split and dried. Because of their important role as a large and stable food source and as a fresh-food source during midwinter months, fishes are shared at Thanksgiving and Christmas feasts and given to relatives, friends, and village elders. Fishes also appear in traditional sharing and bartering networks that exist among North Slope communities.

(h) Marine and Coastal Birds: Waterfowl and coastal birds are a subsistence resource that has been growing in importance since the mid-1960's. The most important of these at Wainwright are white-fronted geese, Pacific brants, oldsquaws, eiders, snow geese, and pintail ducks, although other birds--such as loons--may be occasionally harvested. Waterfowl hunting occurs mostly in the spring, from April through early June. However, less intensive harvesting continues throughout the summer and into September. During the spring, birds are hunted by groups that camp upriver and along the ocean's coast; spits and points of land often provide the best hunting locations. In the summer and early fall, such hunting usually occurs as an adjunct to other subsistence activities, such as checking nets, although black brant are harvested intensely in August and early September.

Virtually the entire community of Wainwright participates in the spring bird hunt. Since it occurs at the end of the school year, this hunt is a major family activity. Because waterfowl is a highly preferred food, it is shared extensively within the community. Birds are often given to relatives, friends, and village elders. While most birds are eaten fresh, usually in soup, some are stored for the winter. Birds are often served for special occasions and holiday feasts such as nalukataq and Thanksgiving. Occasionally, birds may be bartered. Certain species of waterfowl and coastal birds may be harvested and used for special purposes. For example, loons may be harvested to be used in traditional costumes for Eskimo dances.

(2) Barrow-Atqasuk: For Barrow-Atqasuk, the subsistence resources that might be affected by Sale 97 include bowhead whales, beluga whales, seals, walruses, polar bears, caribou, fishes, and marine and coastal birds. The intensity of effort and preferred harvest periods are indicated by Figure III-19 for Barrow and Figure III-20 for Atqasuk. Harvest data for Barrow summarized by Stoker (1983, as cited in ACI-Braund, 1984) appears in Table III-C-16.

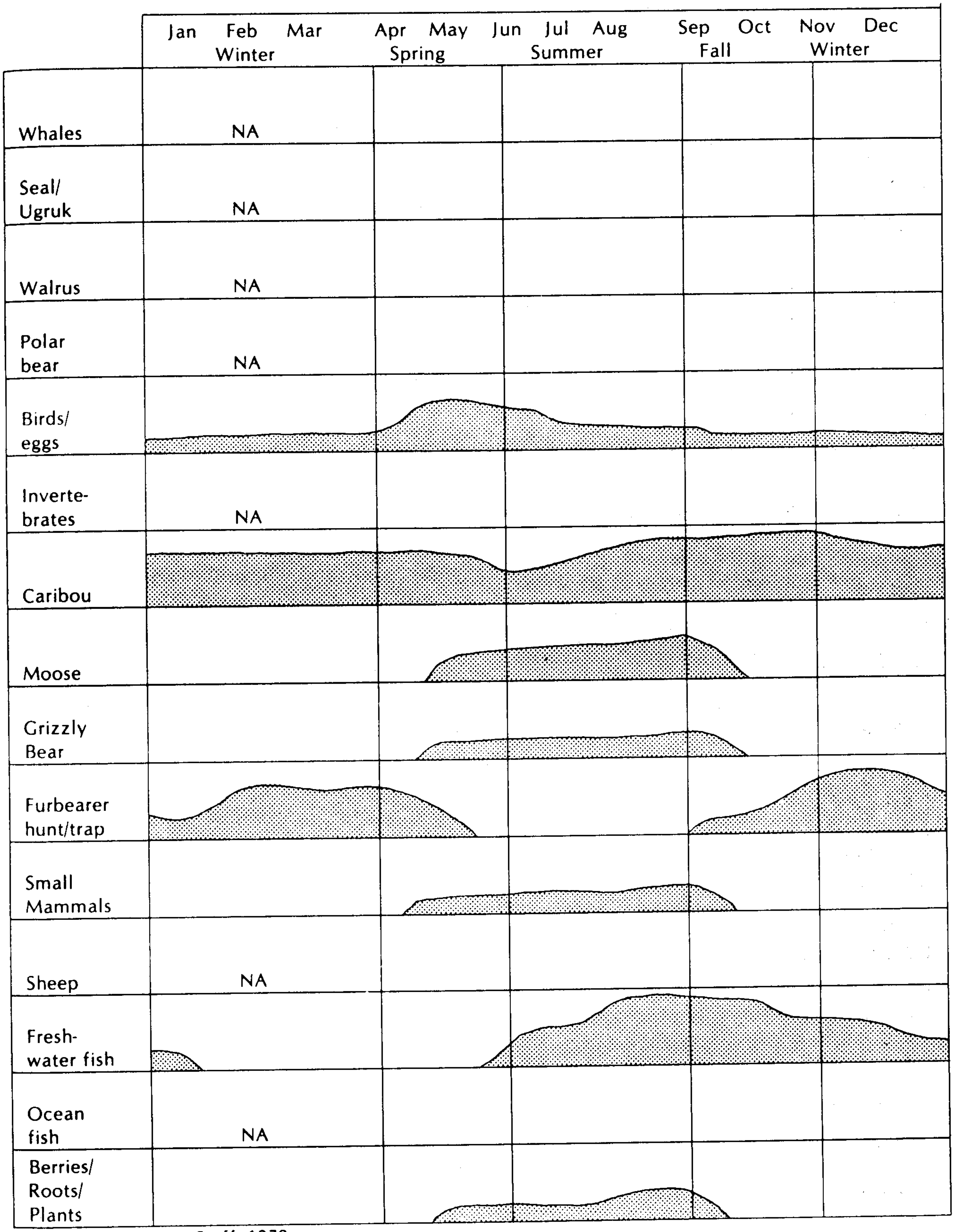
(a) Bowhead Whales: Since the institutionalization of the IWC quota, bowhead whaling usually occurs between the middle of April and mid-June. Depending on these conditions, the season may last more than 2 months or less than 2 weeks. The bowhead is hunted in two different areas, depending on the season. In the spring (from early April until the first week of June), the bowheads are hunted from leads that open when the pack-ice conditions deteriorate. Bowhead whales are harvested along the coast from Point Barrow to the Skull Cliff area. The distance of the leads from shore varies from year to year. The leads generally are parallel and quite close to shore, but they occasionally break directly from Point Barrow to Point Franklin and force Barrow whalers to travel over the ice as much as 16 kilometers offshore to the open leads. The



Source: NSB Contract Staff, 1979.

FIGURE III-19. BARROW YEARLY 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.



Source: NSB Contract Staff, 1979.

FIGURE III-20. ATQASUK YEARLY 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.

Table III-C-16
Barrow's Annual Harvest for the Period 1962-1982
of Species for Which Sufficient Data Are Available

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

Source: Stoker, 1983, as cited in ACI-Braund, 1983.

1/ No data are available for the years 1962 and 1980-1982.
2/ Seal-harvest figures are estimates only and are probably on the low side. No data are available for the years 1964 and 1978-1982.
3/ No subsistence-harvest data are available for the years 1962-1971 and 1982.
4/ Estimated kilograms, includes all species.

lead is normally open from Point Barrow to the coast, and the hunters are able to whale only 2 to 5 kilometers from shore. A stricken whale can be chased in either direction in the lead. Spring whaling in Barrow is conducted almost entirely with skin boats because the narrow leads prohibit the use of aluminum skiffs, which are more difficult to maneuver than the traditional boats (ACI/Courtnage/Braund, 1984). Fall whaling occurs outside of the Sale 109 area east of Point Barrow from the Barrow vicinity in the Chukchi Sea to Cape Simpson in the Beaufort Sea. Hunters use aluminum skiffs with outboard motors to chase the whales during the fall migration, which takes place in open water up to 48 kilometers offshore. During the spring hunt, whaling crews generally hunt bowheads in leads within 10 miles of shore, although leads may occur farther from shore. In the fall, whaling boats cruise for bowheads and may travel 20 miles or more from the coast. Bowheads provide a large source of meat and maktak, an especially preferred food. As at Wainwright, the sharing of the bowhead is central to nalukataq, Thanksgiving, and Christmas feasts, and maktak is shared extensively with Inupiats as far away as Fairbanks and Anchorage. Its baleen is bartered in traditional networks and is used in the manufacture of traditional arts and crafts.

(b) Beluga Whales: Beluga whales are usually harvested in April through June, incidental to the bowhead harvest, although they are sometimes taken later in the open-water season. Barrow hunters do not like to hunt beluga whales during the bowhead hunt for fear of scaring the bowheads. The hunters harvest belugas after the spring bowhead season ends, which depends on when the bowhead quota is achieved. Belugas are harvested in the leads between Point Barrow and Skull Cliff. Later in summer, belugas are occasionally harvested on both sides of the barrier islands of Elson Lagoon. These harvests often occur in the Peard Bay or Elson Lagoon areas. As at Wainwright, the distribution of beluga whales may have a special, traditional form. Beluga meat and maktak are preferred foods that are shared with other communities, and beluga teeth may be used in the production of arts and crafts.

(c) Seals: Seals are hunted year-round, but the bulk of their harvest occurs during the open-water season from late June or early July to August. During the winter, these harvests consist almost exclusively of ringed seals taken along open leads in the ocean ice. These leads are often found many miles offshore. Summer harvests are made by boat crews and are composed of ringed, bearded, and spotted seals. Summer sealing typically occurs 5 to 10 miles offshore but may occur up to 20 miles from shore. While seal meat is eaten (bearded seal is preferred), the dietary significance of seals comes from seal oil, which is served with almost all subsistence foods and is used as a preservative for meats, greens, and berries. Seal skins are important in the manufacture of clothing. Because of their beauty, spotted seal skins are often preferred for making boots, slippers, mitts, and parka trim. However, ringed seal skins are used more often because they are more abundant. Bearded seal hides are used to cover umiats (the traditional skin boats used for whaling) and are also necessary for the manufacture of boot soles. Such products as boots, slippers, mitts, and parkas are often sold, given as gifts to relatives and friends, or bartered.

(d) Walruses: Walruses are harvested west of Point Barrow and southwest to Peard Bay between late June through mid-September with peak harvests from early July to late August. Boat crews venture as far as 50 to 70 miles in seeking these mammals; the hunt usually requires cooperative efforts among the crews. At Barrow, boat crews often specifically hunt for walrus. Walrus meat is eaten and its ivory used in the manufacture of traditional arts and crafts.

(e) Polar Bears: During the winter months, Barrow hunters harvest polar bears on sea ice and along the leads. When discovered, these bears may be pursued 20 miles or more from the coast. Polar bear meat is often consumed. The distribution of polar bear meat may have a special, traditional form and may also play a special role during Christmas festivities. The polar bear is also important for its fur, which is used to manufacture cold-weather gear such as boots, mitts, and coats. These items are often sold, given as gifts to relatives and friends, or bartered.

(f) Caribou: Barrow and Atqasuk harvest several large land mammals including caribou, moose, and brown bear. Of these, caribou is the most important and is of concern under the proposal. Because of the unpredictable movements of the Western Arctic herd and because of the ice and weather-dependent hunting techniques, the Barrow and Atqasuk annual caribou harvests fluctuate markedly. When available and weather permits, caribou are harvested almost year-round. In July, Barrow boat crews hunt caribou along the coast. Such hunting usually lasts into September. The open-water season is a period of intense caribou harvesting for Barrow hunters. Usually in late October, snow buildup allows hunter access to inland caribou. From then until breakup, which usually occurs sometime in May, Barrow and Atqasuk hunters take caribou by snowmachine on the coastal plain or inland as far as the foothills of the Brooks Range.

As at Wainwright, caribou is a staple food and is the most preferred land mammal in the diet. During periods of high availability, caribou can provide a source of fresh meat throughout the year. Large amounts of caribou are shared within the community and are often sent to relatives as far away as Anchorage. Caribou is occasionally bartered, and it plays an important part in holiday feasts. The skins of caribou taken in July and August are used to manufacture such garments as 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: Both marine and freshwater fishes provide an important subsistence resource at Barrow and Atqasuk. The harvests of most subsistence resources fluctuate widely from year to year because of variable migration patterns and because harvesting techniques are extremely dependent on ice and weather conditions. The harvest of fishes is an exception to this rule, which adds to their importance in the Barrow and Atqasuk subsistence system. Morever, in January and February, fishes may provide the only source of fresh subsistence foods.

The subsistence-harvest area for fish is extensive, primarily because Barrow and Atqasuk residents supplement their camp food with fish whenever they are hunting. During the summer, salmon, cisco, whitefish, char, arctic flounder, and arctic cod are netted along the ocean coast and/or in estuaries and lagoons. Summer netting occurs from June into September and is intense for several weeks. It is more concentrated from Barrow (including Elson Lagoon, Dease Inlet, and Admiralty Bay) to the east as far as Pitt Point than from Barrow to Peard Bay to the southwest. Capelin are seined along the beaches near Barrow, probably in August. Fish camps have been established at traditional family sites along the coast. These camps are generally on points of land, at the mouths of rivers, and at other strategic locations. However, riverine fish camps are the most important in terms of effort to harvest and quantity of fish harvested. Inland fish camps are found in the Inaru, Meade, Topogoruk, and Chipp River drainages. These camps provide good fishing opportunities as well as access to inland caribou and birds (ACI/Courtnage/Braund, 1984). Fishing for char, whitefish, and burbot occurs upriver, especially along the Meade, Chipp, Topagoruk, and Ikpikpuk River systems where many permanent fish camps are located. While some begin earlier, most Barrow and Ataqsuk families begin upriver fishing in early July and fish intensely through October. Fishes are netted before freezeup and netted and jigged after freezeup. Such fishing generally ends in January. Arctic cod (tom-cod) are harvested on the sea ice by jigging. In January and February, tom-cod may be the only source of fresh subsistence food for many Barrow families. Fishes are eaten fresh or frozen, and salmon may be split and dried. Fishes are often shared and may appear in traditional sharing and bartering networks that exist among North Slope communities.

(h) Marine and Coastal Birds: Waterfowl and coastal birds are a subsistence resource that has been growing in importance since the mid-1960's. The most important of these birds at Barrow and Atqasuk are the white-fronted goose, Pacific brant, oldsquaw, eider, snow goose, and pintail duck, although other birds--such as loons--may be occasionally harvested. Waterfowl hunting occurs mostly in the spring, from mid-April through early July, but less intensive harvesting continues throughout the summer and into September. During the spring, birds are hunted by groups that camp upriver and along the ocean's coast; the Teshekpuk Lake area is particularly important. In the summer and early fall, bird hunting usually occurs as an adjunct to other subsistence activities, such as checking nets, although Barrow hunters harvest Pacific brant intensely in August and early September.

Since the spring bird hunt occurs at the end of the school year, it is a major family activity. As at Wainwright, waterfowl is shared extensively, is occasionally bartered, and is often served for special occasions and holiday feasts such as nalukataq and Thanksgiving. Certain species of waterfowl and coastal birds may be harvested and used for special purposes. For example, loons may be harvested to be used in traditional costumes for Eskimo dances.

Information on the Teshekpuk Lake Special Area: The Teshekpuk Lake Special Area is about equidistant to Barrow and Atqasuk and slightly nearer to Nuiqsut, but it is predominately used by people residing in Barrow. Of the 40 interviews reported by Silva, Adams, and Gal (1985), 33 were from Barrow, 3 from Nuiqsut, and 4 from Atqasuk. While the interviews did not include all users of the Special Area (for example, 20 of the 27 allotment holders were included), the authors felt that the sample was representative. During the open-water season, access is usually accomplished by boat. Access is also accomplished by charter airplane during the summer and fall and exclusively by snowmachine during the winter.

Silva, Adams, and Gal (1985) found that, because of its ecological richness, this area has been used intensively for a long period of time. For example, since it was an important fur-trapping and reindeer-herding area, several of its villages (Imagruak, Qalluvik, and Isuk) remained permanent settlements well into the 1940's. Since that time, this area has been heavily used by some families for fur trapping (until the 1960's) and for caribou, furbearer, and bird hunting up to the present. Throughout the aboriginal, historical, and present-day periods, the Teshekpuk Lake Special Area has been an especially productive fishing area.

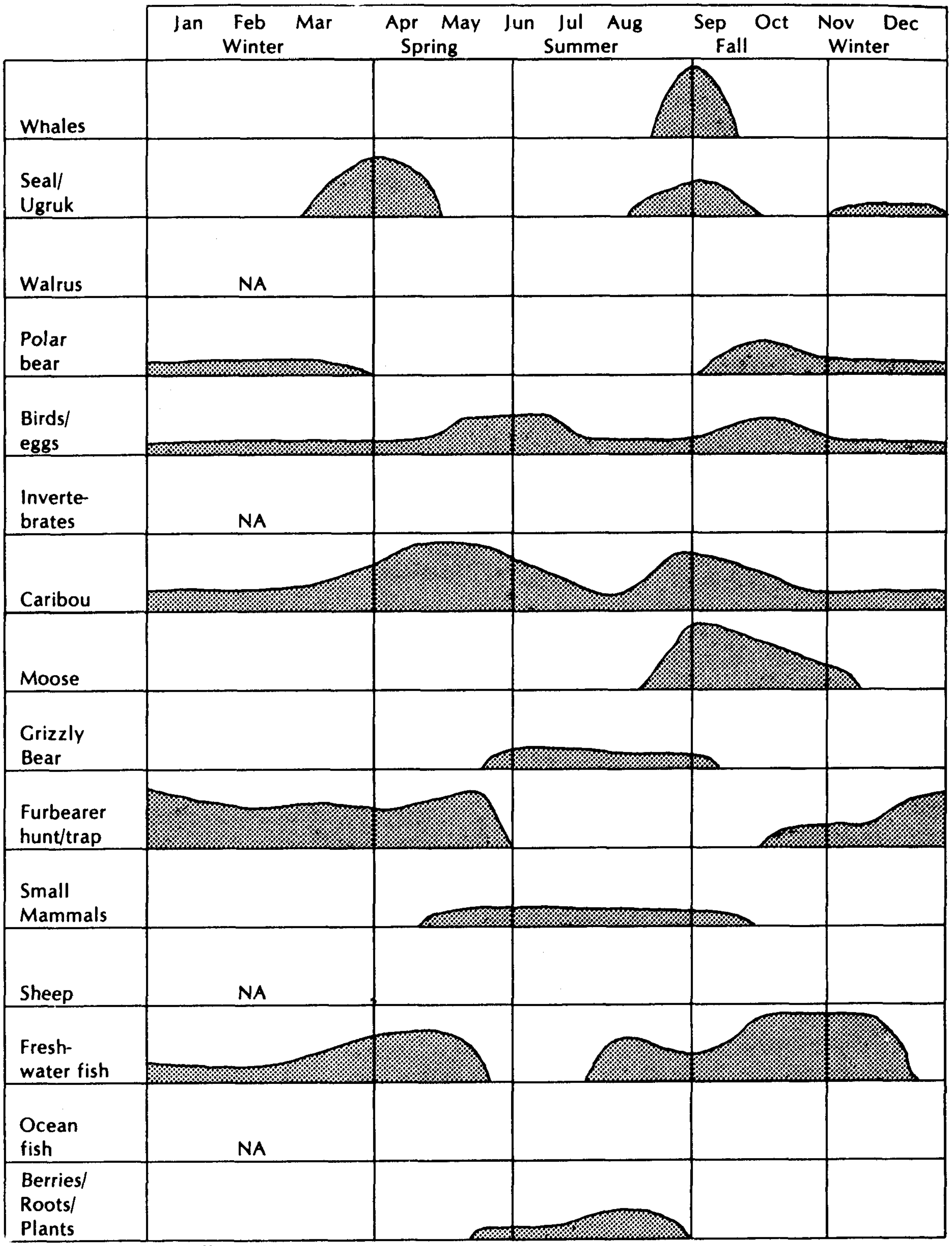
Today, caribou are taken from the area year-round. In the spring, they are taken in conjunction with furbearer hunting and, later, with goose hunting. During open-water hunting, the coastal areas are utilized intensively from approximately Cape Lonely west to Point Barrow. At this time, marine mammals are sometimes taken in conjunction with caribou hunting. There is little existing caribou-harvest data specific to this region. Spring goose hunting is also important in the area. The region used heavily for this activity runs from Smith Bay inland to the south of Teshekpuk Lake. The area south of the lake is also a good one for hunting wolf, wolverine, and fox.

Fishing is probably the most significant subsistence activity in this area. Silva, Adams, and Gal (1985) write, "Fish are taken in nets throughout the summer months and some allotments are continuously occupied from June through October while fish are harvested. . . . Fishing is heaviest in the fall, right after freeze-up, when nets are set through the ice. . . ." Silva et al. conclude that an estimate of 1,000 pounds harvested by a family unit operating in the area should be considered the "minimum figure."

Silva, Adams, and Gal (1985) found that users of the area were involved in such extensive sharing networks that "adverse effects in the vicinity of an allotment may affect an extensive sharing group easily numbering 50 or 60 people." They also note that such allotments normally serve as staging areas for subsistence activities rather than as their specific location and, in cases such as furbearer hunting by snowmachine, people may range up to 60 miles from these staging areas in a single day. Therefore, it must be concluded that adverse effects to any intensively used subsistence area could affect a great number of people.

(3) Nuiqsut: For Nuiqsut, the subsistence resources that might be affected by Sale 97 include bowhead whales, beluga whales, seals, walruses, polar bears, caribou, fishes, and marine and coastal birds (see also "Information on the Teshekpuk Lake Special Area" in the Barrow-Atqasuk description above). The intensity of effort and preferred harvest periods are indicated by Figure III-21.

(a) Bowhead Whales: Even though Nuiqsut is not located on the coast, marine mammals are a major subsistence resource. Nuiqsut hunters sometimes harvest bowhead whales with Kaktovik hunters. Bowhead whaling usually occurs between late August and early October; the exact timing depends on ice and weather conditions. Also depending on these conditions, the season may last more than 2 months or less than 2 weeks. Unlike spring whaling communities, which hunt the bowhead from the edge of ice leads, Nuiqsut whalers hunt bowheads in aluminum skiffs in open water. Generally, they hunt bowheads within 10 miles from shore, but they may travel 20 miles or more from shore. The bowhead is shared extensively with other North Slope communities and as far away as Fairbanks and Anchorage. Its baleen is bartered in traditional networks and is used in the manufacture of traditional arts and crafts.



Source: NSB Contract Staff, 1979.

FIGURE III-21. NUIQSUT YEARLY 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.

(b) Beluga Whales: Beluga whales may be harvested throughout the open-water season and taken incidentally to the bowhead harvest. While belugas do not have the same religious significance as do bowheads, the distribution of beluga whales may have a special, traditional form that involves many non-kin. Beluga teeth may be used in the production of arts and crafts.

(c) Seals: Seals are hunted year-round, but the bulk of their harvest occurs during the open-water season. Breakup usually occurs in June. During the winter, these harvests consist almost exclusively of ringed seals taken along open leads in the ocean ice. In the summer, boat crews harvest ringed, bearded, and spotted seals. 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 is also used as a preservative for meats, greens, and berries. Seal skins are important in the manufacture of clothing. Because of their beauty, spotted seal skins are often preferred for making boots, slippers, mitts, and parka trim; however, ringed seal skins are used more often because they are more abundant. Bearded seal hides are also necessary for the manufacture of boot soles. Such products as boots, slippers, mitts, and parkas may be sold, given as gifts to relatives and friends, or bartered.

(d) Walruses: Walruses also may be occasionally harvested during the open-water season from June through early October. Walrus meat may be 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 the winter. Polar bear meat is often consumed. The distribution of polar bear meat may have a special, traditional form, which involves non-kin, and may also play a special role during Christmas festivities. The polar bear is also important for its fur, which is used to manufacture cold-weather gear such as boots, mitts, and coats. These items are often sold, given as gifts to relatives and friends, or bartered.

(f) Caribou: Nuiqsut harvests several large land mammals including caribou, moose, and brown bear. Of these, caribou is the most important and is of concern under the proposal. Because of the unpredictable movements of the Western, Central Arctic, and Porcupine herds and because of the ice and weather-dependent hunting techniques, Nuiqsut's annual caribou harvest fluctuates markedly. When available and weather permits, caribou are harvested almost year-round. Hunting is often most intense in April, May, August, and September.

Caribou--a staple food--may be the most preferred mammal in Nuiqsut's diet. During periods of high availability, caribou can provide a source of fresh meat throughout the year. Caribou may often be shared with kinsmen, friends, and elders within the community; it may be sent to relatives as far away as Anchorage; and occasionally it may be bartered. Caribou plays an important part in holiday feasts. The skins of caribou taken in July and August are used to manufacture such garments as parkas, boot soles, mitts, and mukluk tops. The skins of caribou taken in October and November are used as blankets and sleeping pads.

(g) <u>Fishes</u>: Anadromous fishes provide an important subsistence resource at Nuiqsut. The harvests of most subsistence resources, such as caribou, fluctuate widely from year to year because of variable migration patterns and because harvesting techniques are extremely dependent on ice and weather conditions. The harvest of fishes is an exception to this rule, which adds to their importance in Nuiqsut's subsistence system. Nuiqsut has the largest documented subsistence harvest on the U.S. Beaufort Sea coast (Moulton, Field, and Brotherton, 1986). Moreover, in October and November, fishes may provide the only source of fresh subsistence foods.

Fishing is an important activity for Nuiqsut residents due to their proximity to the Colville River with its large resident fish populations. The river supports 20 species of fish and approximately half of these are taken by Nuiqsut residents (George and Nageak, 1986). Nuiqsut residents harvest fish primarily during the summer and fall. The summer open-water harvest lasts from breakup to freezeup, early June to mid-September. The summer harvest covers a greater area, is longer than the fall/winter harvest in duration, and there are a greater number of species caught. Broad whitefish is the primary species harvested during the summer and is the only anadromous species harvested in July in the Nechelik Channel. In July, lake trout, northern pike, broad whitefish, humpback whitefish, and arctic char are harvested in the Main Channel south of Nuiqsut. Salmon species have been reportedly caught in August, but not in large numbers. All five species of Pacific salmon have been reported in the Colville; pink and chum salmon are the most commonly caught, although there reportedly has not been a great interest in harvesting these species (George and Nageak, 1986). Although arctic char is found in the Main Channel of the Colville River (Entrix, Inc., 1986), there is little mention of char as a subsistence species in subsistence studies (George and Nageak, 1986; George and Kovalsky, 1986). Apparently char are really liked but are not abundantly caught because the timing is critical (Moulton, pers. comm., 1986).

The fall/winter under-ice harvest begins after freezeup when the ice is safe for travel by snowmachine. The families fish for approximately 1 month or less after freezeup. The Kupigruak Channel is the most important fall fishing area in the Colville region. The primary species harvested are arctic and least cisco, harvested primarily in the Kupigruak Channel; other fishing for arctic and least cisco also occurs in the Nechelik and Main Channels of the Colville River. Arctic and least cisco composed 88 and 99 percent of the harvest in 1984 and 1985; however, this varied greatly depending on the net mesh size. Humpback and broad whitefish, sculpin, and some large rainbow smelt are also harvested, but in low numbers (George and Kovalsky, 1986; George and Nageak, 1986). A fish identified as "spotted least cisco" has also been harvested--this fish is not identified by Morrow (1980) but may be a resident form of least cisco (George and Kovalsky, 1986). Weekend fishing for burbot and grayling also occurs at Itkillikpaat, 6 miles from the village, even though the success rate for grayling is quite low (George and Nageak, 1986).

Fishes are eaten fresh or frozen, and salmon also may be split and dried. Because of their important role as a large and stable food source and as a fresh-food source during the midwinter months, fishes may be shared at Thanksgiving and Christmas feasts and given to relatives, friends, and village elders. Fishes also may appear in traditional sharing and bartering networks that exist among North Slope communities. Fishing serves as a strong social function in the community because it often involves the entire family. Most Nuiqsut families (20-25) participate in some fishing activity; however, the bulk of the fishing appears to be done by less than 12 families (George and Nageak, 1986).

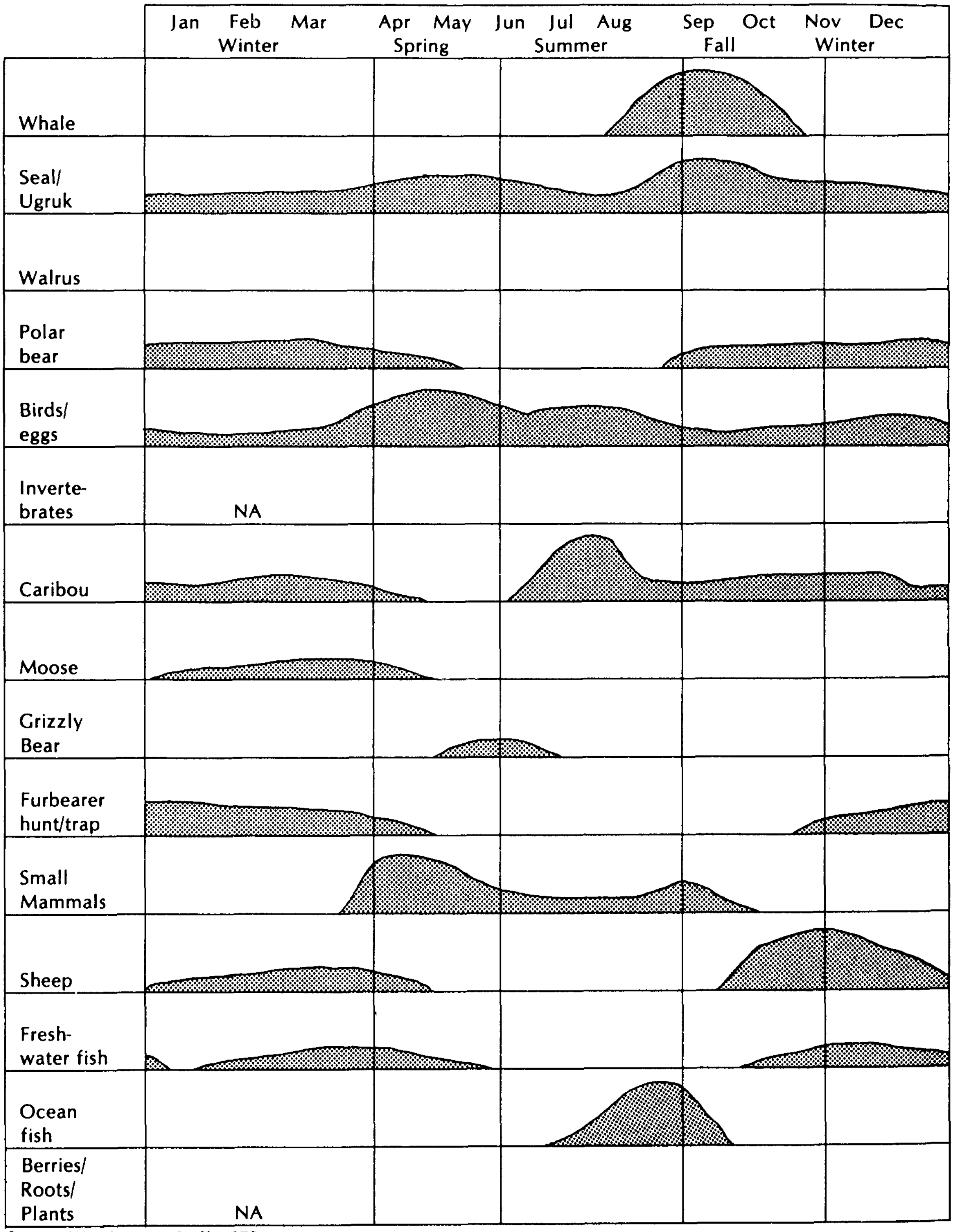
(h) Marine and Coastal Birds: Waterfowl and coastal birds are a subsistence resource that has been growing in importance since the mid-1960's. The most important of these birds at Nuiqsut may be the white-fronted goose, Canada goose, Pacific brant, oldsquaw, eider, snow goose, and pintail duck, although other birds--such as loons--may be occasionally harvested. 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, although eiders are often taken. Nuiqsut hunters may harvest Pacific brant intensely in August and early September.

(4) Kaktovik: For Kaktovik, the subsistence resources that might be affected by Sale 97 are bowhead whales, beluga whales, seals, walruses, polar bears, caribou, fishes, and marine and coastal birds. The intensity of effort and preferred harvest periods are indicated by Figure III-22; harvest data summarized by Stoker (1983, as cited in ACI-Braund, 1984) appears in Table III-C-17.

(a) Bowhead Whales: Bowhead whaling occurs between late August and early October; the exact timing depends on ice and weather conditions. Also depending on these conditions, the season may last more than 1 month or less than 2 weeks. As in Nuiqsut, Kaktovik whalers hunt the bowhead in aluminum skiffs in open water rather than from the edge of ice leads. Whaling crews generally hunt bowheads within 10 miles of shore, although they may occasionally hunt as much as 20 miles from the coast. Bowheads provide a large source of meat and 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 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) Beluga Whales: Beluga whales usually are harvested in August through November, incidental to the bowhead harvest. However, belugas sometimes are taken earlier in the open-water season when boating and camping groups are concentrating on the harvest of seals, caribou, or fish. Kaktovik's subsistence system probably is like that found in Barrow and to the west, in which case the distribution of beluga whales has a special, traditional form, which involves many non-kin.

(c) Seals: Seals are hunted year-round, but the bulk of their harvest occurs during the open-water season from July to September. During the winter, these harvests consist almost exclusively of ringed seals taken along open leads in the ocean ice. These leads are often found many miles offshore. Summer harvests are made by boat crews and consist of ringed, bearded, and spotted seals. Summer sealing typically occurs 5 to 10 miles offshore but may occur up to 20 miles from shore. Seal meat is eaten; bearded seal meat is most preferred. However, the dietary significance of seals comes from seal oil,



Source: NSB Contract Staff, 1979

FIGURE III-22. KAKTOVIK YEARLY 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.

Table III-C-17
Kaktovik's Annual Harvest for the Period 1962-1982
of Species for Which Sufficient Data Are Available

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	0
1975	0	1
1976	2	1
1977	2	4
1978	2	0
1979	5	0
1980	1	22
1981	3	1
1982	0	-

Source: Stoker, 1983, as cited in ACI-Braund, 1983.

1/ No subsistence-harvest data are available for the years 1962-1971 and 1982.

which is served with almost every meal that includes subsistence foods and is used as a preservative for meats, greens, and berries. Seal skins are important in the manufacture of clothing. Because of their beauty, spotted seal skins are often preferred for making boots, slippers, mitts, and parka trim; but ringed seal skins also are important, and bearded seal hides are necessary for the manufacture of boot soles. Such products as boots, slippers, mitts, and parkas are often sold, given as gifts to relatives and friends, or bartered.

(d) Walruses: Because Kaktovik lies east of Point Barrow, walruses are harvested much less frequently than are seals. Walruses are harvested opportunistically, by boat crews hunting other species, in July or August. When harvested, walrus meat may be eaten and its ivory used in the manufacture of traditional arts and crafts.

(e) Polar Bears: Polar bears are harvested during the winter months on ocean ice and along ocean leads. When discovered, these bears may be pursued seaward of the barrier islands for 10 miles or more. Polar bear meat is often consumed. If Kaktovik's subsistence system is like that found in the western portion of the North Slope, the distribution of polar bear meat has a special, traditional form, which involves non-kin and may also play a special role during Christmas festivities. However, the polar bear is primarily important for its fur, which is used to manufacture cold-weather gear such as boots, mitts, and coats. These items are often sold, given as gifts to relatives and friends, or bartered.

(f) Caribou: Kaktovik harvests several large land mammals including caribou, Dall sheep, moose, and brown bear. Of these, only caribou is of concern under the proposal. Because of the unpredictable movements of the Porcupine and Central Arctic herds and because of the ice and weather-dependent hunting technology, Kaktovik's annual caribou harvest fluctuates widely. When available and weather permits, caribou are harvested almost year-round. With open water, which usually occurs in July, Kaktovik boat crews hunt caribou along the coast. Such hunting usually lasts until mid-August, when the caribou move inland and are no longer available. The open-water season is a period of intense caribou harvesting. Approximately 70 percent of all caribou harvests take place on the coastal plain near the coast, and most harvesting is accomplished by boat crews. Usually in late October, snow buildup allows hunter access to inland caribou. From then 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--a staple food that is eaten fresh, frozen, and dried--is the most preferred land mammal in Kaktovik's diet. During periods of high availability, caribou can provide a source of fresh meat throughout the year. Caribou is often shared with kinsmen, friends, and elders within the community; it is often sent to relatives as far away as Anchorage; and it is occasionally bartered. Caribou plays an important part in holiday feasts. The skins of caribou taken in July and August are used to manufacture such garments as parkas, boot soles, mitts, and mukluk tops. The skins of caribou taken in October and November are used as blankets and sleeping pads.

In a recent 3-year study (1981-1983) of Kaktovik's caribou hunting, Pedersen and Coffing (1985) found that the general caribou-hunting range covered about

7,600 square miles and that the intensely used area covered about 2,900 square miles. This latter figure is a short-term measure of intensity. Because the distribution and availability of caribou fluctuate over a period of years, the size and location of the intensely used area also would change. As expected from earlier research (see NSB Contract Staff, 1979), harvest levels were highly variable. In the 1981-1982 season, 43 caribou were taken; in the 1982-1983 season, 110 were taken. The annual average harvest was 71.5, approximately .4 caribou per capita. This indicates that the estimated 100 to 300 caribou harvested per year by Kaktovik hunters (U.S. Department of State, 1980) may be high. The figures presented by Pedersen and Coffing (1985) are comparable to other estimates. 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 found high-yield areas in both coastal and inland habitats, 70 percent of all caribou harvest took place on the coastal plain near the coast. Most of this was accomplished by boat crews.

These figures cannot be extrapolated to other North Slope communities because the species availability and use varies among settlements (see above; see also NSB Contract Staff, 1979). For example, Kaktovik hunts dall sheep, a big game species unavailable to other North Slope communities. Kaktovik is also more heavily dependent on fish than are 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, the period of most intense CIP construction. Reports from other communities indicated that subsistence hunting may have dropped slightly during this period but has increased again since the drop in availability of wage work.

Pedersen and Coffing (1985) also found that Kaktovik's hunting patterns may already have been affected by the area's industrialization. They write:

> "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. No caribou have been reported taken from the area since 1981. . . .It was suggested that unclear harvesting regulations as well as industrialization may have led to avoidance of this region by Kaktovik caribou hunters."

(g) Fishes: Fishes provide an important subsistence resource at Kaktovik. The community's harvests of most subsistence resources fluctuate widely from year to year because of variable migration patterns and because harvesting technologies are extremely dependent on ice and weather conditions. The harvest of fishes is an exception to this rule, which adds to their importance in Kaktovik's subsistence system. Moreover, in January and February, fishes may provide the only source of fresh subsistence foods.

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 ciscos are harvested in the ocean after the arctic char run peaks, beginning about the first of August through early September. Grayling is also a major subsistence fish taken in the Hulahula River and many 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).

Arctic flounder and fourhorn sculpin are occasionally taken during summer ocean fishing off Manning Point or Drum Island, Arey Spit, and in Kaktovik Lagoon between Manning Point and the mainland. Sculpin is usually not eaten because it is too bony. Pike (in Inupiaq, Paigluk), which has not been positively identified, is caught in the Hulahula River and occasionally is also caught 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 on the Canning, Hulahula, Kongakut, and especially in 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 are sometimes taken inland on the Canning River during the snow season. They are harvested only on the inland portions of rivers, at least 10 miles from the coast. During the snow season, lake trout is caught in the Neruokpuk Lakes of the Brooks Range. Arctic cod or tomcod and smelt are sometimes jigged in October and November north of Barter Island and Iglukpaluk. Blackfish is harvested in the winter on the Canning, Hulahula, Kongakut, and especially the Aichilik, rivers (Jacobsen and Wentworth, 1982).

Because of their important role as a large and stable food source and as a fresh-food source during midwinter months, fishes may be shared at Thanksgiving and Christmas feasts and given to relatives, friends, and village elders. Kaktovik traditional-subsistence uses are probably similar to those found elsewhere on the North Slope, in which case fishes also may appear in traditional sharing and bartering networks that exist among North Slope communities.

(h) Marine and Coastal Birds: Waterfowl and coastal birds are a subsistence resource that has been growing in importance since the mid-1960's. The most important of these birds at Kaktovik are black brants, oldsquaws, eiders, snow geese, Canada geese, and pintail ducks, although other birds--such as loons--may be occasionally harvested. Waterfowl hunting occurs mostly in the spring, from May through early July. However, less intensive harvesting continues throughout the summer and into September. During the spring, birds are hunted by groups that camp along the ocean's coast; spits and points of land often provide the best hunting locations. In the summer and early fall, bird hunting occurs as an adjunct to other subsistence activities, such as checking nets.

Virtually the entire community of Kaktovik participates in the spring bird hunt. Since it occurs at the end of the school year, it is a major family activity. Because waterfowl is a highly preferred food, it is shared extensively within the community. Birds are often given to relatives, friends, and village elders. While most birds are eaten fresh, usually in soup, some are stored for the winter. Birds are often served for special occasions and holiday feasts such as nalukataq and Thanksgiving. Occasionally, birds may be bartered.

D. Other Issues:

1. Economy of the North Slope Borough: The direct economic effects of proposed Sale 97 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 description of the economy of the NSB as contained in Section III.D.1 of the Sale 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference; a summary of this description, augmented by additional material, as cited, follows.

The NSB includes the entire northern coast of Alaska and encompasses 88,281 square miles of territory, equal to 15 percent of the land area of Alaska. The predominately Inupiat residents have traditionally relied upon subsistence activities. Subsistence activities and sociocultural aspects of the economy are discussed in Sections III.B.9 and III.C.2, 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 summarized and incorporated by reference from the Economic and Demographic Systems and Base Case Projections on the North Slope Borough (University of Alaska, ISER, 1986). The assumptions used in the model that generated the report's projections for the North Slope are presented in Appendix I, Table I-3. 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] 1984) of the enormously high-valued petroleum-industry-related property in the Prudhoe Bay area. Because of this very valuable property, the NSB's tax base in 1984 was more than triple the base in the Fairbanks North Star Borough and almost equaled the base in the Municipality of Anchorage.

The NSB's general-fund revenues in FY 1985 were estimated at $317 million. The largest source of these revenues were property taxes (71%). A large share of the general-fund revenues (38% in FY 1985 and a projected 47% in FY 1986) must be used to pay for previous expenditures, primarily the debt on general-obligation bonds that were sold to fund CIP projects.

Total property-tax value is projected to rise until 1990 and decline thereafter. 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 1985 mill rate applied by the NSB to assessed property was a record 18.37 mills. This rate is the sum of a rate of 1.78 mills for operations and 16.59 mills for debt service. Due to perceived adverse political and economic consequences, the NSB administration is not expected to increase the total rate any further. Although State statutes limit the mill rate for operations, 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. However, debt service is projected to peak in 1988, and as a consequence the debt-service mill rate is projected to decline. This allows the projected increase in the operations mill rate without increasing the overall mill rate. Total property-tax revenues are projected to rise until 1988 and decline thereafter.

Figure III-23 shows actual and projected expenditures by the NSB from 1985 to 2010. Construction expenditures, primarily CIP, decline dramatically by the year 1990; and operating expenditures decline significantly by the year 2000. These drastic 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 1985 was estimated at around 9,000, down from a peak of over 10,300 in 1983. Around 6,000 (66%) of the jobs in 1985 were in the oil industry, down from a peak of almost 7,800 jobs in 1983. Almost all petroleum-industry jobs (over 99%) are held by workers who commute to permanent residences outside the region. Commuters also held an estimated 390 jobs outside of the petroleum industry in 1985. Most of these jobs (75%) were associated with "other" CIP projects (wages not paid directly by the NSB). The remaining 25 percent of commuter employment was with Federal and State government. The vast majority of the commuters are employed in isolated, self-sufficient industrial enclaves having relatively minor direct economic interaction with the Eskimo communities. Most of these enclaves are related to petroleum production or exploration, although one small enclave is the site of defense-related communications.

Figure III-24 provides data on Native and non-Native resident employment since 1980. Total resident employment in the year 1985 was estimated at around 2,600, with about 57 percent of jobs held by Natives. Table III-D-1 provides a breakdown of employment by category. 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. NSB employment has been both high-paying and very flexible, permitting employees to take time off when they wish to and allowing employees to be rehired after quitting or being fired.

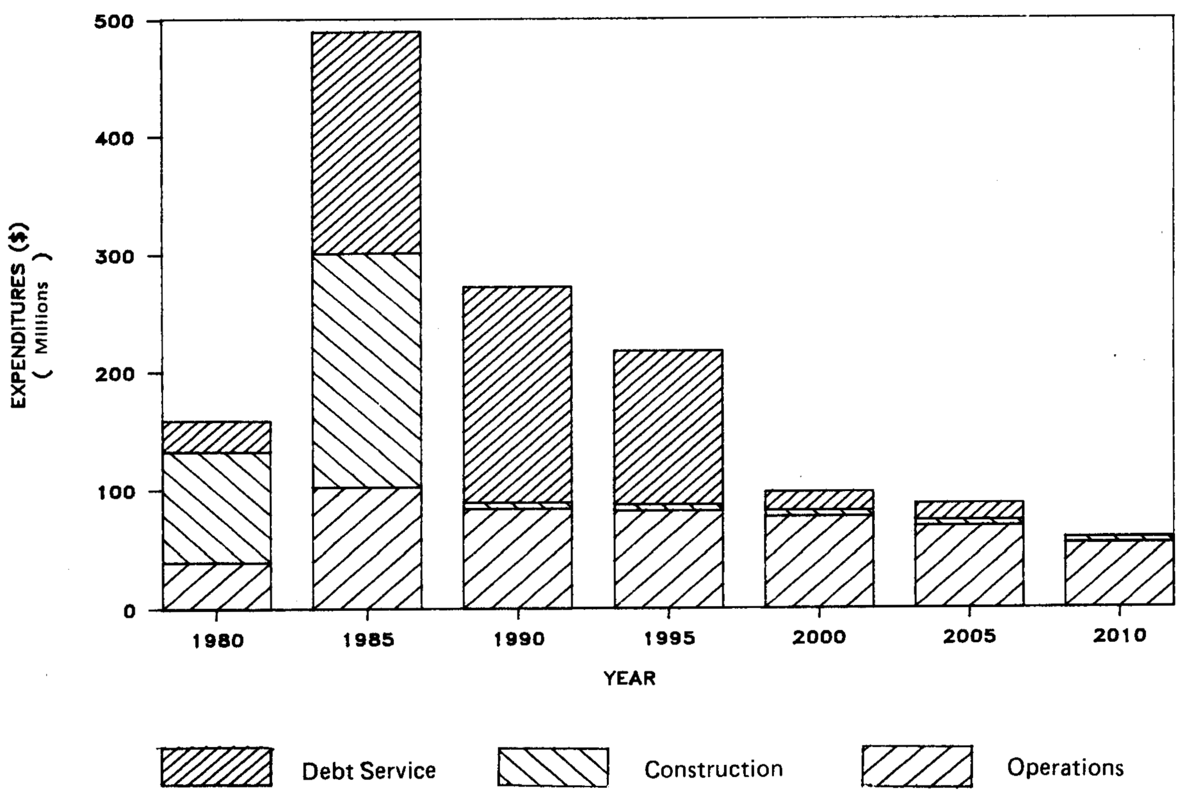
Approximately 96 percent of Native employment in 1985 was related to NSB funds. As shown in Table III-D-1, most of the employment (65%) was either with NSB operations or CIP. In the year 1985, NSB CIP employment had already fallen from its peak of 378 jobs in 1982, while NSB operating employment had reached a new peak.

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. The report, Description of the Socioeconomics of the North Slope Borough (University of Alaska, ISER, 1983), provides a detailed description of the employment situation and the reasons for the small Native involvement in the oil and gas industry.

Non-Native resident employment more than doubled between the years 1980 and 1985. Most of the employment (66%) was with NSB operations and CIP. These employment opportunities for non-Natives have resulted in the significant increase in the non-Native population that is discussed in Section III.B.7 of this EIS.

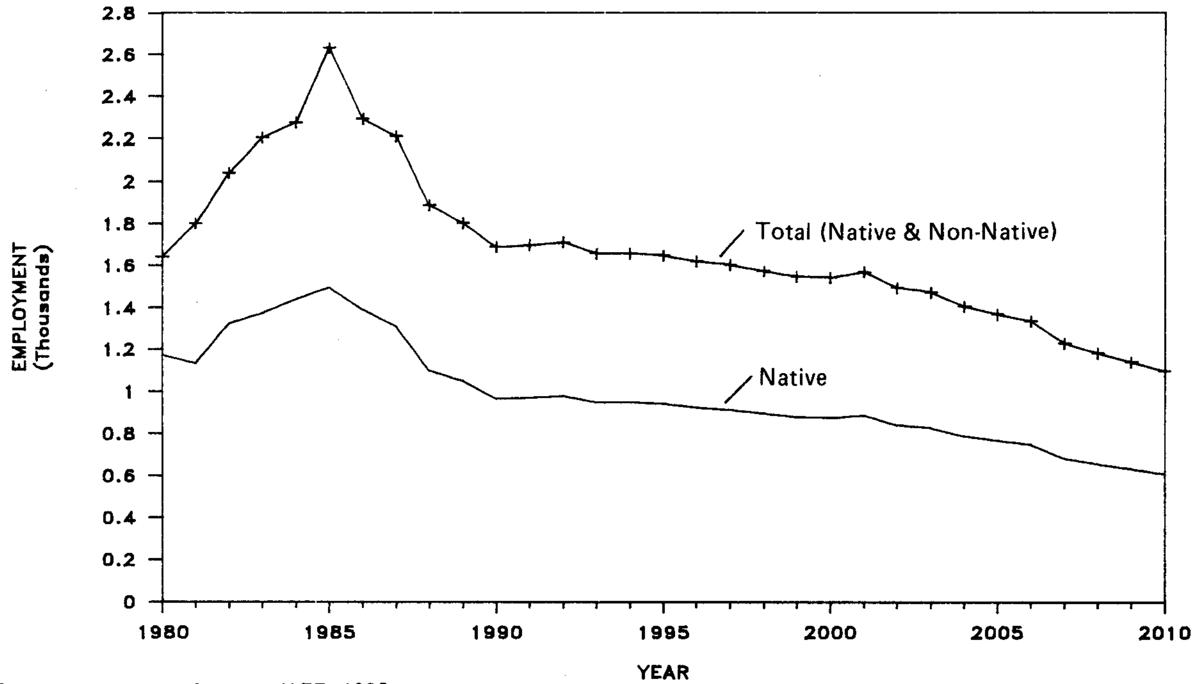
Figure III-24 presents projections of employment in the region. The biggest reason for the projected decline in resident employment is the projected decline in NSB revenues and expenditures, which results in an expected decline in NSB-funded CIP employment from 402 in 1985 to 10 by 1990. Other CIP employment is also expected to decline from 147 in 1985 to 4 by 1990. 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, from 1,343 in 1985 to 1,100 by 1990. The share of resident employment held by Natives remains at about 56 percent between the years 1985 to 2010. The unemployment rate for Natives is shown in Figure III-25. After falling for several years, the rate is projected to rise beginning in 1986 and to reach 50 percent by 2002. Out-migration of residents is projected to occur to keep the unemployment rate from rising above 50 percent. This outmigration would aggravate the reduction in NSB revenues, since intergovernmental transfers and operation revenues (from property taxes) are proportional to population levels.

Employment of Native residents in the petroleum industry is expected to rise quickly between the years 1985 and 1990 and to peak at 92 in the year 1992. This coincides with the projected dramatic decline in CIP employment. Up to 1992, industry employment of Natives is constrained primarily by the Native



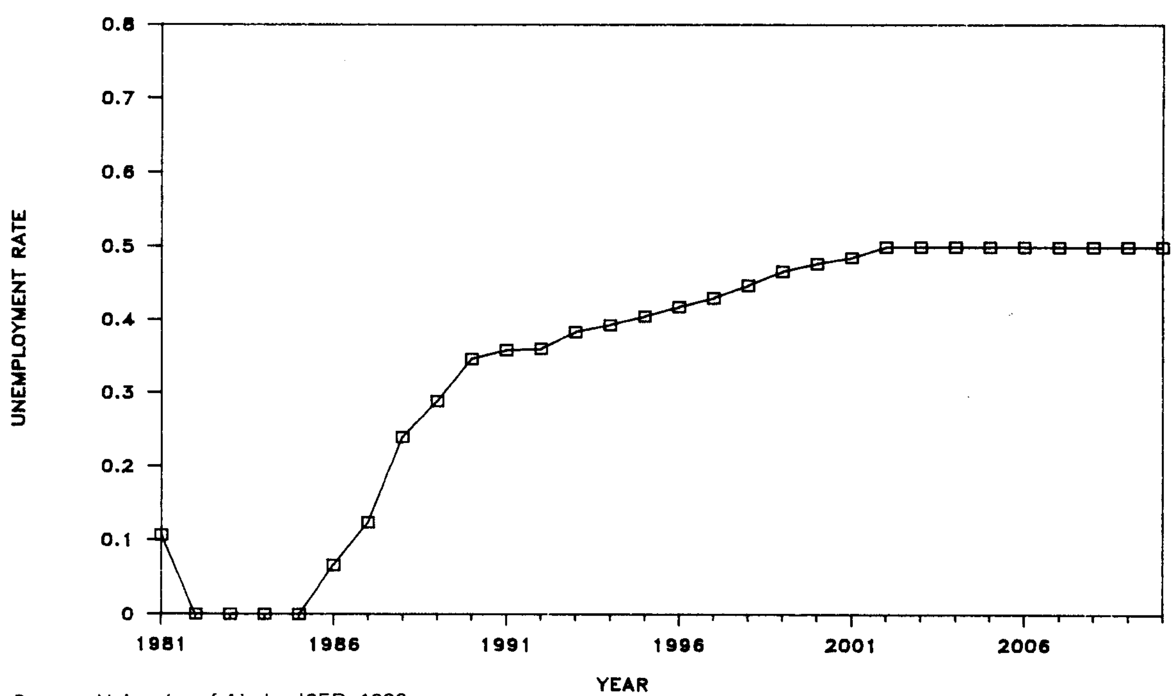
Source: University of Alaska, ISER, 1986.

FIGURE III-23. NSB EXPENDITURES (ACTUAL AND PROJECTED) BY CATEGORY, 1980 TO 2010



Source: University of Alaska, ISER, 1986.

FIGURE III-24. EMPLOYMENT (ACTUAL AND PROJECTED) OF NATIVE AND NON-NATIVE RESIDENTS OF THE NSB UNDER EXISTING CONDITIONS, 1980 TO 2010



Source: University of Alaska, ISER, 1986.

FIGURE III-25. UNEMPLOYMENT RATES (ACTUAL AND PROJECTED) FOR NATIVE RESIDENTS OF THE NSB AFTER MIGRATION, 1981 TO 2010

Table III-D-1
Estimated Native and Non-Native Resident Employment by Category
in the North Slope Region in 1985

Employment Category	Resident's Status Native (percent)	Non-Native (percent)	Total (percent)
NSB Operations	681 (45%)	662 (58%)	1,343 (51%)
NSB CIP	302 (20%)	100 (9%)	402 (15%)
Local Support	315 (21%)	317 (28%)	632 (24%)
Other CIP	147 (10%)	0 (0%)	147 (6%)
Federal and State Government	23 (2%)	57 (5%)	80 (3%)
Oil Industry	30 (2%)	0 (0%)	30 (1%)
Subtotals	1,497 (100%)	1,136 (100%)	2,633 (100%)

Source: University of Alaska, ISER, 1986.

labor supply (willingness to take advantage of industry-employment opportunities). After 1992, Native employment would be limited by industry's demand for labor (ability and willingness to offer industry-employment opportunities to Natives).

2. Land Use Plans and Coastal Management Programs:

a. Land Status and Use: Most land in the North Slope Borough is held by a few major landowners. The predominant landowner within the NSB is the Federal Government. Of the approximately 20 million hectares in the region north of 68° N. latitude, over one-half is contained in the National Petroleum Reserve-Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR). Other major landholders include the State of Alaska (1.4 million hectares) and the eight Native village corporations and the Arctic Slope Regional Corporation (1.9 million hectares). Complexity in land-ownership patterns is a result of the Alaska Native Claims Settlement Act (ANCSA) provisions that only surface-estate rights can be conveyed to Native village corporations; subsurface-estate rights are to be conveyed to 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. The extent and location of hydrocarbon exploration, development, and production operations on the North Slope and offshore areas are discussed in the description of projects included for the cumulative case, Appendix B.

b. Land Use Planning Documents: Documents or programs that modify or control land use in the NSB include the Capital Improvements Program (CIP) and the Borough's Comprehensive Plan and Land Management Regulations. A description of land use planning documents and coastal management programs for the North Slope, as contained in Section III.D.3.c of the 87 FEIS (USDOI, MMS, 1984a), is incorporated by reference; a summary of this description, as augmented by additional material, as cited, follows.

(1) CIP: Improvements in the NSB CIP are designated for each of the eight NSB communities, for Borough-wide projects, and for Service Area 10. The boundaries of Service Area 10 extend from Harrison Bay to the Canning River and include the Kuparuk Industrial Center, Prudhoe Bay, Bullen Point, and the Oxbow Landfill.

Much of the emphasis in the CIP has been on housing. In addition to housing are projects to meet houshold requirements for water, sewage disposal, power supplies, and services; roads; airports; and conceptual master plans for service bases at Kuparuk and Bullen Point. Schools, health-care facilities, and firefighting equipment have been provided in each community. At the Borough level, emphasis seems to have shifted from physical improvements to improvements in communication. The Telehealth System facilitates diagnostic capabilities of health aides in the communities and links the hospital in

Barrow with the Anchorage Native Hospital. The NSB telecommunication system provides the opportunity for people in the outlying communities to express their opinions and concerns.

(2) NSB Comprehensive Plan and Land Management Regulations: The North Slope Borough Comprehensive Plan and Land Management Regulations were adopted in December 1982 and became effective January 1, 1983 (NSB Title 19, Chap. 80). This plan was prepared pursuant to Title 29 of the Alaska Statutes, which confers upon local governments the opportunity to prepare comprehensive plans and implement ordinances. Comprehensive Plan policies apply Borough-wide; however, CMP policies would prevail within the coastal management boundary. The CMP policies complement the comprehensive plan but provide more explicit direction.

The premise on which the comprehensive plan is written is to preserve and protect the land and water habitat essential to subsistence living and the Inupiat character of life. Based on that premise, goals, objectives, and policies have been developed for each issue to accommodate nonrenewable-resource development and to cooperate with those developing the resources.

(a) Policies: Policies of the NSB Comprehensive Plan are subdivided into development policies that detail what is and is not allowable and public policies that describe how the NSB will implement the development policies. Regulations were enacted to implement the policies in the comprehensive plan. The Land Management Regulations integrate the goals, objectives, and policies for each issue into a single set.

Exemptions to mandatory policies are granted only if the Borough's Land Management Administrator or designee determines the policy is not applicable or if the NSB Planning Commission grants a variance. Best-effort policies require only an administrative determination. These can be granted if (1) the policy is not applicable, (2) the developer has made a best effort to comply with the policy, and (3) there is no feasible or prudent alternative to the proposed compliance.

(b) Zoning Districts: Four zoning districts are included in the Comprehensive Plan and Land Management Regulations--Villages, Barrow, Conservation, and Resource Development. The purpose of the Resource Development District designation is to handle the cumulative impacts of large-scale development and to offer developers quick, inexpensive, predictable permit approvals. Development can occur in the Conservation District or without a Master Plan in a Development District but is subject to a close review to assure compliance with development policies and requires a development permit. Rezoning from a Conservation District to a Resource Development District is possible and recommended if a series of activities is anticipated. To quality for rezoning, a Master Plan must be developed and adopted as an amendment to the Comprehensive Plan and Land Management Regulations. Developments included in an approved Master Plan become "uses-by-right."

Master Plans for Kuparuk River, Milne Point, and Prudhoe Bay Resource Development Districts were approved at the time the NSB Comprehensive Plan and Land Management Regulations were adopted. These plans were the Plans of Development and Operations for each field, as approved by the Alaska Department of Natural Resources as of January 1, 1983. Since that date, a master plan for the Endicott Unit has been approved (NSB Assembly Resolution Serial No. 43-84). This Master Plan included lands in the Duck Island Unit, Prudhoe Bay Unit, and Conservation District. Approval followed an extensive review that included NSB staff analyses, public hearings and meetings, and a workshop with the developer. Because the NSB determined that the proposed plan would conflict with six "Best Efforts Policies" and one "Minimization of Negative Impacts" policy, stipulations were attached to mitigate the adverse effects and to encourage beneficial effects. Policies with which development conflicted usually related to adverse effects associated with the construction of the causeway (NSBC 19.80.031 [a], [c], [l] [sic], [q], and [r]; 19.80.032 [a]; and 19.80.040 [b]). Once the Master Plan was approved, individual projects received development permits under the 3-day review process. During these reviews, additional conditions were required to ensure conformance with Mandatory Policies, Best Efforts Policies, and Minimization of Negative Impacts Policies related to hazardous wastes, road crossings, and ice-road construction (NSBC 19.80.021 [d]; 19.80.025 [c]; 19.80.031 [a], [e], [o], [q], [r]; 19.80.032 [c]; and 19.80.040 [b]).

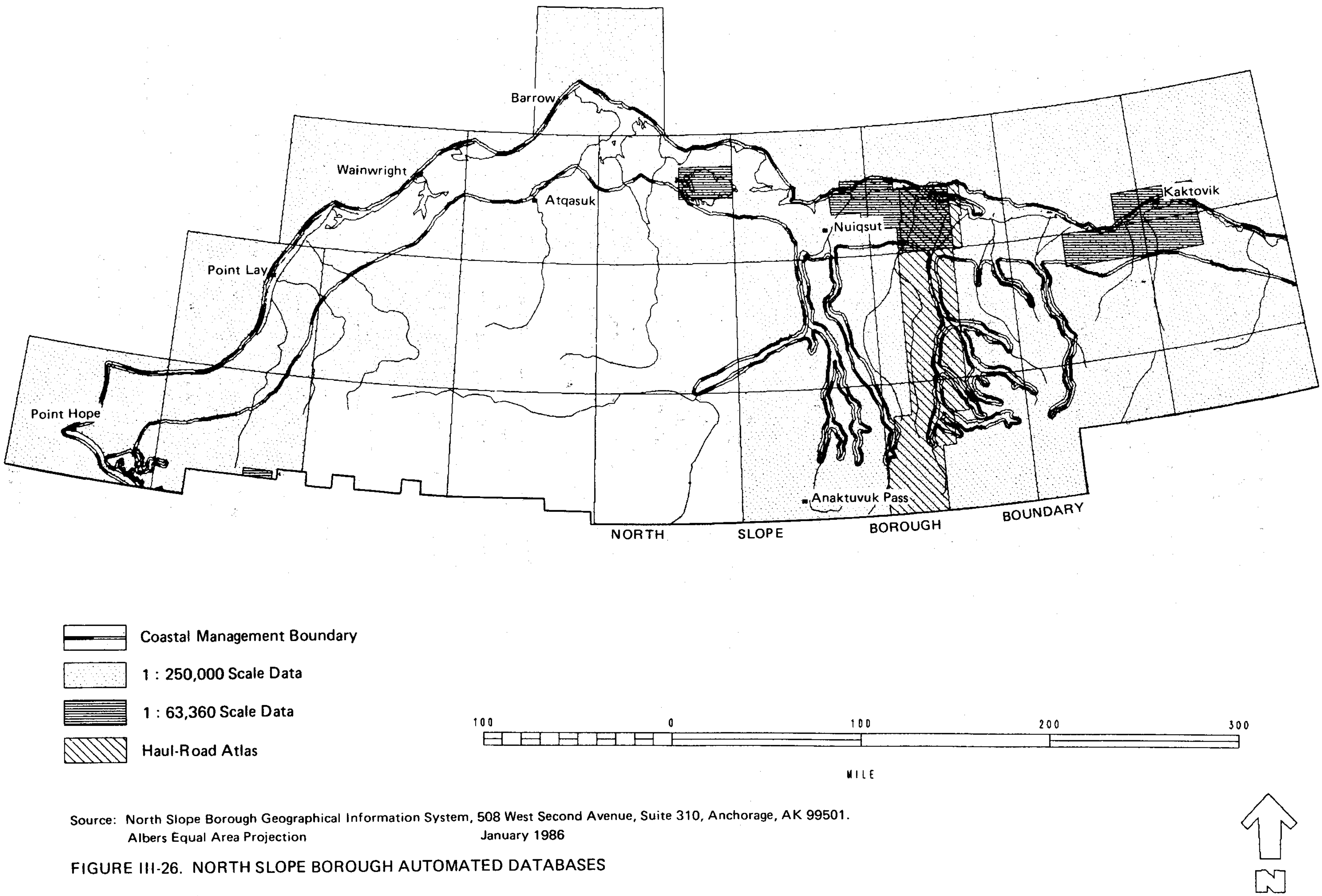
Developments at Lisburne and West Sak Sands have been pursued on a project-by-project basis. Developments included in the CIP are presumed to be consistent with the management plan and are subject only to coastal management consistency reviews.

(c) Automated Geographic Information System: The Automated Geographic Information System is integrated into the NSB Comprehensive Land Use Program. Data are mapped at two scales (Fig. III-26). At the scale 1:250,000, 20 of the 25 USGS quadrangle maps for the NSB are complete. For this scale, data files include integrated terrain units (ITU), which are a composite of vegetation, soils, geology, slope, and land use features; surface hydrology; political and administrative units; infrastructure; settlements and special features; energy and mineral resources; elevation provinces; historical and archaeological sites; NSB planning maps; and regional subsistence land use.

Much of the Prudhoe Bay Unit, Endicott Unit, and portions of the Kuparuk River Unit have been mapped at the scale 1 inch to 1 mile (1:63,360). At this scale, the files include ITU, surface hydrology, infrastructure, political and administrative units, and habitats (adapted from the NSB planning maps). The Dalton Highway also is being mapped at the scale of 1:63,360. The file is restricted to manmade changes along the corridor.

c. Coastal Management Programs (CMP):

(1) State Coastal Management Policies: Alaska's CMP is based upon the Alaska Coastal Management Act (ACMA) passed in 1977. The policies of this statute parallel those of the Federal Coastal Zone Management Act (CZMA). The Alaska Coastal Policy Council (CPC) was responsible for developing standards and guidelines to guide the implementation of the ACMA. The Alaska Department of Fish and Game identified the coastal boundaries for the State. These documents plus the EIS prepared by the U.S. Department of Commerce formed the State's CMP as initially approved by the Secretary of Commerce in 1979. Local coastal districts have developed coastal management programs tailored to their region. These programs must be adopted by the CPC and approved by the Secretary of Commerce before they can be incorporated into the ACMP.



Source: North Slope Borough Geographical Information System, 508 West Second Avenue, Suite 310, Anchorage, AK 99501.
Albers Equal Area Projection January 1986

FIGURE III-26. NORTH SLOPE BOROUGH AUTOMATED DATABASES

Eight habitats are highlighted in the standards developed for the ACMP. Each habitat is regulated to preserve those attributes that contribute to the ability of the habitat to sustain the living resources associated with it. Special policies also were created to regulate 10 aspects of development. For air and water quality, the standards are consistent with the approach taken in the CZMA; the ACMP defers to regulations that were developed for the Clean Air Act and the Clean Water Act. Coastal development standards of the ACMP rely on regulations of the U.S. Army Corps of Engineers with respect to the filling of wetlands and navigable waters. Water dependency is a prime criterion of such development. Other topics for which policies were developed include geophysical hazard areas; recreation; transportation and utilities, fish and seafood processing, timber harvest and processing; mining and mineral processing; subsistence; historic, prehistoric, and archaeological resources; and energy facilities. The greatest level of detail was developed for siting energy facilities; 16 criteria were established that relate to environmental, economic, cultural, and social considerations. For greater detail on the ACMP, refer to USDOI, MMS (1984a), and McCrea (1983), which are incorporated by reference.

State standards continue to be important, even though the NSB district program was adopted by the CPC. First, the U.S. Department of Commerce (DOC) rejected the NSB program as an amendment to the Alaska CMP, and the causes for rejection must removed before it can be incorporated into the State CMP. Second, once the district program is incorporated, the NSB policies supplement those of the State; State standards remain in effect.

(2) North Slope Borough District CMP: After a lengthy review period and many refinements, the NSB CMP was adopted by the CPC in April 1985 and rejected by the DOC in August 1986. The following paragraphs describe the NSB CMP as approved by the NSB and CPC. It is uncertain which policies will need to be altered to gain Federal approval.

The coastal zone management (CZM) boundary for the NSB, adopted in April 1985 by the Coastal CPC, is based on the interim boundary of the ACMP (Fig. III-26). Seaward, the boundary extends to the 3-mile limit of the territorial sea. Onshore, along the Beaufort Sea coast, the boundary extends inland approximately 40 kilometers, generally following the 60-meter contour. In the Mid-Beaufort Sector, the boundary was extended up several waterways to include the spawning and overwintering habitats of anadromous fish. Along the Chukchi Sea coast, it was extended inland to include the Kukpuk River and a 1-mile corridor on each bank.

The NSB CMP was developed to balance exploration, development, and extraction of nonliving natural resources and maintenence of and access to the living resources upon which the traditional cultural values and way of life are based. The approved NSB CMP contains four categories of policies: (1) "Mandatory Policies" that include both "prohibited development (considered improper uses)" and "required features for applicable development"; (2) "Best Efforts Policies" that include both "feasible and prudent policies" and "required features"; (3) "Minimization of Negative Impacts"; and (4) "Beneficial Impacts."

Those activities or developments that are prohibited under Mandatory Policies generally could cause severe harm to subsistence resources or activities or disturb cultural and historic sites. Policies covering required features of the Mandatory Policies address reasonable use of vehicles, vessels, and aircraft; engineering criteria for offshore structures; drilling plans; oil-spill-control and -cleanup plans; pipelines; causeways; residential development associated with resource development; and air quality, water quality, and solid-waste disposal.

As noted above, Best Efforts Policies fall into two categories--feasible and prudent policies and required features. In either case, two criteria were established for determining an exception in those cases where the policy is applicable. First, there must be "a significant public need for the proposed use and activity." Second, developers must have "rigorously explored and objectively evaluated all feasible and prudent alternatives . . . When alternatives are eliminated from consideration, the reasons for their elimination shall be briefly documented . . . ." Feasible and prudent policies permit certain types of development if a development has met the two criteria for Best Efforts Policies "and the developer has taken all feasible and prudent steps to avoid the adverse impacts the policy was intended to prevent." Feasible and prudent policies apply when developments could cause significantly decreased productivity of subsistence resources or ecosystems, could displace beluga whales in Kasegaluk Lagoon, or could restrict access of subsistence users to a subsistence resource. They also create restrictions on various modes of transportation, mining of beaches, or construction in certain floodplains and geologic-hazard areas.

Required features of Best Efforts Policies are applicable except when the development has met the two criteria for Best Efforts Policies and the developer has taken all feasible and prudent steps to maximize conformance with the policy. Developments and activities regulated under these policies include coastal mining, support facilities, gravel extraction in floodplains, new subdivisions, and transportation facilities. Siting policies include the State habitat policies and noninterference with important cultural sites or essential routes for transportation to subsistence resources.

All applicable developments must minimize "negative impacts." Regulated developments include recreational uses, transportation and utility facilities, and seismic exploration. Protected features include permafrost, subsistence activities, important habitat, migrating fish, and wildlife. Geologic hazards must be considered in site selection, design, and construction.

Under Policies for Beneficial Impacts, development can receive positive reviews if it incorporates features that provide benefits to residents, such as preferred employment and housing practices, lower cost fuel or power to adjacent villages, and conservative practices that protect subsistence resources.

The NSB has adopted administrative procedures for implementing these policies based on the permit process established under Title 19 of the Borough's land use regulations and the consistency review process of Title 46 of the Alaska Statutes.

3. <u>Archaeological Resources</u>: The two major time sequences of archaeological resources of the Beaufort Sea Sale 97 area are prehistoric and historic. Archaeological resources are any objects or features that are

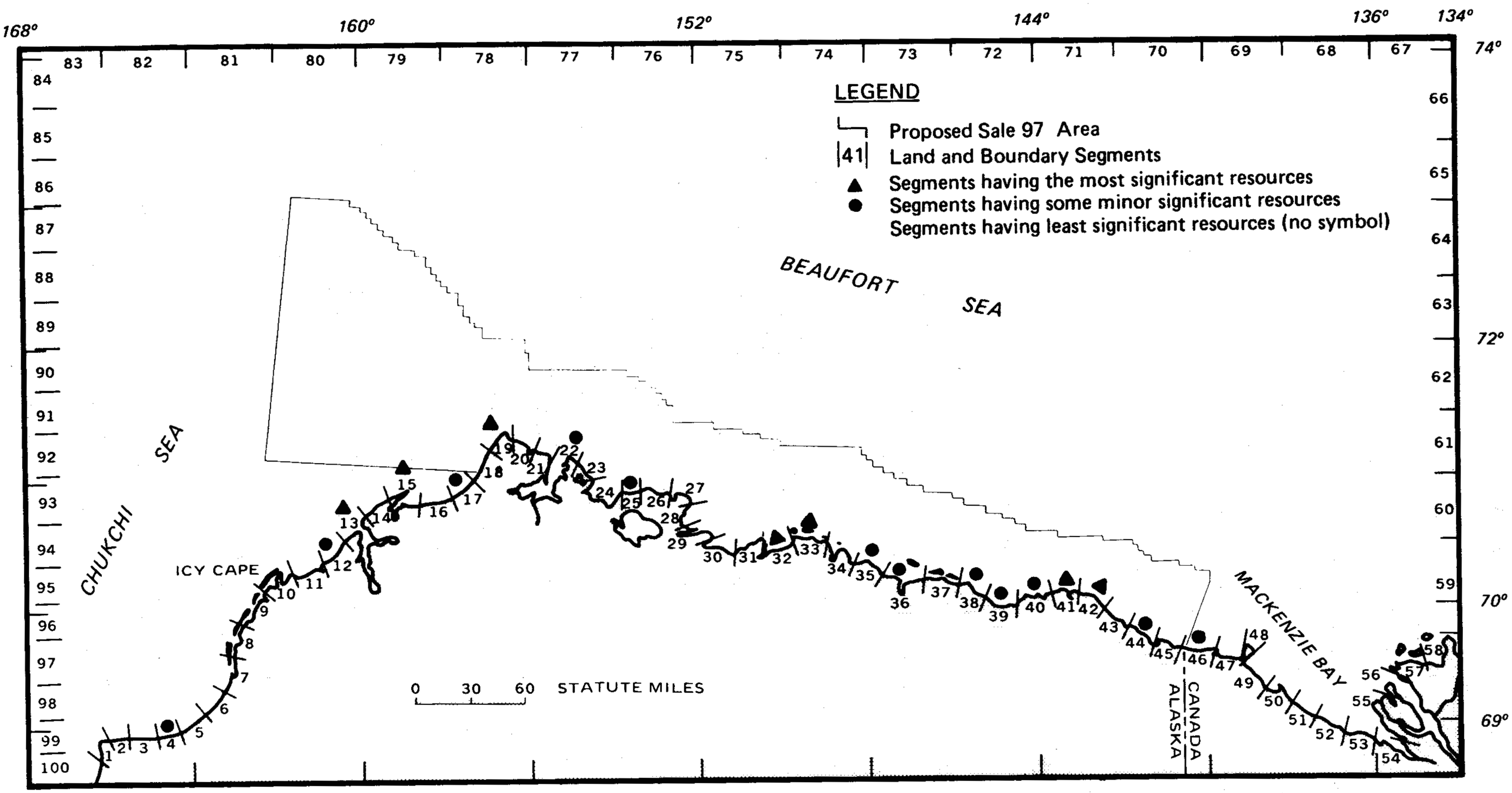
manmade or modified by human activity. Significant archaeological resources are either historic or prehistoric and, as defined by 36 CFR 60.4, generally include properties greater than 50 years old that are associated with events that have made a significant contribution to the broad patterns of our history; are associated with the lives of persons significant in the past; embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; represent a significant and distinguishable entity whose components may lack individual distinction; or have yielded, or may be likely to yield, information important in history or prehistory.

The description of the archaeological resources in the Beaufort Sea and shore as contained in Section III.D.4 of the Sale 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference. A summary of this description, augmented by additional material, as cited, follows. These resources represent the remains of the material culture of past generations of the region's prehistoric and historic inhabitants. They are basic to our understanding of the knowledge, beliefs, art, customs, property systems, and other aspects of the nonmaterial culture. The three major categories of prehistoric and historic archaeological resources identified in the Sale 97 area are 1) onshore sites, 2) offshore sites, and 3) shipwrecks.

a. Onshore Sites: The predominant types of prehistoric resources found on the shores near the proposed Sale 97 area are housepits containing the household and subsistence artifacts of early people (stone lamps, carved ivory, harpoons, etc.). (Refer to the EIS's for Sales 71 [USDOI, BLM, 1982] and 87 for National Register site locations, other archaeological resources, and historic sites and buildings [approximately 1720-1920 and shipwrecks after 1741].) (Also refer to Fig. III-27 for numbers of resources for OSRA land segments.)

The following new information exists that might change the effects of oil exploration and development from those given in the FEIS's for Sales BF, 71, and 87. A recent discovery of an Eskimo family preserved for about two or three centuries in their house on the eroding edge of the Beaufort Sea near Barrow alerts all concerned to the importance of the rapidly eroding shoreline in the Beaufort Sea as a source of knowledge of the past. Appendix H, Table H-1, combines important new material on ancient resources and shipwrecks to categorize segments of the shoreline into four categories of archaeological-resource-type segments that will update and provide easier analysis of the effects of exploration and development on historic and ancient resources (see Sec. IV.B.12).

b. Offshore Sites: The MMS Archaeological Analysis for Lease Sale 87, Diapir Field (see Appendix H, this EIS), has been updated for possible archaeological landforms on the Bering Land Bridge. In this report, new information is examined. The report states that no blocks (1) have the potential for prehistoric sites, (2) contain landforms significant for human habitation, and (3) have enough Holocene sediments for site protection and preservation. "Since prehistoric sites generally occur in predictable geographic areas, it has been proposed in various studies that the same areas where sites of a given period occur on land will be the same areas where sites will occur on the now submerged shelf. These geographic areas with high probability for associated prehistoric sites are listed in Table 1."



Source: MMS, Alaska OCS Region Computer File (Tornfelt, 1986).

FIGURE III-27. SHIPWRECKS AND ARCHAEOLOGICAL, RECREATIONAL, AND TOURISM RESOURCES

(See Table 1, MMS Archaeological Report, Appendix H.) Early man has occupied the Beaufort Sea shelf area during the past 18,000 years, but there is little chance that any of his habitation sites would have survived the tremendous amount of ice gouging that has occurred. If a prehistoric site did survive, it is unlikely that it could be detected by present seismic-reflection methods, because the subsurface sediments are so jumbled and homogenized that they do not give good returns on the records. It appears that ice gouging and scouring of the sea bottom would preclude survival of a prehistoric site anywhere in the Sale 97 area. No new evidence of such survival is provided with surveys done since this report. Open File Report 84-395 (USDOI, USGS, 1984) examines the latest available data. This report was presented at the Information Update Meeting for the Beaufort Sea held at Anchorage, Alaska, on March 6 and 7, 1985 (Sec. I.A.6). On the basis of this report, the possibility of the survivability of offshore archaeological resources other than shipwrecks would be small.

c. Shipwrecks: Between 1868 and 1914, 28 shipwrecks have occurred a few miles north and east of Barrow and 33 have occurred a few miles north and west of Point Belcher (see Fig. III-20). (See Tornfelt, 1982 and 1987, for details on shipwrecks.) No surveys for locations of these shipwrecks have been made. Neither have any of the shipwrecks been accidently or deliberately discovered; therefore, no exact locations are known. As near as can be determined, the blocks where shipwrecks might be located and would be protected by Stipulation No. 1, Protection of Archaeological Resources (see Sec. II.B.I.c), are listed in Appendix H.

Shipwrecks are counted relative to oil-spill-risk analysis (OSRA) land segments in Table H-1, Appendix H, to determine four types of land values with regard to known but undiscovered shipwreck resources. Knowledge of such shipwrecks is useful in analyzing the effects (in Sec. IV) of transportation pipelines and facilities such as causeways interfacing between platforms and onshore transportation of oil.

4. Recreation and Tourism Resources: The description of the recreation and tourism resources in the Beaufort Sea and shore as contained in Section III.D.5 of the 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference. A summary of this description, augmented by additional material, as cited, follows. There are four categories of recreation and tourism values in the Sale 97 area; each is associated with a different type of visitor interest (see Appendix K, Table K-1): Type I, high economic values and high noneconomic qualities; Type II, low economic values and high noneconomic qualities; Type III, high economic values with low noneconomic qualities; and Type IV, low economic values with low noneconomic qualities. These latter two types are less related to recreation and tourism and are not discussed in detail.

The recreational-resource qualities of seasonal changeability of the natural land/seascape, the solitude, the challenge of the environment, the specialness of the area, the visual qualities, and the unity of offshore and onshore are used through transportation by backpacking, skiing, and traveling by snowmachine. Often, recreational fishing and hunting activities are part of the trips. The State Division of Parks and the Joint Federal-State Land Use Planning Commission have identified certain areas adjacent to the Sale 97 area that have recreation and tourism resource values (State of Alaska, Dept. of Natural Resources, Div. of Parks, 1976; State of Alaska Joint Federal/State

Land Use Planning Commission, 1978). These values attract numbers of visitors to the area as shown by the Alaska Department of Commerce and Economic Development study (State of Alaska, Dept. Commerce and Economic Dev., Div. of Tourism, 1983). The Alaska "Travelers Survey and Visitor Industry Analysis" reported that of all surveyed visitors to Alaska, about 2 percent visited the Barrow-North Slope area and the adjacent surrounding area as well as other cities in Alaska. Therefore, of the approximate 645,960 visitors to Alaska from October 1982 to September 1983, a substantial number visited the area at least once (approximately 3,900). The report states that an average of 500 people in the Barrow-North Slope area were employed as a result of these visitors and that the visitors brought in about $19.5 million in total wages to the area. According to recent figures, the trend from 1983 to the present has been toward $25 million in tourist trade for the area.

The descriptive material in the following paragraphs is arranged according to the two major categories labeled Type I and Type II in the first paragraph of this description and identified in Table K-1, Appendix K.

a. Type-I Area--High Economic Values and High Noneconomic Qualities: Land Segments 19, 20, 24, and 30 to 34 (Fig. III-27) are visited most frequently by tourists because of their intrinsic cultural and recreational qualities and because they are accessible by air. Barrow, Nuiqsut, and Kaktovik and adjacent land segments to these cities or villages are such types of shore segments. The area of the OCS seaward of these segments is similarly interesting and fits in the same category.

About 5,000 people come to Barrow yearly and make excursions into remote areas. Such excursions from this entry point and entry points at Nuiqsut and Kaktovik involve backpacking, cross-country skiing, float trips, observing wildlife, and other recreational activities.

The visual values of the coastline near Barrow (Fig. III-27, Seg. 20) differ because of cultural modification. For example, the Prudhoe Bay shoreline is different at night than in daylight. The difference when flying over this vast terrain at night is seeing the lights that highlight the city against the darkness. This kind of skyline is also noticed at Prudhoe Bay and Kaparuk (Fig. III-27, Seg. 34). Those who have seen the shoreline the way it was 5 to 10 years ago especially notice this new shoreline.

b. Type-II Area--Low Economic Values and High Noneconomic Qualities: There are no official onshore wilderness areas adjacent to the Sale 97 area. Wilderness areas have been proposed in the past because the land has qualities that merit this status. However, there is the protected Arctic National Wildlife Refuge (Fig. III-27, Seg. 35-48), where a variety of controlled recreational interests can be pursued. The qualities found in such areas are remoteness, exceptional wildlife species, exceptional terrain, and other wilderness qualities that are not found in more populated regions.

The pristine character of the National Petroleum Reserve in Alaska (NPR-A) (Fig. III-27, Seg. 12-33 and inland) is an attractive onshore feature in the Sale 97 area. Few people actually go deeply into the NPR-A areas onshore. Those who do backpack, cross-country ski, float rivers, and observe wildlife in near-wilderness-type settings. Although these activities are not by themselves exceptional, when they are coupled with the remoteness of the area, these outdoor experiences are almost incomparably better than in any other area in the United States. Even in Alaska, there are few areas such as this where one can be 160 kilometers or more from the closest village or site of human activity. (See the FEIS's for Sales 71 [USDOI, BLM, 1982] and 87 [USDOI, MMS, 1984a] and NPR-A Study Report 2, 1978, for details on specific onshore recreational pursuits and outdoor qualities.) The qualities of seasonal changeability of the natural land/seascape, the solitude, the challenge of the environment, the specialness of the area, the visual qualities, and the unity of offshore and onshore are used through transportation by backpacking, skiing, and snowmachining. Often, recreational fishing and hunting activities are part of the trips.

The offshore environment of the Sale 97 area is seasonally variable. The summer water environment may be comparable to other ocean areas year-round, but the winter is unique because of the presence of sea ice. The pack ice is constantly moving, and on occasion the ice in the nearshore area also moves. Ice motion can form ridges, leads, and polynyas. In the nearshore areas, it forms rubble piles, or the ice advances onshore over low-lying islands or coastal areas. People use the ice areas for hunting, fishing, and recreation. This remote area provides solitude, challenge, a special environment, and other primitive survival values.

Viewed from offshore and onshore, the summer landscape has a character defined by landform, vegetation, water, and color. There are thousands of miles of shoreline in the Sale 97 area. Upon close inspection, one finds that the coastline is not monotonous and unchanging but that it is actively eroding and that there are distinct differences in landforms between the coastlines of the Chukchi and Beaufort Seas (Fig. III-27, Seg. 1 to 19 and 20 to 45, respectively). There is little relief along the Beaufort Sea coastline except where the Arctic National Wildlife Refuge comes to the shoreline and along Elson Lagoon (Seg. 20), Dease Inlet (Seg. 20), and Peard Bay (Seg. 15), where flat, elongated offshore islands and spits formed by longshore currents add to the visual variety (Fig. III-27). The Chukchi Sea shoreline south of Barrow toward Point Belcher also has eroding cliffs and interesting varieties of creek entries to the sea. In the winter, a feature peculiar to the Beaufort Sea (Fig. III-27, Seg. 21-41) is that it is nearly impossible to tell where onshore and offshore begin and end. This unity of shore and offshore lasts for as long as 9 months of the year. It is a particularly unique feature of this area that is related to remote outdoor resources and recreational values.

5. Water Quality: The description of the water quality of the Beaufort Sea Planning Area and inshore waters as contained in Section III.D.6 of the 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference; a summary of this description, augmented by additional material, as cited, follows.

Because there has been little or no industrial activity, most impurities 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, and natural seeps. The rivers that flow into the 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-meter 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-meter isobath had suspended-sediment concentrations that ranged from 0.3 to 2.1 parts per million. The water samples for these measurements were taken at the surface and at various depths; at one of the stations, the water at 90 meters was also 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-meter 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. 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 of oxygen per liter. 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 milliliters of oxygen per liter. In areas of reduced circulation or high respiration, further depletion occurs. Schell (1975) found only 2 milliliters 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: Trace-metal concentrations in the Beaufort Sea Planning Area are low and show no indication of pollution (Table III-D-2). Concentrations within the sediment are similar to those for other coastal seas. Slope and abyssal concentrations in sediments do not show the increase that is often evidenced with greater water depths in oceans. Existing water concentrations are one-to-three orders of magnitude lower than those required by Federal saltwater-quality criteria. A baseline monitoring program originated by MMS in 1984 has found no evidence of trace-metal contamination of sediments or benthic fauna (Boehm et al., 1985).

d. Hydrocarbons: Background hydrocarbon concentrations are low. In the water, they are on the order of 1 part per billion or less and appear to be biogenic. Both aliphatic and aromatic hydrocarbons occur in sediments of the Alaskan Beaufort Sea (OSCEAP data, NODC/NOAA data bank). The aliphatic hydrocarbons range between 13 to 41 parts per million and are mostly of recent biological origin. The aromatic hydrocarbons range between 8 and 16 parts per million and appear to be derived from nonindustrial, abiotic source materials. A baseline monitoring program originated by MMS in 1984 has found no evidence of hydrocarbon contamination of sediments or benthic fauna (Boehm et al., 1985).

6. Air Quality: The description of the air quality of the Beaufort Sea Planning Area and neighboring lands as contained in Section III.D.7 of both the Sale 71 FEIS (USDOI, BLM, 1982) and Sale 87 FEIS (USDOI, MMS, 1984a) is incorporated by reference. A summary of these descriptions follows.

The only major local source of industrial emissions existing in Arctic Alaska is the Prudhoe Bay/Kuparuk complex. This complex increases downwind air concentrations relative to upwind concentrations by 43 percent for nitrogen dioxide, 70 percent for sulfur dioxide, 86 percent for carbon monoxide, and 210 percent for total suspended particulates.

Even with the high level of oil and gas activity at Prudhoe Bay and Kuparuk, the North Slope and nearby Beaufort Sea Planning Area generally have what is considered good air quality. In summer and fall, regional pollutant levels are extremely low, in some cases similar to those of the Antarctic. However, in winter and spring, pollutants are transported to Arctic Alaska from across the North Pole, from industrial Europe and Asia. Concentrations of aerosol haze during winter and spring at Barrow are similar to those of major cities in the continental U.S. but are considerably higher than levels south of the Brooks Range at Fairbanks. Despite this seasonal long-distance transport of pollutants into the Arctic, regional air quality still is within Federal and State standards.

Table III-D-2
Trace-Metal Concentrations in the Beaufort Sea

	Chromium	Mercury	Lead	Zinc	Cadmium	Barium	Copper	Nickel	Vanadium
A. SEDIMENTS (parts per million)									
Nearshore, Lagoons, and Bays [1]	52	0.02[2]	8	62	0.1	405	19	33[3]	79
Shelf [4]	85[3]	0.07[5]	3[5]	98	0.2[5]	--	57	47	140[3]
Slope and Abyssal [4]	99[6]	--	--	82	--	--	59	56	192[6]
Average World Coastal Ocean [7]	100	--	20	5-200[5]	0.2-3.0[5]	750	48	55	130
B. SUSPENDED SEDIMENTS (parts per million of dry weight) [8]	21-140	--	--	8-232	--	--	5-83	10-100	2-307
C. Water (parts per billion)									
Total [8]	0.1-2.1	--	--	0.4-3.7[9]	--	--	0.4-2.1	--	--
Dissolved [5]	0.02-0.3	0.01-0.027	0.02-1.7	0.2-3.4	0.02-0.11	--	0.3-1.8	--	--
EPA Total Saltwater Criteria [10]	50[11]	0.025[11]	5.6[11]	86[12]	9.3[11]	None	2.9[14]	7.1[12]	None

Sources: As indicated in the footnotes below.

1/ Boehm et al., 1985.
2/ Northern Technical Services, 1981b.
3/ Naidu, 1982.
4/ Naidu, 1974.
5/ Thomas, 1978.
6/ Naidu et al., 1980.
7/ Chester, 1965.
8/ OCSEAP data, NODC/NOAA data bank.
9/ Burrell et al., 1970.
10/ USEPA, 1986.
11/ 4-hour average, not to be exceeded more than once in 3 years.
12/ 4-day average concentration (52 FR 6213)
13/ 1-hour average, not to be exceeded more than once in 3 years.
14/ 24-hour average, not to be exceeded.

IV

ENVIRONMENTAL CONSEQUENCES

IV

Section IVA and IVB - Table of Contents

Page

IV. Environmental Consequences....................... A- 1

A. Basic Assumptions for Effects Assessment.... A- 1
1. Oil-Spill-Risk Analysis................ A- 2
a. Estimated Quantity of Resource........................ A- 2
b. Probability of Oil Spills Occurring...................... A- 3
(1) Transportation Assumptions... A- 3
(2) Projected Spillage........... A- 4
(3) Probability of Spillage...... A- 5
(4) Most Likely Number of Spills.................... A- 5
(5) Size of a 1,000-Barrel-or-Greater Spill........... A- 5
(6) Exploratory Spills........... A- 6
(7) Cumulative Case.............. A- 6
c. Oil-Spill-Trajectory Simulations.......................... A- 6
(1) Winter Trajectories.......... A- 7
(2) Summer Trajectories.......... A- 8
(3) Conditional Probabilities.... A- 8
(4) Combined Probabilities....... A- 9
2. Aspects of Spilled Oil................ A- 9
a. Fate and Behavior of Spilled Oil............................ A- 9
b. Likelihood, Extent, and Persistence of Oiled Shoreline......... A- 10
(1) Likelihood of Land Contact... A- 10
(2) Extent of a Shoreline Spill..................... A- 11
(3) Persistence of Stranded Oil....................... A- 12
(4) Summary...................... A- 12
c. Oil-Spill-Contingency Measures.... A- 13
(1) Contingency Plans............ A- 13
(2) Applicability of Oil-Spill-Response Techniques in the Proposed Sale Area......... A- 14
(3) Locally Available Spill-Cleanup Equipment.......... A- 14
(4) Mobilization Time............ A- 15
(5) Effectiveness of Oil-Spill Cleanup at Sea............. A- 15
(6) Effectiveness of Oil-Spill Cleanup in Ice............ A- 16
d. Toxicity of Oil in the Marine Environment.................... A- 16
(1) Crude Oil Characteristics.... A- 17
(2) Comparative Toxicity of Different Oil Forms in Water..................... A- 17
(3) Comparative Toxicity of Oil Types..................... A- 17
(4) Biological Differences....... A- 17
3. Constraints and Technology............ A- 18
a. Sea Ice.......................... A- 18
(1) Exploration.................. A- 18
(2) Development and Production... A- 21
(3) Transportation............... A- 22
(a) Offshore Pipelines...... A- 22
(b) Marine-Transportation System............... A- 23
b. Other Constraints................ A- 25
(1) Permafrost................... A- 25
(2) Natural Gas Hydrates......... A- 26
(3) Waves, Currents, and Storm Surges--Flooding and Erosion................... A- 26
(4) Faults and Earthquakes....... A- 27
(5) Unstable Sediments........... A- 27
(6) Shallow-Gas Deposits......... A- 28
4. Major Projects Considered in Cumulative-Effects Assessment........ A- 29

DEFINITIONS ASSUMED FOR EFFECTS ASSESSMENT........... B- 1

B. Alternative I - Proposal................... B- 1
1. Effects on Lower-Trophic-Level Organisms........................... B- 1
a. Effects of the Proposal........... B- 1
(1) Oil Spills.................. B- 1
(a) Effect of Oil on Marine Plants......... B- 2
(b) Effect of Oil on Bacteria............. B- 3
(c) Effect of Oil on Invertebrates......... B- 4
(d) Effect of Oil on Communities........... B- 6
(2) Seismic Surveys.............. B- 8
(3) Drilling Discharges.......... B- 9
(4) Construction Activities...... B- 10
(5) Summary...................... B- 11
(6) Conclusion................... B- 12
b. Cumulative Effects................ B- 12
(1) Oil Spills................... B- 12
(2) Shallow-Hazards Surveys...... B- 13
(3) Drilling Discharges.......... B- 13
(4) Construction Activities...... B- 14
(5) Conclusion................... B- 15
2. Effects on Fishes..................... B- 15
a. Effects of the Proposal........... B- 16
(1) Oil Spills................... B- 16
(a) General Effects......... B- 16
(b) Aspects of Habitats and Life Histories Vulnerable to Effects of Oil............... B- 16
(c) Species-Specific Effects B- 18
(d) Site-Specific Effects... B- 23
(2) Seismic Surveys.............. B- 24
(3) Drilling Discharges.......... B- 24
(4) Construction Activities...... B- 25
(5) Summary...................... B- 26
(6) Conclusion................... B- 27
b. Cumulative Effects................ B- 27
(1) Oil Spills................... B- 27
(2) Shallow-Hazards Surveys...... B- 28
(3) Drilling Discharges.......... B- 28
(4) Construction Activities...... B- 29
(5) Conclusion................... B- 31
3. Effects on Marine and Coastal Birds.... B- 31
a. Effects of the Proposal........... B- 31
(1) Effects of Oil Spills........ B- 31
(a) General Effects......... B- 31
(b) Site-Specific Effects--Oil Spills............ B- 32
(2) Effects of Disturbance....... B- 33
(3) Effects of Exploration and Production Construction Activities.............. B- 35
(4) Effects of Pipeline and Onshore Construction....... B- 35
(5) Summary...................... B- 36
(6) Conclusion................... B- 37
b. Cumulative Effects................ B- 37
(1) Effects of Oil Spills........ B- 37
(2) Effects of Offshore Construction.............. B- 38
(3) Effects of Onshore Construction.............. B- 38
(4) Effects of Noise and Disturbance............... B- 39
(5) Overall Cumulative Effects... B- 39
(6) Conclusion................... B- 40
4. Effects on Pinnipeds, Polar Bears, and Beluga Whales..................... B- 40
a. Effects of the Proposal........... B- 40
(1) Effects of Oil Spills........ B- 40
(a) General Effects of Oil Pollution............ B- 40
(b) Direct Effects of Oil... B- 40
(c) Oil-Spill Avoidance..... B- 41
(d) Indirect Effects of Oil................. B- 41
(e) Site-Specific Effects of Oil Spills............ B- 41
(2) Effects of Noise and Disturbance............... B- 43
(a) Airborne Noise.......... B- 43
(b) Underwater Noise........ B- 44
(c) Site-Specific Noise and Disturbance Effects... B- 46
(3) Effects of Geophysical Seismic Activities......... B- 47
(4) Effects of Offshore Construction................. B- 48
(5) Effects of Onshore Construction................. B- 48
(6) Summary...................... B- 48
(7) Conclusion................... B- 50

Section IVA and IVB - Table of Contents
(continued)

Page

b. Cumulative Effects................ B- 50
(1) Effects of Oil Spills........ B- 50
(2) Effects of Noise and Disturbance................ B- 51
(3) Effects of Habitat Alteration....................... B- 51
(4) Overall Cumulative Effects... B- 52
(5) Conclusion................... B- 52
5. Effects on Endangered and Threatened Species............................. B- 52
a. Endangered Species Act (ESA) Consultation.................... B- 52
b. Effects on the Bowhead Whale...... B- 53
(1) Effects of the Proposal...... B- 53
(a) Summary................. B- 61
(b) Conclusion.............. B- 61
(2) Cumulative Effects........... B- 61
c. Effects on the Gray Whale......... B- 63
(1) Effects of the Proposal...... B- 63
(a) Summary................. B- 67
(b) Conclusion.............. B- 67
(2) Cumulative Effects........... B- 67
d. Effects on the Arctic Peregrine Falcon.......................... B- 69
(1) Effects of the Proposal...... B- 69
(a) Summary................. B- 70
(b) Conclusion.............. B- 70
(2) Cumulative Effects........... B- 70
6. Effects on Caribou..................... B- 70
a. Effects of the Proposal........... B- 70
(1) Effects of Present North Slope Development.......... B- 70
(2) General Effects of Disturbance................ B- 71
(3) Effects of Site-Specific Onshore Development Associated With the Proposal.................. B- 72
(a) Oil Transportation East of Prudhoe Bay........ B- 72
(b) Oil Transportation West of Prudhoe Bay to Barrow................ B- 73
(c) Oil Transportation West of Point Barrow....... B- 73
(4) Effects of Oil Spills........ B- 74
(a) General Effects of Oil Spills................ B- 74
(b) Site-Specific Effects of Oil Spills......... B- 74
(5) Summary...................... B- 74
(6) Conclusion................... B- 76
b. Cumulative Effects................ B- 76
(1) Effects of Disturbance....... B- 76
(2) Effect on Displacement from Calving Areas......... B- 77
(3) Effects of Habitat Alteration and Destruction....... B- 78
(4) Effect of Roads.............. B- 78
(5) Overall Cumulative Effects on Caribou................ B- 78
(6) Conclusion................... B- 79
7. Effects on Population.................. B- 79
a. Effects of the Proposal........... B- 79
b. Cumulative Effects................ B- 80
8. Effects on North Slope Sociocultural Systems............................. B- 81
a. Effects of the Proposal........... B- 82
(1) Effects of Revenues.......... B- 82
(a) Recent Changes in the Quality of Family Life.................. B- 82
(b) Private-Sector-Enterprise Opportunities.................. B- 83
(c) The Effects of Community Services on Traditional Social Behavior............. B- 83
(d) Social Pathologies...... B- 84
(e) Kinship and Sharing..... B- 85
(f) The Persistence of Sharing Bowhead Whale Meat.................. B- 85
(g) Changing Attitudes Towards Sharing Bowhead Whale......... B- 86
(h) Changes in the Sharing of Meat.............. B- 86
(i) Traditional Values--Native-Language Retention............ B- 87
(j) Effects of Energy Development on Community Attitudes Toward Government..... B- 87
(2) Effects of Offshore Oil Spills..................... B- 87
(3) Summary...................... B- 88
(4) Conclusion................... B- 88
b. Cumulative Effects................ B- 88
(1) Cumulative Effects of Onshore and Offshore Revenues...... B- 88
(a) Quality of Community Life: Cost of Living................ B- 88
(b) Private-Sector-Enterprise Opportunities.................. B- 89
(c) The Effects of Community Services on Traditional Social Behavior............. B- 89
(d) Social Pathologies...... B- 90
(2) Offshore Development: Cumulative Effects of Oil Spills................. B- 90
(3) Summary of Cumulative Effects of Offshore Oil Spills..... B- 91
(4) Summary of Cumulative Effects of Onshore Development..... B- 91
(5) Conclusion: Cumulative Effects of Onshore and Offshore Development....... B- 92
9. Effects on Subsistence-Harvest Patterns............................ B- 92
a. Effects of the Proposal........... B- 92
(1) Effects on Subsistence Harvests by Resource....... B- 92
(a) Effects on Marine Mammal Harvests.............. B- 92
(b) Effects on Caribou Harvests.............. B- 97
(c) Effects on Fish Harvests.............. B- 98
(d) Effects on Marine and Coastal Bird Harvests. B- 99
(2) Summary of Effects on Subsistence Harvests by Community................. B-100
(a) Wainwright.............. B-100
(b) Barrow-Atqasuk.......... B-100
(c) Nuiqsut................. B-101
(d) Kaktovik................ B-101
(e) Other Communities....... B-102
(3) Conclusion (Effect on Subsistence-Harvest Patterns)................. B-102
b. Cumulative Effects................ B-102
(1) Oil Spills................... B-103
(2) Noise and Disturbance........ B-104
(3) Facility Sitings............. B-105
(4) Summary...................... B-105
(5) Conclusion................... B-106
10. Effects on the Economy of the North Slope Borough.................. B-106
a. Effects of the Proposal........... B-106
(1) NSB Revenues and Expenditures...................... B-106
(2) Employment................... B-106
(3) Summary...................... B-108
(4) Conclusion................... B-108
b. Cumulative Effects................ B-108
(1) NSB Revenues and Employment....................... B-108
(2) Conclusion................... B-109

Section IVA and IVB - Table of Contents
(continued)

Page

11. Effects on Land Use Plans and Coastal Management Programs.......... B-109
- a. Effects of the Proposal........... B-109
  - (1) Land Use Plans............... B-109
    - (a) Capital Improvements Program.............. B-109
    - (b) NSB Comprehensive Plan and Land Management Regulations........... B-109
  - (2) Coastal Management Programs.................. B-111
    - (a) Coastal Development (6 AAC 80.040)........ B-111
    - (b) Geophysical Hazard Areas (6 AAC 80.050).. B-112
    - (c) Energy Facilities (6 AAC 80.070)........ B-112
    - (d) Transportation and Utilities (6 AAC 80.080)........ B-113
    - (e) Mining and Mineral Processing (6 AAC 80.110)........ B-113
    - (f) Subsistence (6 AAC 80.120)........ B-114
    - (g) Habitats (6 AAC 80.130)........ B-114
    - (h) Air, Land, and Water Quality (6 AAC 80.140)........ B-116
    - (i) Historic, Prehistoric, and Archaeologic Resources (6 AAC 80.150)........ B-116
  - (3) Summary...................... B-117
  - (4) Conclusion................... B-117
- b. Cumulative Effects................ B-117
  - (1) Land Use Plans............... B-117
  - (2) Coastal Zone Management...... B-118
    - (a) Energy Facilities (6 AAC 80.070) and Transportation and Utilities (6 AAC 80.080)........ B-118
    - (b) Subsistence (6 AAC 80.120)........ B-118
    - (c) Habitats (6 AAC 80.130)........ B-119
    - (d) Air, Land, and Water Quality (6 AAC 80.140)........ B-119
    - (e) Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)........ B-119
  - (3) Summary...................... B-120
  - (4) Conclusion................... B-120

12. Effects on Archaeological Resources..... B-120
- a. Effects of the Proposal........... B-120
- b. Cumulative Effects................ B-121

13. Effects on Recreation and Tourism Resources.................... B-122
- a. Effects of the Proposal........... B-122
- b. Cumulative Effects................ B-122

14. Effects on Water Quality............... B-123
- a. Effects of the Proposal........... B-123
  - (1) Oil Spills................... B-123
  - (2) Dredging..................... B-126
  - (3) Gravel-Island Construction... B-127
  - (4) Artificial-Island Destruction............... B-128
  - (5) Deliberate Discharges During Exploration................ B-128
  - (6) Deliberate Discharges During Production................. B-128
  - (7) Summary...................... B-130
  - (8) Conclusion................... B-131
- b. Cumulative Effects................ B-131
  - (1) Oil Spills................... B-131
  - (2) Causeways.................... B-131
  - (3) Dredging..................... B-132
  - (4) Gravel-Construction Projects.................. B-132
  - (5) Gravel-Island Removal........ B-132
  - (6) Deli[illegible]rges... B-132
  - (7) Overall Cumulative Effects on Water Quality........... B-132
  - (8) Conclusion................... B-133

15. Effects on Air Quality................. B-133
- a. Effects of the Proposal........... B-133
  - (1) Normal Offshore Operations... B-133
  - (2) Secondary Effects............ B-134
  - (3) In Situ Burning of Offshore.. Oil Spills................. B-135
  - (4) Summary...................... B-136
  - (5) Conclusion................... B-136
- b. Cumulative Effects................ B-136

IV. ENVIRONMENTAL CONSEQUENCES

A. Basic Assumptions for Effects Assessment

This section quantifies effects that could result from the proposed lease sale. All figures are relative to the mean case because the mean case is used for quantification of probable levels of developmental activity. (See Appendix E for a summary of minimum and maximum effects.) There are, however, many areas in which it is difficult to quantify effects due to the variable factors that affect any potential development.

For each effects analysis, all pertinent laws of the United States, as well as Federal regulations and Alaska OCS Orders, are assumed to be operating. The Alaska OCS Orders and some laws would mitigate certain effects. Further, the discussion of cumulative effects contained in each effects section is based on the interrelationship of this proposed action with other major, current, and proposed projects. Projects considered in preparation of the cumulative effects assessment are discussed later in this section.

In accordance with regulations promulgated by the Council on Environmental Quality, this document notes any scientific uncertainty or missing information where appropriate. Unless the "worst case" is analyzed, other available information shows that any such uncertainty or missing information does not concern relevant information about significant adverse effects, which is essential to a reasoned choice among alternatives or important to the Secretary's decision.

Potentially affected communities should not use this EIS as a "local planning document." Site-specific planning cannot yet be done; it would be several years hence before such specific projections could be made. The facility locations and scenarios described in this document, which are only representative of the locations and scenarios that presently seem likely, serve simply as a basis for identifying characteristic activities and resulting effects for this EIS. They do not represent an MMS recommendation, preference, or endorsement of facility sites or development schemes.

The basic assumptions used for assessing the effects of Sale 97 are summarized in Table IV-A-1. The probability of oil spills occurring and the numbers of oil spills assumed for this analysis are presented in Section IV.A.1.b. Since Sale 97 is the fourth oil and gas lease sale in the Beaufort Sea Planning Area, the effects associated with the previous lease sales form the existing conditions upon which the analysis in this EIS is based. The basic assumptions used for the existing conditions are also summarized in Table IV-A-1. The activities associated with projected exploration, development and production, and transportation of Sale 97 oil are described in more detail in Section II.A of this EIS.

The level of activities is based on the mean-case resource estimates for Sale 97 and previous lease sales (Appendix G, Tables G-2 and G-4). Resource estimates are also provided for a low case (Appendix G, Table G-1) and a high case (Appendix G, Table G-3). The low-case estimate represents a quantity of oil that offers a greater chance of discovery than the mean case but may be too small to permit recovery until sometime in the future; thus, only activities associated with the exploration phase would be undertaken. The high-case estimate represents a quantity of oil that is larger than the mean case but less likely to be discovered. Associated discoveries represented by the high case would be spread over a longer period of time. Thus, the mean-case resource estimates were selected to form the basis for the analysis because they (1) represent quantities of oil and gas that are estimated to be large enough for recovery and (2) offer a reasonable chance for discovery.

Three deferral alternatives also have been considered; these are Alternative IV--Barrow Deferral Alternative, Alternative V--Kaktovik Deferral Alternative, and Alternative VI--Chukchi Deferral Alternative. The level of activities and schedule of events are based on a mean-case resource estimate for each alternative (Appendix G, Tables G-5 through G-7) and summarized in Table II-A-2. Because the resource estimates for the alternatives are about the same as for the proposal, it is assumed that the basic exploration, development and production, and transportation scenarios for each of the alternatives will be the same as they are for the proposal (Sec. II.A.6).

1. Oil-Spill-Risk Analysis:

a. Estimated Quantity of Resource: Considerable uncertainties exist in estimating the volume of oil that may be discovered and produced as a result of an OCS lease sale. The search for oil is known as "wildcatting" because of these uncertainties. The estimated oil resource used for the oil-spill-risk calculations is the mean-case resource estimate (Sec. II.A). There is, however, an important qualification in the way this and other estimates are used in this document. The mean-case resource is assumed to be leased, found, and produced. The projected number of spills and, accordingly, the results of the oil-spill-risk analysis reflect the expected oil-spill risk based on the mean-resource estimate. There is a 69-percent chance that commercial quantities of hydrocarbons would be found as a result of proposed Sale 97.

Oil production and transportation from proposed Sale 97; from existing Sales BF, 71, and 87 lease tracts and Endicott Field; from offshore Lisburne Field; from Seal Island; and from the Canadian Beaufort Sea constitute the cumulative case in the oil-spill-trajectory analysis (Table IV-A-2). Additional offshore lease sales have been held or are planned by the State of Alaska; but because commercial offshore reserves have not been found and no resource estimates are available, no risk estimates can be made for these sales. A cumulative oil-spill-trajectory analysis for proposed Chukchi Sea Sale 109 and the Beaufort Sea sales will be done for the EIS on Sale 109. The oil-spill risk from proposed Sale 109 is analyzed in the cumulative case in this EIS, but not as part of the trajectory analysis. An oil-spill-trajectory analysis for the cumulative case with Sale 109 was completed for the Sale 109 DEIS (USDOI, MMS, 1987). This analysis is incorporated by reference; in summary, it demonstrates that hypothetical spill trajectories in the Chukchi Sea move predominately westward and would not significantly contribute to the cumulative case in the Beaufort Sea Planning Area.

The Geological Survey of Canada estimates Mackenzie Delta-Beaufort Sea oil resources at 9.2 billion barrels (Hatter, 1984). In this EIS, about half of this resource has been assumed to lie offshore, within the model boundaries. Current development strategies of Canadian oil companies indicate that initial shipments of this oil would be to Pacific-rim markets, via the U.S. Beaufort,

Table IV-A-1
Summary of Hypothetical Petroleum-Industry Activities in the Beaufort Sea Planning Area

PHASE/Activity	Previous Lease Sales[1]	Sale 97 (Proposed Action)[2]
EXPLORATION		
Exploration and Delineation	Artificial islands, ice islands, and bottom-founded mobile units, such as the Concrete Island Drilling System (CIDS) and the Single-Steel Drilling Caisson (SSDC), would be used to drill the wells in waters shallower than 20 meters; the bottom-founded units would also be used in waters as deep as 40, and perhaps 50, meters. Floating units, such as the ice-strengthend drillships and the Conical Drilling Unit (CDU), would also be used in waters deeper than 20 meters. For the purpose of effect analyses, it is estimated that two artificial islands would be constructed in previous lease-sale areas and one island would be constructed in the Sale 97 area.	
Drilling, Shallow-Hazards Seismic Activity, and Support Activities	Additional exploration drilling is predicted to began in 1985, end in 1990, and to result in 35 wells. The total shallow-hazards seismic activity is estimated to take 70 days and cover 2,247 line kilometers in an area of 805 square kilometers.[3] During the exploration phase, the total estimated number of helicopter flights is 3,150.[4]	Exploration drilling is predicted to begin in 1989, end in 1994, and result in 15 wells. The total shallow-hazards seismic activity is estimated to take 30 days and cover 963 line kilometers in an area of 345 square kilometers.[3] During the exploration phase, the total estimated number of helicopter flights is 1,350.[4]
Muds and Cuttings	Each well will require an estimated 970 tons, dry weight, of drilling mud and generate approximately 1,800 tons, dry weight, of cuttings.	
	The estimated total amount of drilling mud is 33,950 tons and of cuttings is 63,000 tons.	The estimated total amount of drilling mud is 14,500 tons and of cuttings is 23,250 tons.
DEVELOPMENT AND PRODUCTION		
Production Platforms and Production and Service Wells	Hypothetical production-platform locations are (1) 130 kilometers north and east of Bullen Point in waters 40 meters deep and (2) 70 kilometers west of Cape Halkett in waters 20 meters deep.	Hypothetical production-platform locations are (1) 40 kilometers north of Oliktok Point in waters 30 meters deep and (2) 120 kilometers north of Point Belcher (Chukchi Sea) in waters 40 meters deep.
	Installation of 2 oil-production platforms is predicted to occur in 1992; an estimated 36 oil-production and service wells will be drilled. The total seismic activity is estimated to take 14 days and cover 608 line kilometers in an area of 184 square kilometers.[5] During the development phase, the estimated number of helicopter flights is 1,620.[6]	Installation of 2 oil-production platforms is predicted to occur in 1998. In 1998 and 1999 an estimated 39 oil-production and service wells will be drilled. The total seismic activity is estimated to take 14 days and cover 608 line kilometers in an area of 184 square kilometers.[5] During the development phase, the total estimated number of helicopter flights is 1,755.[6]
	The platforms would be constructed from concrete or steel in harbors outside Alaska and installed at the production sites during the ice-free period.	

Table IV-A-1 (Continued)
Summary of Hypothetical Petroleum-Industry Activities in the Beaufort Sea Planning Area

PHASE/Activity	Previous Lease Sales[1/]	Sale 97 (Proposed Action)[2/]
DEVELOPMENT AND PRODUCTION		
Muds and Cuttings[7/]	Each well will generate an estimated 77 tons, dry weight, of drilling mud and approximately 1,850 tons, dry weight, of cuttings for disposal. The estimated total amount of drilling mud is 2,772 tons and of cuttings is 66,600 tons.	Each well will generate an estimated 77 tons, dry weight, of drilling mud and approximately 1,600 tons, dry weight, of cuttings for disposal. The estimated total amount of drilling mud is 3,003 tons and of cuttings is 62,400 tons.
Production--Oil[8/]	Oil production is predicted to begin in 1993 and continue through 2011; peak production would be from 1994 to 1999. Total oil production is estimated to be 600 million barrels.	Oil production is predicted to begin in 2000 and continue through 2018; peak production would be from 2001 to 2006. Total oil production is estimated to be 650 million barrels.
SUPPORT FACILITIES AND TRANSPORTATION		
Support Facilities	It is assumed that the infrastructure at Prudhoe Bay will be used to support major construction and operation activities for the development, production, and transportation of crude oil. If development were to occur in the Chukchi Sea as a result of Beaufort Sea or Chukchi Sea Planning Area lease sales, a support base adjacent to or near the northeastern part of the Chukchi Sea may be developed. It is also assumed that the Trans-Alaska Pipeline (TAP) will be available to transport the oil produced to Valdez, where it will be loaded into tankers and carried to refineries outside of Alaska; some of the oil may be shipped to refineries in Alaska.	
Subsea Pipelines	The produced oil is expected to be transferred from the production platforms to the onshore facilities by subsea pipelines. The pipelines would be laid during the ice-free period and buried in areas of known or anticipated ice gouging. To the extent possible, subsea pipelines would take the most direct route from the production platforms to the shore. The pipelines would join with existing, proposed, or hypothetical pipelines connected to TAP.	
	Pipelaying is anticipated to occur between 1990 and 1992. The length of oil pipeline is estimated to be 200 kilometers. Approximately 21 square kilometers of seafloor would be disturbed.[9/] The onshore segments of the pipelines associated with previous lease sales are estimated to total about 200 kilometers; these pipelines would be elevated in a manner similar to existing North Slope lines.	Pipelaying is anticipated to occur between 1998 and 1999. The length of oil pipeline is estimated to be 160 kilometers. Approximately 24 square kilometers of seafloor would be disturbed.[9/] The onshore segments of the pipelines associated with Sale 97 are estimated to total about 160 kilometers; these pipelines would be elevated in a manner similar to existing North Slope lines.

Table IV-A-1 (Continued)
Summary of Hypothetical Petroleum-Industry Activities in the Beaufort Sea Planning Area

1/ The estimated level of activities associated with the revised mean-case resource estimate for previous lease sales forms the base case for the assessment of the environmental effects that are predicted to occur as a result of Sale 97.

2/ See Appendix G, Table 2.

3/ See Section III.A.2.c.

4/ Assumptions used to estimate the number of helicopter flights and supply-boat trips are: (1) 90 days to drill and test an exploration/delineation well and (2) one flight per day per drilling unit.

5/ See Sections II.A.2.c and II.A.3.a.

6/ Assumptions used to estimate the number of helicopter flights: (1) 45 days to drill and complete a production/service well and (2) one flight per day per platform.

7/ See Section II.A.3.a.

8/ The mean-case resource estimates for Sales 97 and previous lease sales occur at different percentiles, thus they should not be added to obtain statistically valid estimates for the amounts of oil in the entire basin. However, the difference between the mean percentiles is small enough so that the number of units for each of the activities shown in the table can be added to obtain a reasonable estimate of such scenario elements as the number of platforms installed and wells drilled or amount of pipe laid.

9/ See Section II.A.3.c.

Table IV-A-2
Oil Resources Assumed in Oil-Spill-Risk Analysis

	Resource (Billion Barrels)
Proposed Action	0.65
Barrow Deferral Alternative	0.630
Chukchi Deferral Alternative	0.620
Kaktovik Deferral Alternative	0.560
Cumulative Development	
Existing Leases	
Endicott Reservoir	0.350
Sales BF, 71, and 87	0.60
Offshore Lisburne Reservoir	0.075 1/
Seal Island	0.300
Chukchi Sea Sale 109 (Proposed) 2/	2.68
Canadian Development	
Production	4.6 3/
Westward Tankering	1.7 4/

Source: Table IV-9 and Section IV.A.1.a.

1/ Assumed to be one-sixth of total Lisburne resource.
2/ Analyzed in EIS, but not included in oil-spill-trajectory analysis.
3/ The resource listed is one-half of that for the entire Mackenzie-Beaufort area, see Text.
4/ Remaining oil production is assumed to be offshore-loaded and tankered eastward outside of the model area or piped ashore.

Chukchi, and Bering Seas (Oil and Gas Journal, 1987). Subsequent, larger volumes of crude would be transported to inland Canada via a pipeline south through the Mackenzie River Valley. If economically successful, the initial tankering could be expanded to a year-round basis through use of icebreaking tankers. This EIS hypothesizes that, starting no sooner than 1990 but continuing for the remaining life of Canadian Beaufort Sea fields, one tanker a week--both in summer and in winter--might be routed westward through the U.S. Beaufort Sea to Asian markets, for a total westward tankering of a potential 1.7 billion barrels. In the cumulative analysis of oil-spill risk, this Canadian oil is assumed to be tankered through the Sale 97 area.

b. Probability of Oil Spills Occurring: The procedures and statistics used by MMS to calculate frequencies and probabilities of spillage, including validation of projections of spillage for Alaskan conditions, are described and discussed in detail in Section IV.A.1.b of the Sale 100 FEIS (USDOI, MMS, 1985d). This information is incorporated by reference; a summary of this information, as augmented by additional material as cited, follows. The expected numbers of spills of 1,000 barrels or more are calculated as proportionate to the volume of oil produced and transported and to the number of port calls by tankers (Table IV-A-3). The probabilities of such spills occurring are calculated from the expected numbers through use of standard (Poisson) statistical distributions governing the occurrences of rare, random events. Frequency of smaller spills is calculated as proportionate to the number of drilling days during exploration and to the amount of oil produced and transported during production.

(1) Transportation Assumptions: In the analysis for this proposed sale, the obvious transportation scheme is assumed: oil is transported by offshore and onshore pipelines to a connection with TAP. From there, it is transported south by pipeline to Valdez and then shipped to the continental U.S. by tankers. In the oil-spill-risk analysis, OCS offshore pipelines come ashore at Point Belcher, Pitt Point, Oliktok Point, and Point Bullen. Oil estimated to be produced from existing State and Federal Beaufort Sea leases (Sales BF, 71, and 87) is assumed to be transported by the same pipeline system. Oil from the Lisburne Reservoir, Seal Island, and the Endicott Reservoir is assumed to be piped directly to shore. The proposed Lisburne gravel island and causeway within Prudhoe Bay waters are very close to shore. In this analysis, spillage from this offshore Lisburne development is not modeled with a hypothetical launch point but is assumed to contact the Prudhoe Bay shoreline. The other two fields are farther offshore and are represented in the model by launch points. The modeled study area and the proposed Sale 97 area are shown in Figure IV-1, as are the hypothetical launch points that represent possible platform locations, pipeline routes, and Canadian tanker routes. Note that all transportation scenarios are hypothetical and are put forth only to aid in analyzing possible effects. Use of any transportation routes would depend upon finding commercial quantities of oil, where that oil is found, and subsequent environmental and economic analyses of transportation modes and routes.

In addition to the proposed action (Alternative I), three block-deferral alternatives are considered in this oil-spill-risk analysis: The Barrow Deferral Alternative (Alternative IV), the Chukchi Deferral Alternative (Alternative V), and the Kaktovik Deferral Alternative (Alternative VI). These alternatives are described in Section II.B.

An assumption is made for the oil-spill-risk analysis that only 25 percent of the at-sea risk of oil spills from Canadian tankers occurs in the study area. This is because only a fraction of the entire tanker route, which neither originates nor ends in waters of the U.S. OCS, lies within the study area. An additional 50 percent of spillage is assumed to occur in the Chukchi and Bering Seas (Sale 100 FEIS, USDOI, MMS, 1985d). The remaining 25 percent is assumed to occur elsewhere, in the Pacific Ocean, en route to market. In this analysis, Canadian tankering of oil is considered only within the boundaries of the study area. Because if tankered it is likely that Canadian crude would be loaded offshore (that is, without a port call), only at-sea spill risk was considered for the study area (see Table IV-A-3).

(2) Projected Spillage: Spill frequencies were calculated for proposed Sale 97. Table IV-A-4 shows the statistically expected number of spills of 100,000 barrels or greater and of 1,000 barrels or greater (including those spills in the larger category) that could occur as a result of the proposed sale, the deferral alternatives, and the cumulative case. These projections assume that the mean resource is discovered and produced. Spills of 100,000 barrels or greater occur about 25-fold less frequently than spills within the broader category of 1,000 barrels or greater.

These two larger-size categories for spills are of special interest. To place these sizes in perspective to the type of accident usually involved, spills in the larger category of 100,000 barrels or greater are usually associated with major casualties, such as large, destructive blowouts or shipwrecks. Spills of 1,000 barrels or greater typically include these and other serious events, such as structural failures and collisions. The choice of size to use depends upon the analysis to be performed. If, for example, a particular effect could occur only from a massive oil slick, then only larger spills are examined.

In addition to the possible occurrence of these large spills of 1,000 barrels or greater, more frequent spillage of smaller volumes is also anticipated. Worldwide, oil spills of 50 barrels or less from platforms contribute 0.02 to 0.03 million barrels and operational discharges contribute 0.05 to 0.08 million barrels to a total annual release to the ocean from worldwide offshore petroleum production (of 0.3-0.5 MMbbls) (National Research Council, 1985). Therefore, small spills of 50 barrels of less constitute only 4 to 10 percent of the total industry discharge and are not usually a major concern.

During exploration in northern Alaskan waters, spills of less than 1,000 barrels occur once for about every 57 days of drilling activity. These spills of less than 1,000 barrels, however, have been very small, averaging 0.25 barrels in size. At a similar rate for the proposal, during the drilling of 20 exploration and delineation wells over 6 years, on the order of 23 such spills could occur, but the total spilled would be only about 6 barrels.

Spills of less than 1,000 barrels would be more frequent during the years of production, but the anticipated volumes of such spills would still be very small. Since 1971, the offshore oil industry in Alaskan waters has experienced spills at a rate of 265 spills per billion barrels produced and transported. None of the reported spill sizes has been as large as 1,000

Table IV-A-3
Spill-Rate Constants Used in Oil-Spill-Risk Analysis, Based on Historical OCS Spill Rates

	Spills Per Billion Barrels	
	1,000 barrels or greater	100,000 barrels or greater
Platforms	1.0	0.036
Pipelines	1.6	0.065
Tankers		
At sea	0.9	0.19
Per port call	0.2	0.042

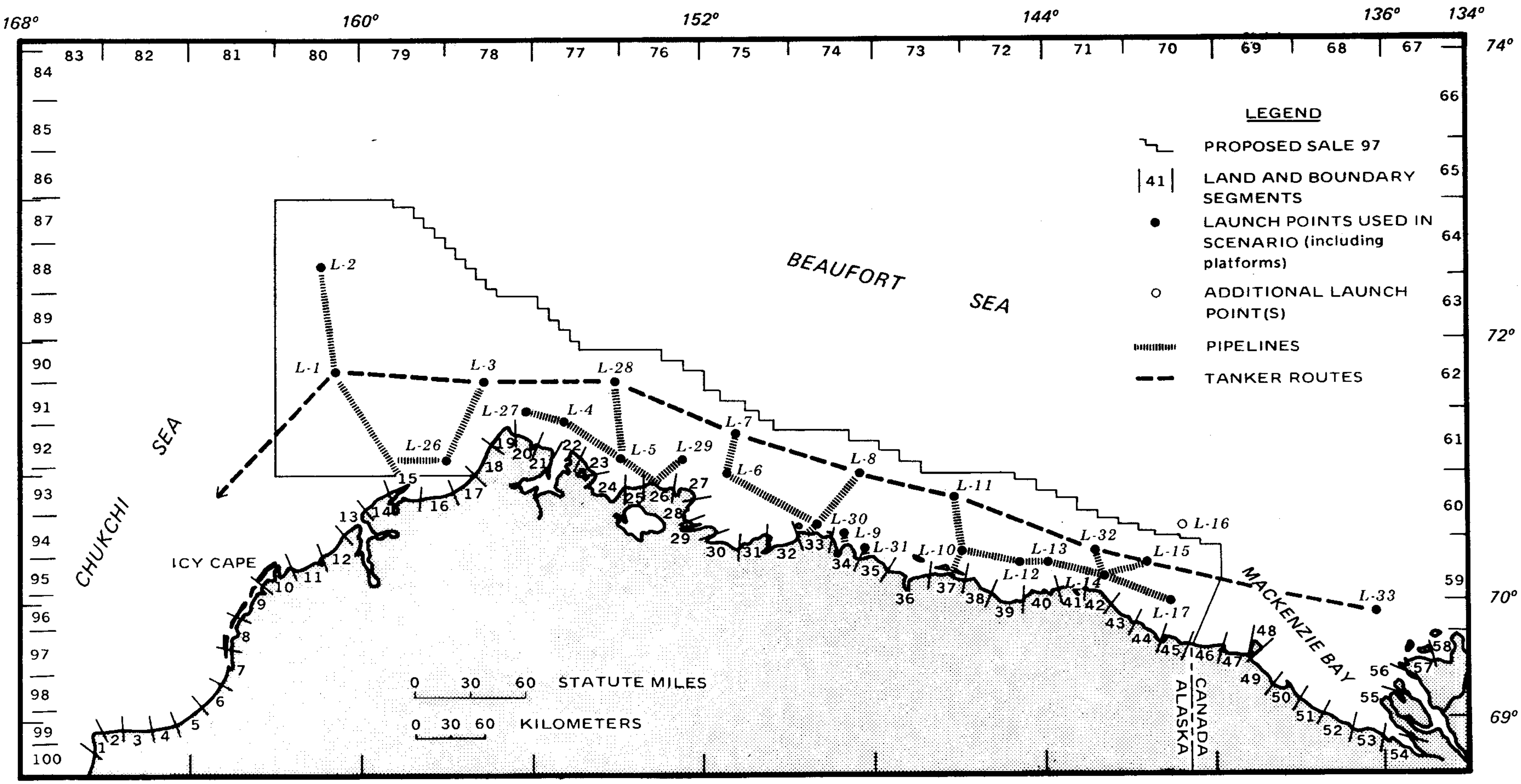


FIGURE IV-1. STUDY AREA, LAND AND BOUNDARY SEGMENTS, TRANSPORTATION ROUTES, AND SPILL-LAUNCH POINTS HYPOTHESIZED IN OIL-SPILL-TRAJECTORY ANALYSIS barrels, and the average size has been 4.4 barrels. Extrapolation of this rate and average size to the proposal gives a projection of 172 spills of less than 1,000 barrels each over the production years, totaling 758 barrels.

Total spillage projected for the proposal during both exploration and production from such small spills would be 194 spills totaling 764 barrels. Because of lower estimated oil reserves, slightly smaller numbers and total spill volume would be expected for any of the three deferral alternatives.

(3) Probability of Spillage: The likelihood that one or more large oil spills would occur under the proposed action is high as a consequence of the high projected resource. For the proposal, MMS projects an 82-percent chance of one or more oil spills of at least 1,000 barrels over the life of the field (Table IV-A-4). The deferral alternatives would reduce this risk by 2 to 9 percentage points. For the cumulative case with the proposal, the probability of one or more such spills occurring within the model area increases to greater than 99 percent. A most likely number of 24 spills of 1,000 barrels or greater is projected. Note, however, that the model area is large and covers portions of the Canadian Beaufort Sea and Chukchi Sea in addition to the proposed sale area. The greatest probability of spillage in the cumulative case would be in Canadian waters, from production and transportation of Canadian offshore oil.

Note also that based on increased information, including results of unsuccessful wildcatting, MMS and the Canadian Geological Survey, respectively, have reduced the estimated oil resources in the U.S. Beaufort Sea Planning Area and in the Canadian Beaufort Sea from those previously projected to be present and found. Because of these reductions in estimated resources, the projected spillage and the likelihood of spillage for both the proposal and the cumulative case are less than those projected in the FEIS for the previous Beaufort Sea Sale 87 (USDOI, MMS, 1984a).

(4) Most Likely Number of Spills: In this EIS, analysts use the "probability of one or more spills" occurring or contacting a resource. For situations where the probability of two or more spills becomes greater than the probability of one spill, the analysts in addition refer to and use the "most likely number of spills."

The relationship between the most likely number of spills (mode), the expected number of spills, and probability distribution for various numbers of spills is shown in Figure IV-2 for the proposal, Figure IV-3 for the cumulative case, and Figures IV-4 through IV-6 for the deferral alternatives. For the proposal and deferral alternatives, the most likely number of spills of 1,000 barrels or greater is 1 and the most likely number of spills of 100,000 barrels or greater is 0. For the cumulative case, the most likely number of spills of 1,000 barrels or greater is 24. In the cumulative case, the most likely number of spills of 100,000 barrels or greater is 1.

(5) Size of a 1,000-Barrel-or-Greater Spill: The logarithmic mean size of 1,000-barrel-or-greater spills is 8,000 barrels for platform spills, 7,500 barrels for pipeline spills, and 20,000 barrels for tanker spills (Lanfear and Amstutz, 1983). For the proposal and deferral alternatives, the source (frequency)-weighted, log-normal-mean size for spills of 1,000 barrels or greater is 7,700 barrels. For the cumulative case, which

includes a small amount of spillage from Canadian tankering, the source-weighted, log-normal-mean size for spills of 1,000 barrels or greater is 7,900 barrels. The log-normal-mean size provides an estimate of the median size of a spill. In this EIS, a spill size somewhat larger, 10,000 barrels, is standardly used as an example of a spill of 1,000 barrels or greater.

(6) Exploratory Spills: The purpose of this EIS is to project the effects of all phases of oil and gas development rather than just exploration. The oil-spill-risk analysis is based on the mean, unrisked resource estimate assumed to be both discovered and produced. Because pipelines and tankers are used during production but not during exploration, exploration spills would be only platform and minor supply spills. The number of smaller spills has already been estimated for exploration (31 spills totaling 8.5 barrels).

For the spill category of 1,000 barrels or greater, platforms account for about 38 percent of the spill risk in the proposal, each deferral alternative, and the cumulative case (Table IV-A-4). The order-of-magnitude frequency for such spills during exploration in the OCS is about one-twelfth of the total platform-spill-occurrence rate during exploration plus production (Sale 87 FEIS, USDOI, MMS, 1984a). Thus, the likelihood of a spill of 1,000 barrels or greater during exploration is on the order of 30 times less probable (12/0.38) than the likelihood during exploration plus production described in this EIS. On a per-exploration-well basis (including delineation), the projected spill rate for the proposal would be 4 spills of 1,000 barrels or greater per 1,000 wells drilled. (Only 15 such wells are actually projected for the proposal.) Note also that this estimate per exploration well is unrisked; it assumes that commercial quantities of oil would be discovered. The marginal probability of commercial quantities of hydrocarbons being present within the proposed sale area is 69 percent.

(7) Cumulative Case: In the cumulative case, the locations of the 24 spills of 1,000 barrels or greater would be widely distributed throughout the Beaufort and Chukchi Seas. The likelihood that more than one of these spills would contact most nonmigratory resources other than land is very low. Therefore, discussions of cumulative effects for resource targets are projected on the assumed occurrence of one spill of at least 1,000 barrels. Only if a resource is migratory is there an appreciable chance that more than one spill could contact the resource in the cumulative case. For such resources, effects of multiple-spill contacts are considered.

c. Oil-Spill-Trajectory Simulations: Oil-spill trajectories for the proposal, the cumulative case, and the deferral alternatives were simulated by the Rand Corporation in Santa Monica, California, using Rand's three-dimensional circulation, weather, and spill-trajectory models. The description of models and model documentation as contained in Section IV.A.1.c of the Sale 100 FEIS (USDOI, MMS, 1985d) are incorporated by reference; a summary of this description, as augmented by additional material, as cited, follows.

Essential components of the models and their interrelationships are shown in Figure IV-7. Aspects of weathering, toxicity, and oil dispersion are considered and taken into account in this EIS, but not as part of the trajectory analysis (see Sec. IV.A.2.a). The actual modeled trajectories are

Table IV-A-4
Projected Spillage and Probabilities of Spillage in the Oil-Spill-Trajectory Model Over the Expected Production Life of Proposed Beaufort Sea Sale 97, Existing State and Federal Leases, and Canadian Development

	Volume of oil (billion barrels)	Expected number of spills from platforms		Expected number of spills from transportation		Total number of spills		Probability of one or more spills (platforms)		Probability of one or more spills (transport.)		Probability of one or more spills (total)	
		1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater	1,000 barrels or greater	100,000 barrels or greater
Beaufort Sea Sale 97													
Proposed Action	(0.65)	0.6	0.02	1.0	0.04	1.7	0.07	0.48	0.02	0.65	0.04	0.82	0.06
Barrow Deferral Alternative	(0.630)	0.6	0.02	1.0	0.04	1.6	0.06	0.46	0.02	0.64	0.04	0.81	0.06
Chukchi Deferral Alternative	(0.620)	0.6	0.02	1.0	0.04	1.6	0.06	0.46	0.02	0.63	0.04	0.20	0.06
Kaktovik Deferral Alternative	(0.560)	0.6	0.02	0.9	0.04	1.5	0.06	0.43	0.02	0.59	0.04	0.77	0.05
Cumulative Case													
Existing Leases	(1.325)[1/]	1.3	0.05	2.1	0.09	3.4	0.13	0.73	0.05	0.88	0.08	0.97	0.13
Proposed Sale 109	(2.68)[1/]	2.7	0.10	4.3	0.17	7.0	0.27	0.93	0.09	0.99	0.16	0.99	0.24
Production and Tankering of Canadian Oil	(4.6)[2/]	4.6	0.17	7.7	0.38	12.3	0.55	0.99	0.15	0.99+	0.32	0.99+	0.42
Total Cumulative (including proposal)	(9.255)[1/]	9.3	.33	15.2	0.68	24.4	1.04	0.99+	0.28	0.99+	0.49	0.99+	0.65

Source: MMS, Alaska OCS Region

1/ This oil-spill risk from proposed Chukchi Sea Sale 109 is analyzed separately in the cumulative case in this EIS, not as part of the oil-spill-trajectory analysis; see text.

2/ Only 1.7 billion barrels are assumed to be tankered, and tankering accounts for only 0.4 spills of 1,000 barrels or greater and 0.08 spills of 100,000 barrels or greater; see text.

```
                                        SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  1.7
PROBABILITY OF ONE OR MORE =  82%
MOST LIKELY (MODE) =  1

                                10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 18.45%  0 I*********
PROB. OF  1 = 31.18%  1 I****************
PROB. OF  2 = 26.35%  2 I*************
PROB. OF  3 = 14.84%  3 I*******
PROB. OF  4 =  6.27%  4 I***
PROB. OF  5 =  2.12%  5 I*
PROB. OF  6 =  0.60%  6 I

                                        SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.07
PROBABILITY OF ONE OR MORE =   6%
MOST LIKELY (MODE) =  0

                                10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 93.65%  0 I***********************************************
PROB. OF  1 =  6.14%  1 I***
```

FIGURE IV-2. MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR PROPOSAL

SPILLS OF 1,000 BARRELS OR GREATER

```
EXPECTED NUMBER (MEAN) = 24.40
PROBABILITY OF ONE OR MORE = 99+
MOST LIKELY (MODE) = 24

                                10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
PROB. OF 14 =  0.77% 14 I
PROB. OF 15 =  1.25% 15 I*
PROB. OF 16 =  1.91% 16 I*
PROB. OF 17 =  2.74% 17 I*
PROB. OF 18 =  3.71% 18 I**
PROB. OF 19 =  4.77% 19 I**
PROB. OF 20 =  5.82% 20 I***
PROB. OF 21 =  6.76% 21 I***
PROB. OF 22 =  7.50% 22 I*****
PROB. OF 23 =  7.96% 23 I*****
PROB. OF 24 =  8.09% 24 I*****
PROB. OF 25 =  7.89% 25 I****
PROB. OF 26 =  7.41% 26 I****
PROB. OF 27 =  6.70% 27 I***
PROB. OF 28 =  5.83% 28 I***
PROB. OF 29 =  4.91% 29 I**
PROB. OF 30 =  3.99% 30 I**
PROB. OF 31 =  3.14% 31 I**
PROB. OF 32 =  2.40% 32 I*
PROB. OF 33 =  1.77% 33 I*
PROB. OF 34 =  1.27% 34 I*
PROB. OF 35 =  0.89% 35 I
PROB. OF 36 =  0.60% 36 I
```

SPILLS OF 100,000 BARRELS OR GREATER

```
EXPECTED NUMBER (MEAN) =  1.04
PROBABILITY OF ONE OR MORE =  65%
MOST LIKELY (MODE) =  1

                                10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 35.35%  0 I************************
PROB. OF  1 = 36.76%  1 I******************
PROB. OF  2 = 19.11%  2 I*******
PROB. OF  3 =  6.63%  3 I**
PROB. OF  4 =  1.72%  4 I*
```

FIGURE IV-3. MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR CUMULATIVE CASE INCLUDING PROPOSAL

```
                    SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  1.6
PROBABILITY OF ONE OR MORE =  81%
MOST LIKELY (MODE) =  1

                            10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 19.44%  0 I**********
PROB. OF  1 = 31.84%  1 I****************
PROB. OF  2 = 26.07%  2 I*************
PROB. OF  3 = 14.24%  3 I*******
PROB. OF  4 =  5.83%  4 I***
PROB. OF  5 =  1.91%  5 I*
PROB. OF  6 =  0.52%  6 I

                    SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.06
PROBABILITY OF ONE OR MORE =   6%
MOST LIKELY (MODE) =  0

                            10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 93.84%  0 I***********************************************
PROB. OF  1 =  5.97%  1 I***
```

FIGURE IV-4. MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR BARROW DEFERRAL ALTERNATIVE (ALTERNATIVE IV)

```
                    SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  1.5
PROBABILITY OF ONE OR MORE =  77%
MOST LIKELY (MODE) =  1

                            10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 23.32%  0 I************
PROB. OF  1 = 33.95%  1 I*****************
PROB. OF  2 = 24.71%  2 I************
PROB. OF  3 = 11.99%  3 I******
PROB. OF  4 =  4.37%  4 I**
PROB. OF  5 =  1.27%  5 I*

                    SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.06
PROBABILITY OF ONE OR MORE =   5%
MOST LIKELY (MODE) =  0

                            10%  20%  30%  40%  50%  60%  70%  80%  90%
                        +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 94.50%  0 I***********************************************
PROB. OF  1 =  5.34%  1 I***
```

FIGURE IV-5. MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR THE KAKTOVIK DEFERRAL ALTERNATIVE (ALTERNATIVE V)

```
                                   SPILLS OF 1,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  1.6
PROBABILITY OF ONE OR MORE =  80%
MOST LIKELY (MODE) =  1

                                      10%  20%  30%  40%  50%  60%  70%  80%  90%
                                  +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 19.95%  0 I**********
PROB. OF  1 = 32.16%  1 I****************
PROB. OF  2 = 25.92%  2 I***********
PROB. OF  3 = 13.93%  3 I*******
PROB. OF  4 =  5.61%  4 I***
PROB. OF  5 =  1.81%  5 I*

                                   SPILLS OF 100,000 BARRELS OR GREATER

EXPECTED NUMBER (MEAN) =  0.06
PROBABILITY OF ONE OR MORE =   6%
MOST LIKELY (MODE) =  0

                                      10%  20%  30%  40%  50%  60%  70%  80%  90%
                                  +----+----+----+----+----+----+----+----+----+----+
PROB. OF  0 = 93.93%  0 I***********************************************
PROB. OF  1 =  5.88%  1 I***
```

FIGURE IV-6. MOST LIKELY NUMBER AND POISSON DISTRIBUTION OF SPILL PROBABILITIES FOR THE CHUKCHI DEFERRAL ALTERNATIVE (ALTERNATIVE VI)

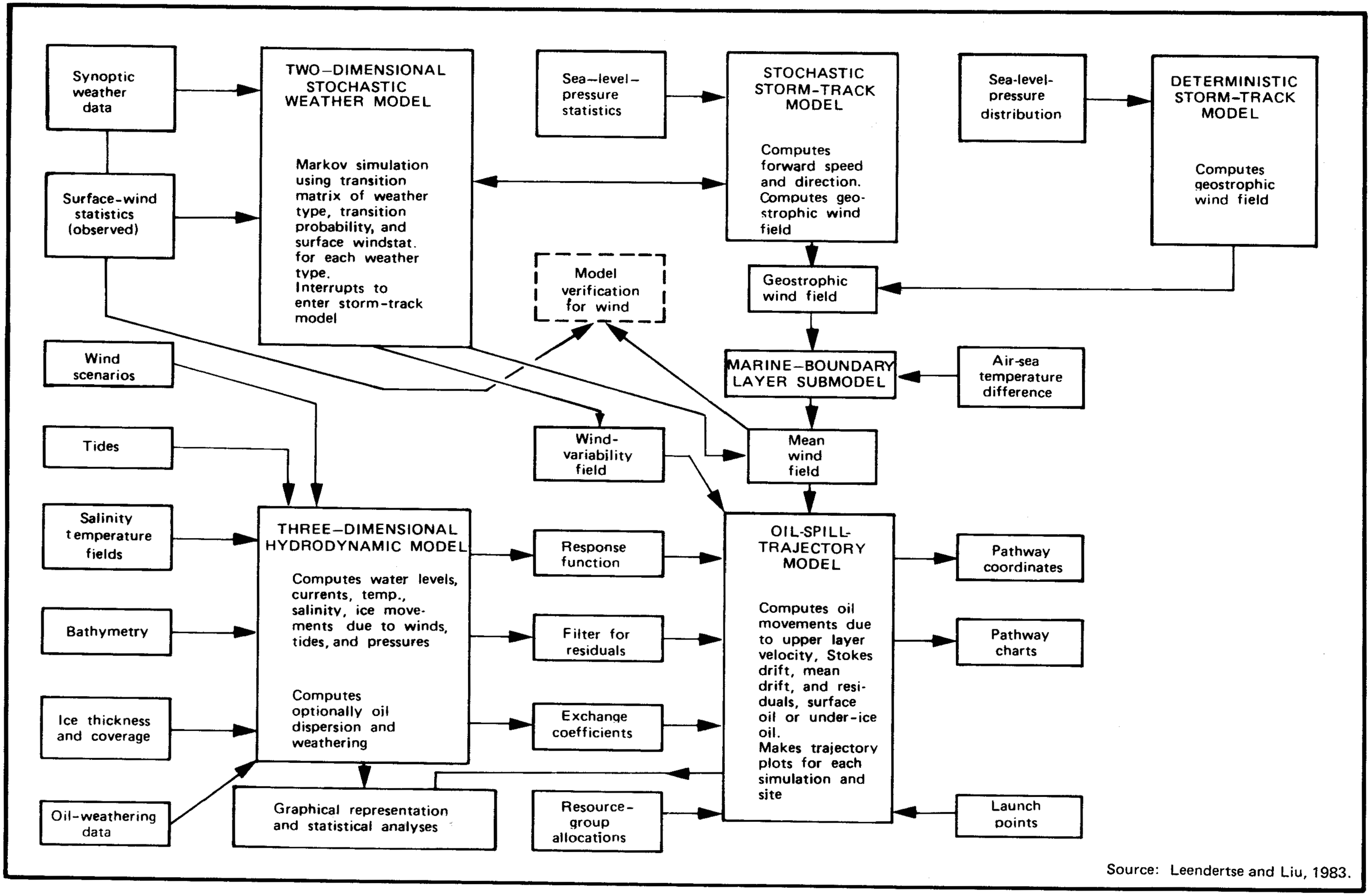


FIGURE IV-7. ESSENTIAL COMPONENTS OF THE TWO-DIMENSIONAL STOCHASTIC-WEATHER-SIMULATION MODEL; ALSO SHOWING INTERRELATIONSHIP BETWEEN THE THREE-DIMENSIONAL HYDRODYNAMIC MODEL AND THE OIL-SPILL-TRAJECTORY MODEL center-of-mass trajectories. Rand Corporation transmitted 12-hour-trajectory positions to the MMS Branch of Environmental Modeling (BEM) in Reston. The BEM applied trajectories to land/boundary segments and to biological resources identified by the MMS in order to determine the environmental-risk factors.

(1) Winter Trajectories: For winter, the Rand Corporation simulated 20 trajectories from each of 25 hypothetical launch points (L1 through L25, Fig. IV-1). Launches were staggered, starting on three dates during the winter--October 1, January 1, and April 1--that represent different seasonal ice conditions. The number of trajectories started at each of these dates was proportioned by the period of time and duration of ice conditions that the dates represented. Winter trajectories were simulated for the entire winter period when oil could be frozen into winter ice (see Sec. IV.A.2.a), until breakup. Thus, some winter trajectories were modeled for up to 9.5 months. At the end of the winter season, at breakup, the trajectories were converted into summer trajectories and modeled for an additional 30 days.

Conditions of ice in the model for the three winter periods are different. The areal extent of landfast ice in the model changes through the winter, based on data from Labelle et al. (1983) and other sources. During the cooling period and breakup period, significant areas of open water persist in polynyas and leads. In midwinter, ice coverage exceeds 90 percent in the landfast-ice zone.

Driven by infrequent but strong reversals in the usually northward-moving currents and winds, Chukchi Sea pack ice occasionally "breaks out" through the Bering Strait, moving south into the Bering Sea. The Bering Sea is a bottleneck, and pack ice will arch across the strait as wind and currents attempt to drive the ice south. Persistence of southward forces causes the arching ice closest to the strait to fail, releasing a sudden pulse of ice into the Bering Sea. The arches and their failure propagate northward along the U.S. side of the Chukchi Sea. Such breakout events occur about four times each winter and persist about 4 days (Truett, 1984). This frequency and persistence of breakout events has been explicitly incorporated into the oil-spill-trajectory model.

In the modeled winter, oil moves with ice or water depending upon the differential velocity of ice and underlying water. For smooth first-year ice, the differential velocity of the water has to be greater than about 15 centimeters per second to strip oil from the underside of the ice. Rough first-year ice or multiyear ice requires greater velocities to strip oil. Because ice and underlying water are being moved by the same forces, the necessary differential velocity is seldom reached, and oil almost always moves or stays with the ice no matter whether the oil was spilled onto, into, or underneath the ice (see Sec. IV.A.2.a).

The trajectories of simulated winter spills were stopped when (1) the oil contacted land, (2) the oil moved beyond the boundaries of the model, or (3) breakup occurred. The end points of trajectories in the third category were converted into summer spills. Because of several factors, a winter spill--or whatever portion of a winter spill is not cleaned up--would become a fresh, unweathered spill when the ice melts during early summer breakup. In the Sale 87 FEIS (USDOI, MMS, 1984a), it was assumed that platform spills into landfast ice would be cleaned up before breakup. Because of technical difficulties resulting from use of a more complex winter model, a similar treatment was not feasible in the oil-spill-trajectory analysis for this EIS. In this analysis, platform spills into landfast ice do persist into summer. However, such spills constitute less than 4 percent of the total numbers of spills of at least 1,000 barrels considered in the analysis of the proposal. The different treatments in the two EIS's would not produce significantly different probabilities.

The end points of trajectories in the model that persisted through the winter were used to define another set of launch points that would represent the new starting positions of groups of overwintering oil spills after breakup. These new starting points were derived from the distribution of winter end points, using as a new starting point one of the original 25 winter launch points or one of 14 new launch points specifically added to represent winter end points. This modification permitted the consolidation of about 500 trajectory end points into 39 summer launch points.

(2) Summer Trajectories: These 39 launch points were used by the BEM to model hypothetical breakup and summer-season spills. The Rand Corporation reported simulated trajectory positions to BEM for every 12 hours of 30 model-days. The BEM analyzed 55 trajectories per summer launch point. All contacts from these 39 launch points were attributed to the original 25 spill locations, not to location of the hypothetical spills at breakup. In the modeled summer, if a trajectory contacted land or a boundary segment of the model, the trajectory was ended.

We emphasize that the trajectories simulated by the model represent only pathways of hypothetical oil slicks. They do not involve any direct consideration of cleanup, dispersion, or weathering processes that could determine the quantity or quality of oil that might eventually come in contact with targets. An implicit analysis of weathering and decay can be considered by knowing the age of simulated oil spills when they contact targets. For this analysis, three time periods were selected as relevant to the summer Arctic: 3 days--to represent diminished toxicity of the spill, 10 days--during which cleanup could be a mitigating factor, and 30 days--to represent the difficulty of tracking or locating spills after this time (see also Sec. IV.A.2).

(3) Conditional Probabilities: Results of the trajectory simulations are presented in terms of conditional and combined probabilities. The probability that if an oil spill occurred at a specific launch point, it would contact either a land/boundary segment or a resource target is termed a conditional probability. Conditional probabilities assume a spill occurs; they do not consider the likelihood of a spill occurring--a function of the presence and amount of oil and transportation assumptions. In calculating conditional probabilities, the assumption is made that a spill has occurred from the respective launch point. The conditional probabilities give the percentage chance of oil from that hypothetical launch point contacting specific land/boundary segments and biological resources. The conditional probabilities are useful in identifying those areas that pose the highest chance of contact to specific targets and land/boundary segments should spills occur.

Two sets of conditional probabilities are used in this EIS: (1) contacts with winter spills during winter (Appendix F, Tables F-3 through F-8) and (2) open-water contacts with summer or overwintering spills during the open-water season (Appendix F, Tables F-9 through F-14). Conditional probabilities have an appreciable Monte Carlo error range at the 90-percent level of significance (Appendix F, Table F-2). For individual winter conditional probabilities, this range is about ±6 to ±18 percent and for open-water conditional probabilities about ±2 to ±10 percent.

(4) Combined Probabilities: In the analysis, the conditional probabilities were combined with the expected spill rates, transportation scenarios, and the unrisked mean-resource estimates to yield overall, combined probabilities for spills of 1,000 barrels or greater and for spills of 100,000 barrels or greater. Thus, these probabilities include both the likelihood that a spill would occur and whether the spill would contact land/boundary segments or resource targets. The associated Monte Carlo error for combined probabilities--because all trajectories and spill information for all spill points are incorporated--is much lower that that for conditional probabilities, ranging from ±1 to ±2 percent.

Trajectory analysis for spills of less than 1,000 barrels would be meaningless because of the very short persistence and very small average size of such spills (see Sec. IV.A.1.b). These spills have not been included as a category in the trajectory analysis, but their occurrence and possible effects are considered elsewhere in the EIS when relevant.

Combined probabilities for land/boundary segments for the proposed lease sale, the cumulative case, and each deferral alternative are discussed in Section IV.A.2.b; and combined probabilities for biological resources are discussed in Sections IV.B through H. Tables of combined probabilities are provided for the proposal, the cumulative case with the proposal, and for each of the deferral alternatives in Appendix F, Tables F-15 through F-30. Land/boundary segments are identified in Figure IV-1 and resource targets in Figures IV-13 through 16. In this EIS, oil-spill trajectories and potential oil-spill contact are discussed predominantly in the context of combined probabilities.

2. Aspects of Spilled Oil: Detailed descriptions of the behavior and fate of spilled oil, extent and persistence of oiled shoreline, and oil-spill-contingency measures are contained in Appendix C of this EIS. A summary of these descriptions follows.

a. Fate and Behavior of Spilled Oil: Surface spills and subsurface spills both form surface slicks and similarly weather. A spill of 10,000 barrels in the Beaufort Sea could physically cover 1 to 2 square kilometers and a spill of 100,000 barrels could cover less than 10 square kilometers. Winds, movement of the slick, and other forces would tend to spread the oil discontinuously over an area 10- to 100-fold greater than this actual area of oiled surface. Dissolution would account for only about 5 percent of slick mass; most spilled oil evaporates, grounds on the shoreline, or eventually forms tar balls or pancakes (Fig. IV-8). The presence of broken ice would (1) retard spreading and (2) promote both of the competing processes of dispersion and mousse formation.

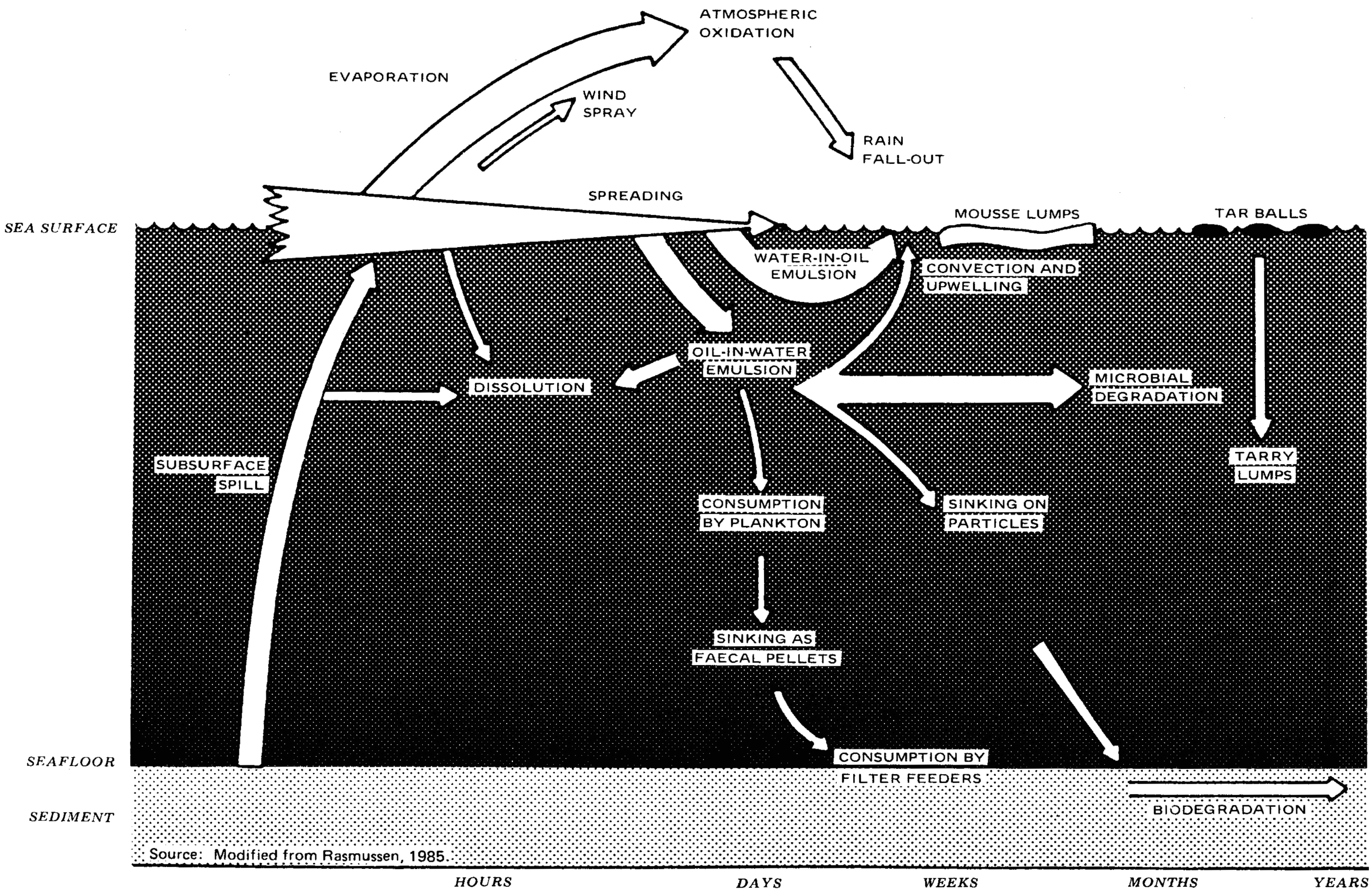


FIGURE IV-8. FATE OF OIL SPILLS IN THE OCEAN

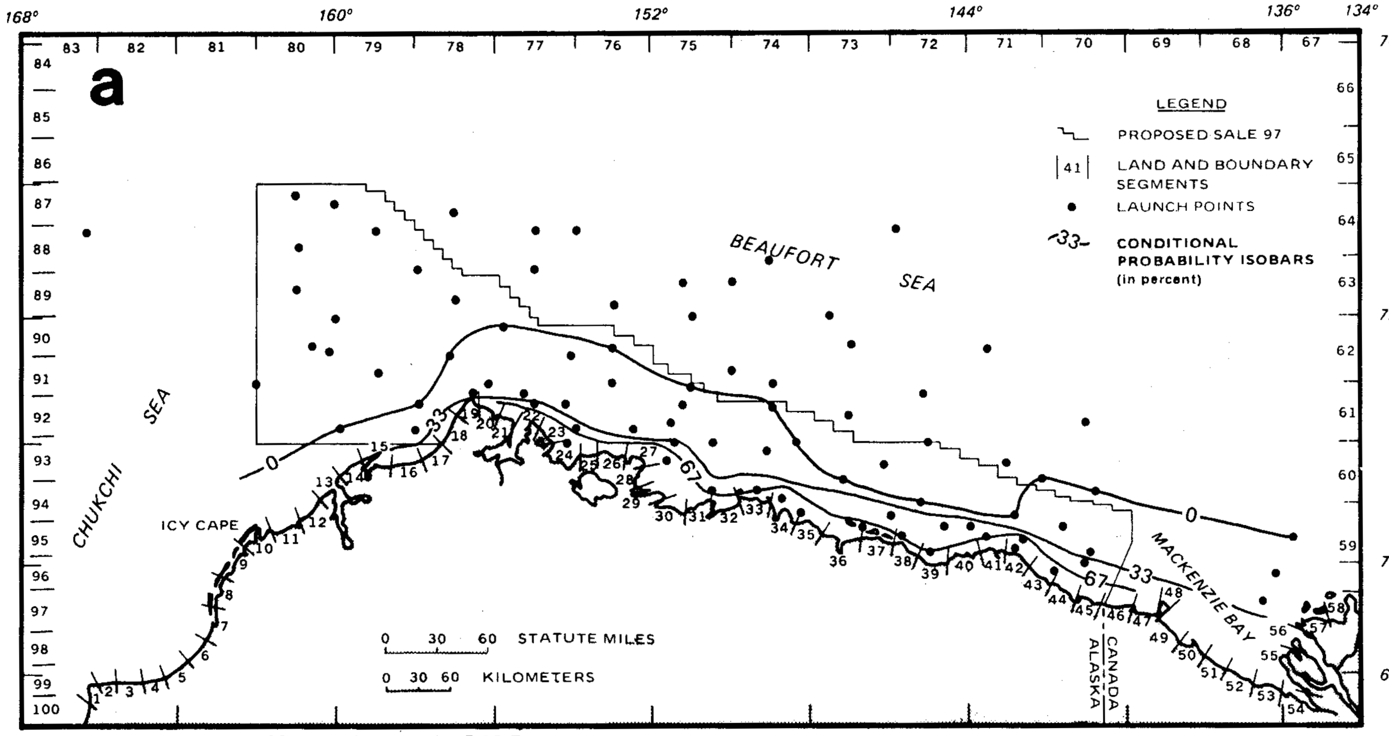
Oil spilled under winter ice would pool and freeze to the underside of the ice. The multiyear ice that covers most of the sale area in winter can store 1.8 million barrels per square kilometer in under-ice relief. Thus, oil would not spread appreciably along the underside of the ice before being frozen into the ice. The spill would then move as part of the ice pack. Oil would melt out from multiyear ice more slowly than it would from first-year ice. Most oil would be released through the first summer following the spill, but some oil would not be released until the subsequent summer(s).

b. Likelihood, Extent, and Persistence of Oiled Shoreline: If an oil spill occurs, three important but nonbiological questions arise: (1) will the oil reach the shore; (2) if so, how much shoreline will be contaminated; and (3) how long will 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 three questions is much greater for spill contacts during the open-water season than for spill contacts during winter. The following discussion, therefore, emphasizes spills that occur at any time of the year but contact land during the open-water season.

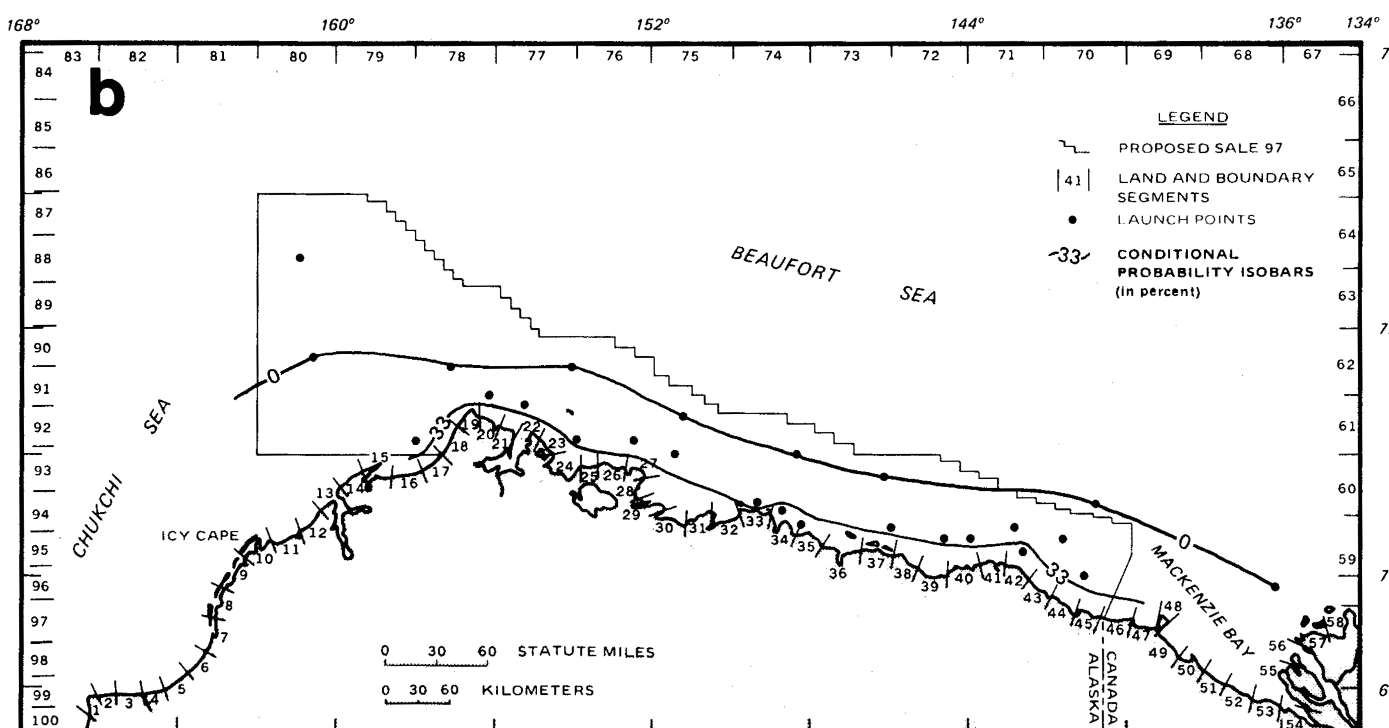
(1) Likelihood of Land Contact: The conditional probabilities that oil spills at specific locations would contact land are summarized in Figure IV-9 for summer spills and for open-water spills (summer plus overwintering spills). The probability that a spill in winter would persist into summer and then contact land in the model area is considerably less than the probability that a spill in summer would contact land. There is almost no chance that a spill in the Chukchi Sea portion of the proposed Sale 97 area would contact land within 10 days of a spill. However, a spill in the Beaufort Sea portion of the proposed sale area could contact land. The likelihood of contact with land increases rapidly the closer to shore that a spill is assumed to occur.

For the proposal, the combined probabilities that one or more spills of 1,000 barrels or more would occur and contact the shores of the study area are relatively low, both for the open-water season and winter (Tables IV-A-5 and IV-A-6). The odds are that such a spill would not occur and contact land. Westward-facing shores and headlands from Griffin Point (Land Segment 42) to Point Barrow (Land Segment 19) are the only shorelines at risk from a spill of 1,000 barrels or greater as a result of the proposed action (Fig. IV-10). However, only the shoreline around the Kuparuk River mouth/western Prudhoe Bay (Land Segment 34) has as great as a 3-percent chance of contact within 10 days during the open-water season. There is only a 1-percent chance that a spill as large as 100,000 barrels would occur and contact land within 10 days during the open-water season.

In the cumulative case, combined probabilities that one or more spills of 1,000 barrels or greater would occur and contact the shores of the study area are very high (Tables IV-A-5 and IV-A-6). A most likely number of three such spills would occur and contact the shoreline in winter, and an additional most likely number of one such spill would occur and contact land in the open-water season. Most land segments from Griffin Point (Land Segment 42) to Point Barrow (Land Segment 19) are at risk from a spill of at least 1,000 barrels in the cumulative case (Fig. IV-10). The greatest chance of at least one spill



Source: Samuels et al., 1983 and MMS, Alaska OCS Region.



Source: Table F-10.

FIGURE IV-9. CONDITIONAL PROBABILITIES THAT (a) IF A SPILL OCCURRED IN SUMMER IT WOULD CONTACT LAND WITHIN 10 DAYS AND (b) IF A SPILL OCCURRED IT WOULD CONTACT LAND IN THE OPEN-WATER SEASON WITHIN 10 DAYS OF SPILLAGE OR MELTOUT OF A WINTER SPILL

Table IV-A-5
Combined Probabilities (Percentage Chance) that One or More Oil Spills Would Occur and Contact Land During the Open-Water Season Over the Production Life of the Field 1/ 2/ 3/

	3 Days		10 Days		30 Days	
	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater
Proposal	9	n	23	1	27	1
Cumulative Case (Proposal, Existing Leases, and Tankering from Canadian Beaufort Sea)	46	2	77	6	88	8
Alternative IV Barrow Deferral	9	n	23	1	27	1
Alternative V Kaktovik Deferral	7	n	19	1	23	1
Alternative VI Chukchi Deferral	9	n	23	1	27	1

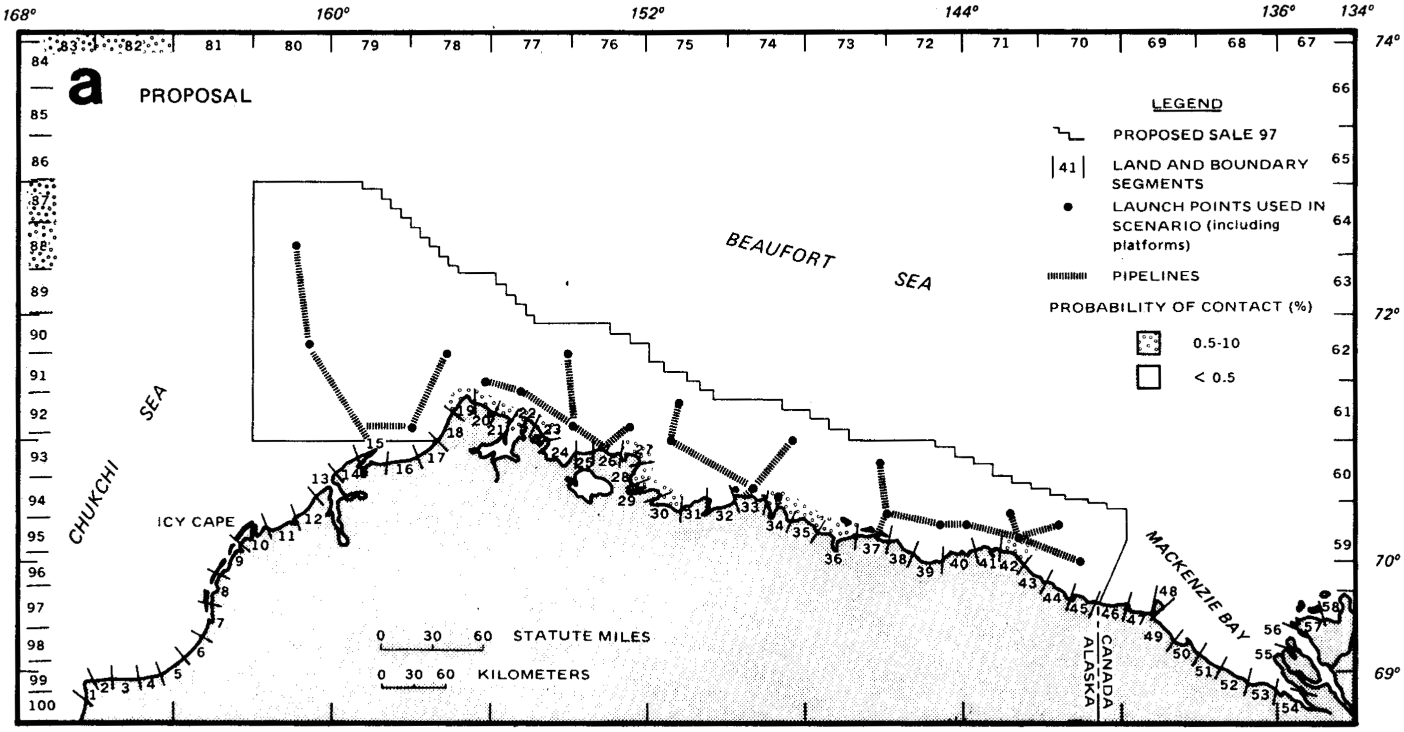
Source: Tables F-19, F-20, F-27, and F-28.

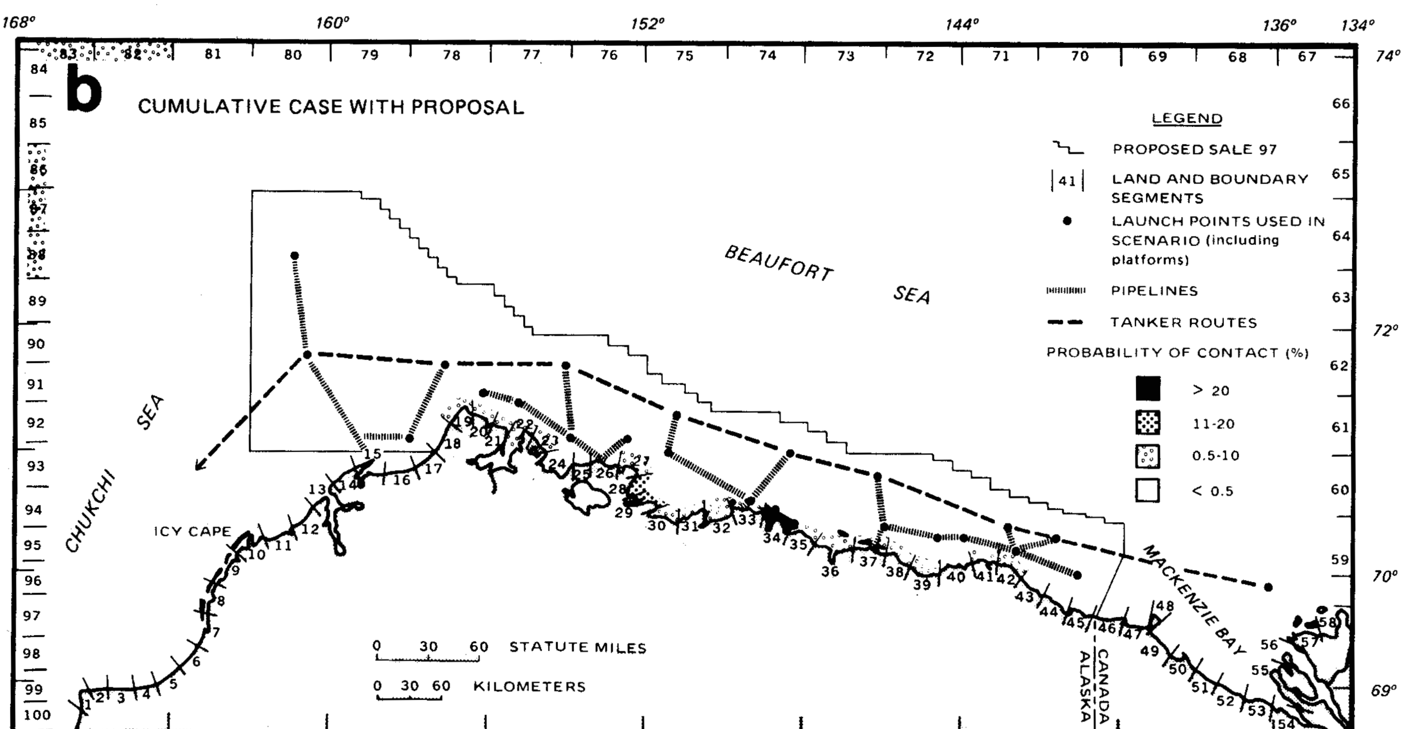
Table IV-A-6
Combined Probabilities (Percentage Chance) that One or More Oil Spills Would Occur and Contact Land During Winter Over the Production Life of the Field 1/ 2/ 3/

	3 Days		10 Days		All Winter	
	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater	1,000 bbls or greater	100,000 bbls or greater
Proposal	16	1	32	1	33	2
Cumulative Case (Proposal, Existing Leases, and Tankering from Canadian Beaufort Sea) Development	71	5	90	9	96	12
Alternative IV Barrow Deferral	16	1	31	1	33	2
Alternative V Kaktovik Deferral	14	n	28	1	29	1
Alternative VI Chukchi Deferral	16	1	32	1	33	2

Source: Tables F-15, F-16, F-23, and F-24.

1/ Based on the unrisked estimate, which assumes the mean resource estimates for the proposed action and each alternative will be discovered and produced.
2/ The number of days corresponds to the number of days after a summer spill or meltout of a winter spill.
3/ n=less than 0.5 percent.





Source: Table F-21.

FIGURE IV-10. COMBINED PROBABILITIES FOR CONTACT OF LAND/BOUNDARY SEGMENTS BY AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER (WITHIN 10 DAYS OF SPILLAGE OR MELTOUT OF A WINTER SPILL) of 1,000 barrels or greater occurring and contacting a land segment within 10 days is to the Kuparuk River mouth/western Prudhoe Bay (Land Segment 34) at 36 percent (Table F-21). Much of this risk to this area is from development of offshore oil fields in nearby State waters (Endicott Reservoir, Lisburne Reservoir, and Seal Island). Cape Halkett and the shoreline immediately south (Land Segments 28 and 29) are the only other land segments with a greater than 10-percent chance of contact.

The oil-spill-trajectory analysis indicates no oil-spill risk to the Chukchi Sea coast from oil development in the Beaufort Sea or proposed Sale 97. Proposed Sale 109 in the Chukchi Sea, which was not part of the trajectory analysis, poses additional risk of oil-spill contact with land. This latter risk, however, is only to the Chukchi Sea coastline. Predominant winds and currents would interact to direct spill trajectories in the Chukchi Sea farther away from the Beaufort Sea.

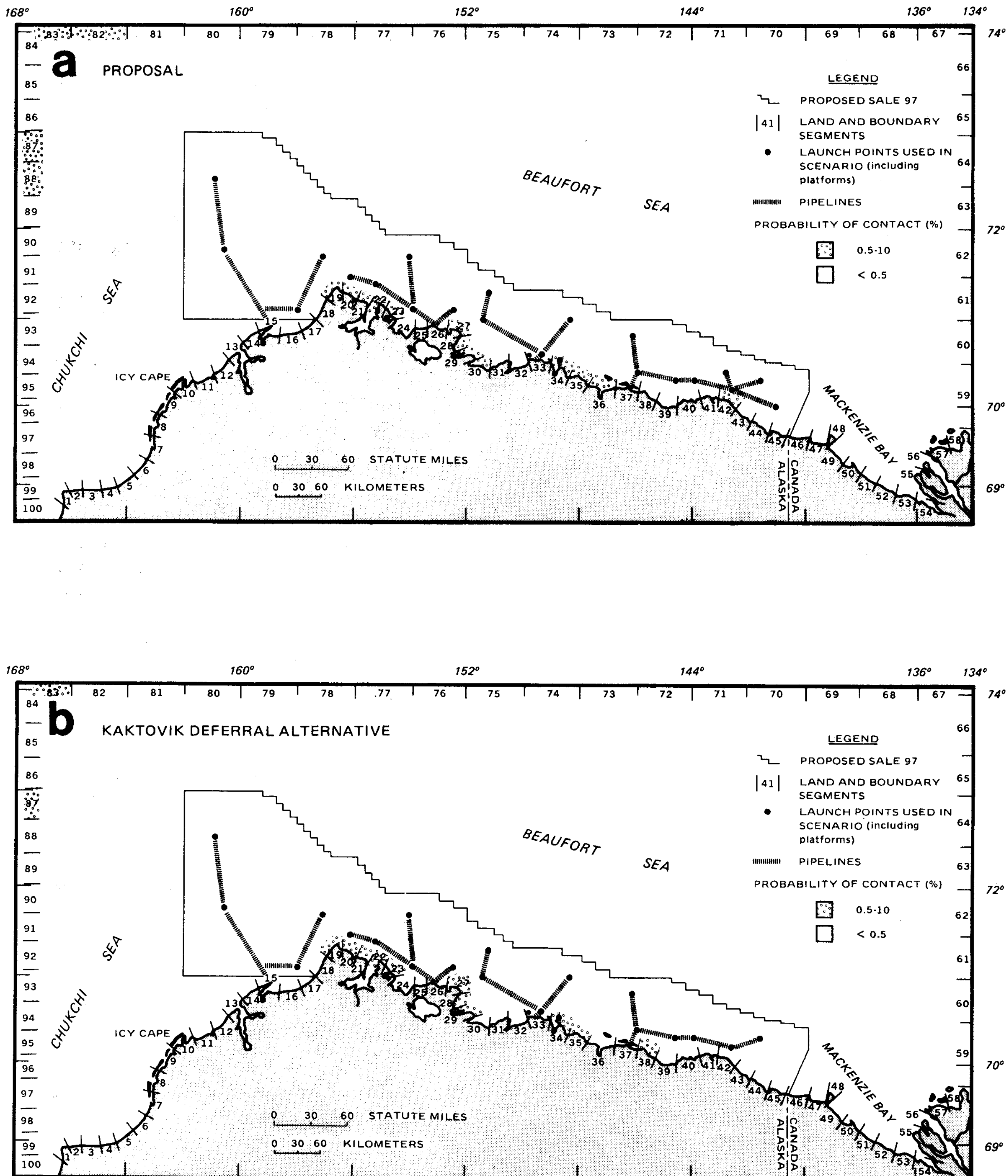
In the cumulative case, one or more spills of 100,000 barrels or greater could--but would be unlikely to--contact land during open-water or winter seasons (Tables IV-A-5 and IV-A-6). The Kuparuk River mouth/western Prudhoe Bay area (Land Segment 34) is also the area most at risk from contact with spills of at least 100,000 barrels, with a 3-percent chance of contact over all of winter (Table F-25) and a 2-percent chance of contact within 10 days during the open-water season (Table F-29).

Conditional probabilities (Fig. IV-9) indicate that spills within the Barrow Deferral area (the area deferred in Alternative IV) could contact land. However, the combined probabilities indicate that Alternative IV would not significantly reduce the likelihood of one or more spills occurring and contacting land (Tables IV-A-5 and IV-A-6). Neither would Alternative IV change the locations where contact would be most likely. The distribution and magnitude of land contacts would be identical to those shown for the proposal in Figure IV-10. This lack of effect for this deferral alternative is because of the low amount of oil resource assumed to be present within the deferred area.

Alternative V (the Kaktovik Deferral Alternative) provides a slight but significant reduction in the combined probability that land would be contacted by oil spills of 1,000 barrels or greater (Tables IV-A-5 and IV-A-6). This alternative would eliminate the slight threat of shoreline contact farther east than the Canning River Delta (Land Segment 38; Fig. IV-11).

Alternative VI (the Chukchi Deferral Alternative) would neither reduce the combined probability of land contact (Tables IV-A-5 and IV-A-6) for spills of 1,000 barrels or greater nor change the most likely locations of landfall for such spills: the distribution and magnitude of land contacts would be identical to those shown for the proposal in Figure IV-10. This lack of effect is because any spills in the Chukchi Sea Deferral Area have little chance of reaching land (Fig. IV-9) and because of the low amount of oil resource assumed to be present within the deferred area.

(2) Extent of a Shoreline Spill: An offshore spill that reaches 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 nature of winds and



Source: Table F-22.

FIGURE IV-11. COMBINED PROBABILITIES FOR CONTACT OF LAND/BOUNDARY SEGMENTS BY AT LEAST ONE OIL SPILL OF 1,000 BARRELS OR GREATER (WITHIN 10 DAYS OF SPILLAGE OR MELTOUT OF A WINTER SPILL) longshore current. In general, if a spill of 10,000 barrels occurred and contacted land, about 30 kilometers of shoreline could be expected to be oiled. For a spill of 100,000 barrels, expected oiling would be on the order of 90 kilometers if the spill occurred and reached land--only a 3-percent chance. 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.

For the purposes of this EIS, we assume that spills of the size of interest, 1,000 barrels or greater, are capable of contacting portions of vast segments of coastline greater than 30 kilometers; or roughly the effective width of 1 to 1.5 land segments. (The actual number of kilometers of shoreline composing an individual land segment is usually much greater than the effective width of that land segment because of shoreline complexity; that is, the presence of lagoons, bays, islands, and headlands--see Fig. IV-1). Because the trajectory model tracks only the center of mass of the spill, we account for spreading or smearing of the spill along the coast by assuming that the entire land segment and possibly its closest neighbors could have been contacted.

Long-duration spills are depicted less precisely in the oil-spill-risk analysis than are instantaneous spills. The oil-spill-risk analysis can still be used to represent the relatively rare occurrence of a long-duration spill. For such spills, the center of mass of the spill is still depicted accurately. However, the spreading of the oil over different trajectories through time would result in more frequent contacts of oil with land, but each contact would involve only a fraction of the total spill. For such spills, the conditional probabilities of contact from an individual hypothetical launch point represent the fraction of the total spill that would contact that target or land segment, disregarding weathering and cleanup. (The conditional probability would normally represent the likelihood that the target or land segment was contacted by the entire spill.)

(3) Persistence of Stranded Oil: 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) Summary: For the proposal, the oil-spill-risk analysis projects a 23-percent chance that one or more spills of 1,000 barrels or more would occur and, during the open-water season, contact land within 10 days of summer spills or meltout of winter spills. About 30 kilometers of shoreline could be oiled by such a spill, but effects would very likely be limited to a narrow tidal band. Because much of the shoreline is rated moderate to high in oil-spill persistence, oil that is not cleaned up could take decades to naturally cleanse or erode away.

For the cumulative case with the proposal, the oil-spill-risk analysis projects a 77-percent chance that one or more spills of 1,000 barrels or more would occur and, during the open-water season, contact land within 10 days of summer spills or meltout of winter spills. Most of the risk is not from proposed Sale 97. Much of the additional risk to shorelines in the cumulative case occurs at Prudhoe Bay and the Kuparuk River Delta and is attributable to nearby spills from planned and proposed development in State waters. About 30 kilometers of shoreline could be oiled by a single spill, but effects would very likely be limited to a narrow tidal band. Because much of the shoreline is rated moderate to high in oil-spill persistence, oil that is not cleaned up could take decades to naturally cleanse or erode away. If a very large spill, 100,000 barrels or more, occurred and contacted land during the open-water season (only an 8-percent chance), at least 90 kilometers of shoreline would be likely to be oiled.

Neither Alternative IV (the Barrow Deferral Alternative) nor Alternative VI (the Chukchi Deferral Alternative) would decrease the likelihood of shoreline oiling. For either deferral alternative, the oil-spill-risk analysis projects a 23-percent chance that one or more spills of 1,000 barrels or more would occur and, during the open-water season, contact land within 10 days of summer spills or meltout of winter spills. About 30 kilometers of shoreline could be oiled by such a spill, but effects would very likely be limited to a narrow tidal band. Because much of the shoreline is rated moderate to high in oil-spill persistence, oil that is not cleaned up could take decades to naturally cleanse or erode away. The cumulative case with either of these deferral alternatives would be similar to that of the cumulative case with the proposal.

Alternative V (the Kaktovik Deferral Alternative) would provide a slight but significant reduction--to a 19-percent chance--in the combined probability that land would be contacted by one or more oil spills of 1,000 barrels or greater within 10 days of summer spills or meltout of winter spills. This alternative would eliminate the slight threat of shoreline contact to the coast east of the Canning River Delta. About 30 kilometers of shoreline could be oiled by a single spill, but effects would very likely be limited to a narrow tidal band. Because much of the shoreline is rated moderate to high in oil-spill persistence, oil that is not cleaned up could take decades to naturally cleanse or erode away. The cumulative case with this deferral alternative would be similar to that of the cumulative case with the proposal.

c. Oil-Spill-Contingency Measures: The bottom line for oil-spill response in the OCS is that oil-spill cleanup is the responsibility of the spiller. The Federal Government will step in only if the Government considers the spiller's response to be inadequate. The basic philosophy of both the Government and the oil and gas industry is to prevent spills before they happen. Considerable attention is given to preventive measures such as better technology and better training.

(1) Contingency Plans: The U.S. and Canada have developed the Joint Canada-U.S. Marine Contingency Plan to respond to oil spills that could cross the border between the two countries. The plan was developed in 1974 and amended in 1983. Annex four of the plan applies to waters off of the Arctic coast of Canada, and the U.S. coordination and control of Federal/National spill response are directed by a Joint Response Team (JRT) through the On-Scene Coordinator (OSC). The JRT is composed of officials from the Canadian Coast Guard and the U.S. Coast Guard (USCG) and also from other National/Federal and Provincial/State organizations. The primary function of the JRT is to provide assistance and advice to the OSC, who is responsible for cleanup activities at the spill site. The OSC is designated from the country

in which the pollution incident occurs. A deputy OSC is designated from the adjoining country.

The industry spill-response cooperative, the Alaska Beaufort Sea Oil Spill Response Body (ABSORB), is expected to expand its coverage to include any leases from the proposed sale area prior to exploration, as has been the case elsewhere along the Arctic coast of Alaska. ABSORB is part of the umbrella organization, Alaska Clean Seas, which is a Statewide cooperative. The ABSORB area of interest is currently defined as follows (Alaska Clean Seas, 1984):

> "The public and private properties, including but not limited to beaches, harbors, inland waterways, and offshore islands and water along the coast of the State of Alaska, within the area bounded on the east by the Canadian border, on the west by 156 degrees W. longitude, on the south by the mainland shoreline of the State of Alaska, and on the north by the sixty meter isobath."

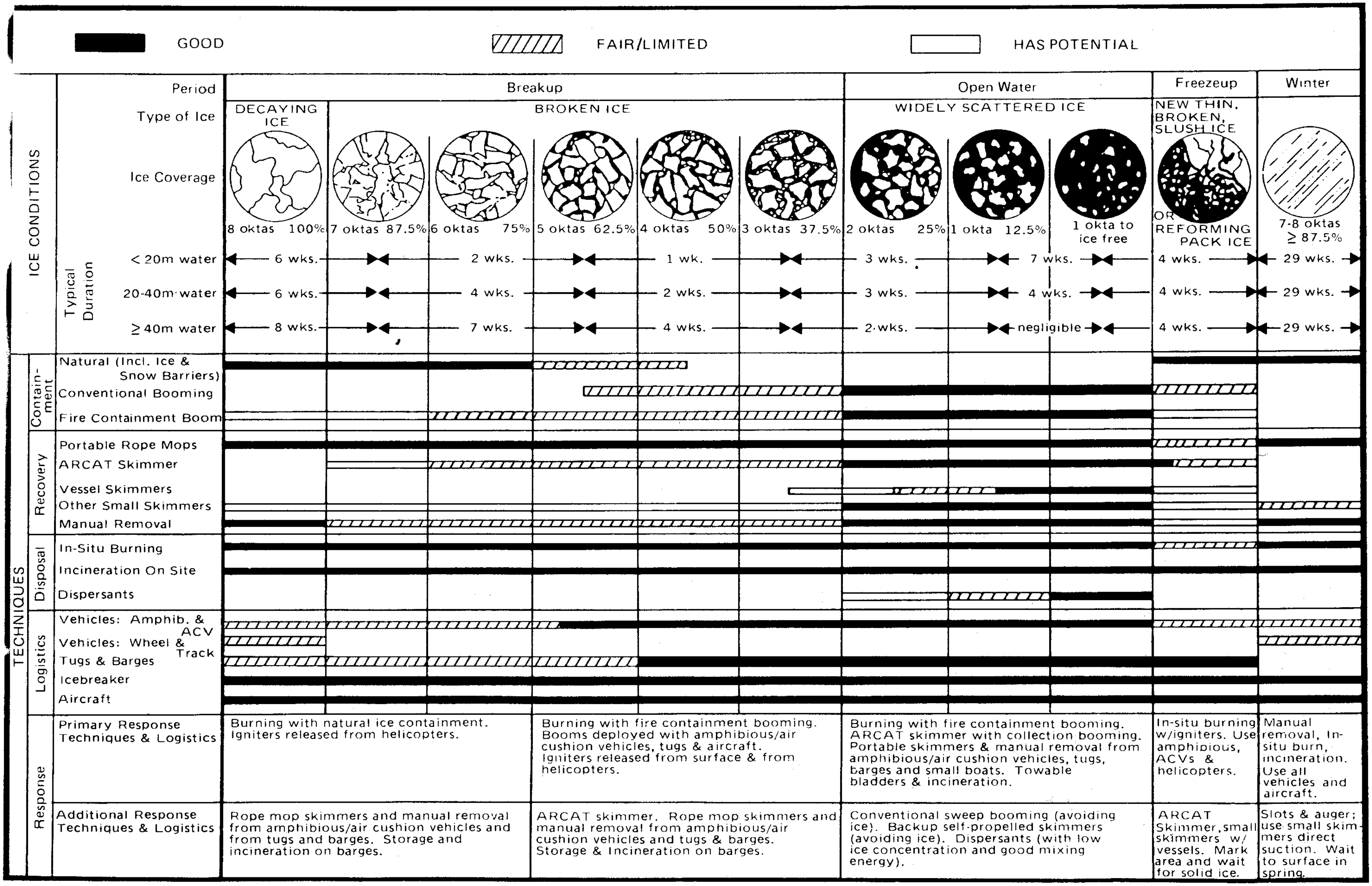
Lessees are required to develop oil-spill-contingency plans as part of their exploration plans prior to drilling. More than a dozen oil-spill-contingency plans have been submitted and approved to date for exploration of existing leases in the Beaufort Sea Planning Area. By having on hand prior knowledge of the nature of the spilled material, slick dynamics, and the characteristics of the threatened environment, plus available equipment and manpower, the responsible party can order and evaluate selected actions.

Responses to spills from OCS activities are approached by arranging and ranking lines of defense to prevent spilled oil from affecting identified vulnerable environment. The first line of defense is always offshore containment. Open-water collection of spilled oil (without containment) is usually not successful (see "Effectiveness of Oil-Spill Cleanup at Sea" below).

Containment is useful in stopping the spreading of the oil and in providing extra time for deployment of more equipment and manpower. In the presence of sea ice--which can act as a natural containment barrier--in situ burning may be an effective treatment. For a blowout, well ignition is a drastic but potentially effective contingency measure. If conventional cleanup equipment cannot recover the oil before spill contact with important resources is likely to occur, it may be appropriate to use chemical agents to disperse the slick--if permission for their use can be obtained. The Regional Response Team in Alaska, chaired by the USCG and the Environmental Protection Agency, is trying to streamline guidelines and gain partial preapproval for using dispersants in some Alaskan waters.

(2) <u>Applicability of Oil-Spill-Response Techniques in the Proposed Sale Area</u>: Figure IV-12 summarizes techniques and equipment and the ice conditions under which they could be used in the Sale 97 area. "Good" applicability does not necessarily imply effective recovery or removal of spilled oil. Effectiveness of spill response is discussed at a later point.

(3) <u>Locally Available Spill-Cleanup Equipment</u>: The MMS Alaska OCS Region requires a lessee who wishes to drill to have an initial spill-response capability of 1,000 barrels per day. To date, during drilling



Source: Alaska Clean Seas, 1984, and Labelle et al., 1983.

FIGURE IV-12. APPLICABILITY OF OIL-SPILL-RESPONSE TECHNIQUES IN THE PROPOSED SALE AREA of exploration wells in the Beaufort Sea, this requirement has been met with equipment warehoused at Deadhorse by ABSORB and with equipment positioned on site by individual lessees.

(4) Mobilization Time: The MMS Alaska OCS Region requires that initial mobilization and deployment of response equipment be undertaken within 6 to 12 hours of a spill, geography permitting. However, the spiller must be prepared to respond before the spill reaches shore (in less than 6 hours, if necessary). Only on-site equipment and that which could be transported from Deadhorse by helicopter could meet this guideline for deployment for most of the sale area. The limited geographic and temporal presence of open water and slow vessel speeds in broken ice would preclude timely transport of spill equipment by sea. For large spills--those that could exceed the local cleanup-response capability--the MMS Alaska OCS Region requires that additional equipment be made available on site within 48 hours. Additional response equipment to handle a large spill would be available from a multitude of sources.

Equipment stored at Deadhorse or airlifted to Deadhorse would be capable of meeting the criteria of the 48-hour-response time set by MMS. Additional, slower-arriving equipment would still be useful in case of a major spill; but MMS would not consider such equipment in judging whether oil-spill-contingency plans met the MMS 48-hour-response criteria. Once spill-cleanup equipment reaches Deadhorse or Prudhoe Bay, it could be transported relatively quickly to the spill site only if it could be carried by helicopter and then only if weather permitted. A helicopter could reach any point in the sale area within 3 hours.

(5) Effectiveness of Oil-Spill Cleanup At Sea: The 6-to-12-hour and 48-hour response times required of drilling lessees by the MMS Alaska OCS Region are mobilization and deployment requirements. Cleanup would continue as long as necessary, without any timeframe or deadline. For example, a winter spill in pack ice might require initial on-site response followed by further cleanup of oil melting out and pooling on top of the ice in late spring or summer.

Mechanical cleanup at sea is usually much more effective on low-viscosity or medium-viscosity oils than on high-viscosity oils. A low-viscosity oil could be a diesel or fresh, light crude. A medium-viscosity oil could be a lubricating oil or a light, flowing emulsion. A high-viscosity oil would be a weathered crude, bunker oil, or thick emulsion. An oil such as Prudhoe Bay crude would initially have low viscosity but would quickly weather and form a high-viscosity emulsion.

Because of natural dispersion, oil slicks in the open ocean are seldom tracked for more than about 10 days before the oil becomes too dispersed to locate or identify as a slick (USDOI, MMS, Gulf of Mexico OCS Region, 1983). Out of necessity or otherwise, natural dispersion has frequently been the chosen response technique in Alaskan waters.

Uncontained burning is also a possible spill remedy. Experiments suggest that burn efficiencies on the order of 50 to 60 percent may be possible if the spill can be immediately set on fire (Laperriere, 1984). However, any delay in ignition would decrease combustion efficiency.

The effectiveness of mechanical recovery and in situ burning of spilled oil at sea decreases rapidly with increasing sea state (roughness of the sea), while the effectiveness of dispersants and natural dispersion increases. Mechanical cleanup becomes nonfunctional between International Sea States 3 and 4. During the months of July through September in the small fraction of the Beaufort Sea Planning Area with open water, Sea States of 3 or greater occur from 13 to 30 percent of the time and Sea States of 4 or greater occur 9 to 18 percent of the time. Ice cover the remainder of the year would eliminate both high sea states and standard uses of most mechanical-cleanup equipment.

The review of the historical record of oil-spill cleanup at sea as contained in Section IV.B.5 of the Final Regional Environmental Impact Statement (USDOI, MMS, Gulf of Mexico OCS Region, 1983) is incorporated by reference; a summary of this review follows. Offshore containment and cleanup are major tasks. Weather, sea conditions, and crew fatigue become critical factors; and cleanup at sea is generally only marginally effective. Recovery of oil usually ranges between 5 percent and 15 percent of that spilled. Inshore containment and cleanup operations generally occur in calmer waters and closer to logistical bases. Inshore operations are, therefore, more effective, with recovery of spilled oil on the order of 20 to 50 percent.

(6) Effectiveness of Oil-Spill Cleanup in Ice: When a spill is dispersed far from its source or when ice is moving, containment and cleanup are more difficult. Planning an effective surface response with mechanical equipment to spills in pack ice would require that an icebreaker (or icebreaking-supply ship) be locally stationed in both winter and summer as a dedicated oil-recovery vessel.

In situ burning of spilled oil during heavy ice periods may be a more promising approach. Exposed oil would be ignited whenever possible. Existing response capabilities are more effective on landfast ice than on broken or pack ice. Spills in the latter two sorts of ice would be easiest to burn if the spill were contained within a small area close to its source. The ice itself can be useful in restricting the spreading of the oil, keeping the oil thicker and more amenable to burning. Experiments conducted to date indicate that in situ burning should be more a more effective technique for spill response in the Arctic than is mechanical recovery in more temperate climates.

d. Toxicity of Oil in the Marine Environment: In general, the determination of the ultimate effect and the recovery of an ecosystem from petroleum contamination depends on the physical and chemical form of the oil and the state of the ecosystem at the specific time of the oil spill. The dispersion of oil in water, its movements, chemical modifications, effects on aquatic organisms, and persistence in the sea are all influenced by: (1) type and characteristics of the oil (for example, viscosity and percent aromatics); (2) amount and duration of oil spilled; (3) state of the sea, in particular the tidal cycle and wave activity; (4) location of the spill, including the physiography of the area and the distance from shore; (5) the geographical and topological configuration of the affected coast, including textural characteristics of shore sediments; (6) climatic conditions, in particular temperature, wind, and solar radiation; (7) biota of the area; (8) season of the spill; (9) previous exposure of the area to oil; (10) exposure to other pollutants; and (11) effectiveness of mitigating measures taken by appropriate Federal and State agencies.

(1) Crude Oil Characteristics: The toxicity of petroleum on marine organisms is dependent upon the concentration and composition of its individual hydrocarbons at the time of contact. The relative effect of the oil will shift as spilled oil weathers due to the change in its chemical composition.

Crude oil is a complex mixture of alkanes (aliphatic), naphthenes (cyclo paraffinic), aromatics, and asphaltics (asphaltenic and heterocyclic compounds containing oxygen, sulfur, or nitrogen). The low-molecular-weight components are more toxic but are rapidly lost through evaporation and solution during the first days of a spill. High-molecular-weight aliphatics are the least toxic, although they may have an anesthetic or narcotic effect if concentrations are great enough.

In general, the relative toxicity of an oil is proportional to its aromatic content. Studies have shown lower-molecular-weight aromatic hydrocarbons (benzenes and toluenes) to be moderately toxic to a variety of animals. Intermediate-molecular-weight aromatic hydrocarbons (naphthalenes) have been found toxic to phytoplankton and many species of aquatic animals. Laboratory studies have shown that chronic exposure to hydrocarbon fractions can produce mutagenic and carcinogenic effects. However, in the field the benzenes and naphthalenes are quickly lost to the atmosphere or diluted into the water column.

(2) Comparative Toxicity of Different Oil Forms in Water: Although laboratory toxicity tests show that the deleterious effects of oil are related to its chemical components, the form of oil at sea is just as, if not more, important in determining toxicity. That portion of the oil that dissolves, the water-soluble fraction (WSF), appears to be the most highly toxic to organisms, possibly due to the easier uptake of oil in this form (Ottway, 1976; Winters and Parker, 1977). Water-in-oil emulsions of spilled oil are likely to cause biological damage due to physical effects, while oil-in-water emulsions probably cause more biological damage due to toxic effects. Oil in dispersed droplets exhibits slightly less toxicity than the WSF's.

(3) Comparative Toxicity of Oil Types: Toxicities vary between oil types because the concentration and composition of individual hydrocarbons within the oil vary. In general, refined oils are considered more toxic than crude oils due to their high aromatic hydrocarbon concentrations and their greater ability to mix into the water column as a result of their less viscous nature. In general, spills of crude oil, residual fuel, and lubricating oil are more likely to cause biological damage by virture of their viscous physical properties when considered over a length of time, while spills of refined oil, including gasoline and kerosene, are likely to cause biological damage by virtue of their toxic nature over a relatively short period of time (Ottway, 1976).

(4) Biological Differences: The severity of oil pollution on different organisms in various habitats varies from no effect to responses of avoidance, decreased activity, physiological stress, and death. Different species react differently, and different lifestages of an organism will show different sensitivities to petroleum hydrocarbons. Lethal effects

of the soluble aromatic hydrocarbons from bioassays range from 1 to 100 parts per million for most adult marine organisms and from 0.1 to 1 parts per million for the more sensitive larval and juvenile lifestages. Sublethal effects may occur from soluble aromatic concentrations ranging from 1 to 100 parts per billion. Major sublethal effects from exposure to petroleum hydrocarbons are reduced growth rates, reproductive maturation, and the reproductive potential or fecundity of an organism. The ecological significance of these responses is important at the population and community levels. A species may be proven sensitive to oil in the laboratory, but in the natural environment, due to such factors as effective reproduction and dispersal strategies and immigration, an entire population may recover rapidly. Conversely, although an individual organism may show high tolerance to oil contamination in the laboratory, recovery of that population under natural conditions may be delayed due to such factors as competition for food and space or dependence on a specific food resource. See Section IV.B for more specific discussions of toxicity as it relates to biological resources found in the proposed sale area.

3. 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. The discussion in this section summarizes and incorporates by reference the description of constraints and technologies contained in the Sale 87 FEIS (USDOI, MMS, 1984a); a summary of this discussion, augmented by additional material, as cited, follows.

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 ice floes and sheets, ridges, floebergs, and ice islands are a major concern in the design and operation of offshore facilities associated with petroleum exploration and 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 (SSDC) and the Concrete Island Drilling System (CIDS), and (5) floating units such as the ice-strengthened drillships and the Conical Drilling Unit (CDU).

Artificial islands, as well as other bottom-founded units, are designed and constructed to resist the lateral forces that are associated with ice movement. These manmade islands are constructed from sand and gravel dredged from offshore deposits or mined from onshore deposits. The total weight of the unit provides the resistance required to overcome the lateral forces of moving ice. The failure mode of greatest concern is the mass sliding of the island on a horizontal shear plane through the fill or the seafloor. To prevent these failures, islands are designed to withstand the maximum force--the design load--associated with an event that is not expected to happen during the intended life of the structure. The islands are actually designed to withstand forces larger than the design load, and this provides a safety factor to account for the uncertainties in sea-ice descriptions and ice-load predictions.

The sloping sides of the island cause advancing (1) ice sheets to fail in the flexure, or bending, mode (the strength of sea ice is less in flexure than in compression) and (2) deep-draft ice masses to ground (the grounded masses help to stabilize the nearby ice and initiate subsequent failure). Failure of the ice on the side results in ice pileups that become grounded. As they grow seaward, the pileups help to protect the island from future rideups or overrides. Manmade ice-rubble piles have been built around caisson-retained islands and bottom-founded mobile units to help protect the units in a manner similar to the grounded masses.

Caisson-retained islands could also be used to drill the exploration and delineation wells on a year-round basis. These structures consist of prefabricated concrete and steel caissons that are floated into position and lowered onto the seafloor or onto a subsea berm composed of fill material. The area enclosed by the caissons is then filled with sand or gravel. Concrete and steel Arctic offshore drilling units are designed so that damage or failure of any element does not result in a catastrophic collapse of the unit.

Ice has been used to construct a bottom-founded drilling unit and may be used to build future units. Construction of the foundation begins when the first-year ice is thick enough and stable enough to support the construction equipment. Two techniques have been developed to form an ice foundation thick enough to be grounded on the seafloor and strong enough to support a drilling rig and the associated auxiliary equipment.

Flooding was the first technique used to construct an ice island in the Alaskan Beaufort Sea. The island was built at a site located in the eastern part of Harrison Bay in waters about 3 meters deep during the winter of 1976/1977. Drilling from the Harrison Bay ice island began in mid-February and ended during the last part of April.

A more recently developed technique for building ice islands involves spraying seawater into subfreezing air where the drops form into ice crystals before falling to the surface (OGJ, 1985d). Spray ice is added to the surface until the island rests on the seafloor for stable grounding and the mass is large enough to resist predicted loads associated with moving sea ice. Two experimental spray-ice islands were constructed in the Beaufort Sea prior to 1986. One island was constructed in the Mackenzie Delta area of the Canadian Beaufort. The other island was constructed in waters that are about 9 meters deep and are located about 19 kilometers northwest of Prudhoe Bay. These islands were built to test the construction techniques and the ability to withstand various loads and ice stresses; no drilling occurred from either of these islands. The technique of using spray ice was also used to construct a grounded, horseshoe-shaped berm around the CIDS, during its first operating season in the Beaufort Sea, and an island that was used to drill an exploration well in Harrison Bay. The island was constructed in waters that are about 8 meters deep and are located about 5 kilometers northeast of Cape Halkett. The well was drilled between March 12 and April 19, 1986.

Bottom-founded mobile units are capable of resisting the sea-ice forces. The first unit of this type, the Single Steel Drilling Caisson (SSDC), began operation in the fall of 1982 in 31-meter-deep water in the Canadian Beaufort Sea. Two other units have been constructed and began operations in 1984: the Mobile Arctic Caisson (MAC) was built for use in the Canadian Beaufort Sea and the Concrete Island Drilling System (CIDS) for use in the Alaskan Beaufort Sea.

Ice-strengthened drillships have been used to drill exploratory wells in waters deeper than 20 meters in the Canadian Beaufort Sea since 1976. On the average, drilling and testing a single well from a drillship has taken nearly two drilling seasons. With assistance of icebreakers or icebreaking supply boats, the drillships are able to operate from about mid-July to mid-October or the first part of November. The drillships are designed to operate in waters that range in depth from 15 to 303 meters. One of the Canadian ice-strengthened drillships was used to drill three exploration wells in the Alaskan Beaufort Sea during the 1985 and 1986 summer/fall drilling season. Two of the wells were drilled at a site 19 kilometers north of Flaxman Island in waters 32 meters deep and one exploration well at a site about 32 kilometers northwest of Barter Island. The drillship was supported by an Ice Class 3 icebreaking supply vessel and two ice-class supply vessels (Alaska Report, 1985).

Sea-ice forecasting has developed as a strategy to maximize drilling time and 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 and the drillship to be disconnected from the mooring system if weather and sea-ice conditions become severe enough to threaten the operation.

Icebreakers and icebreaking supply boats perform ice-management tasks to reduce the threat that sea ice poses to the drillship (Browne, Carter, and Kimmerly, 1984). These ice-management duties include breaking up ice around the drillship and breaking, towing, or pushing large floes so that their drift trajectories miss the drillship. In heavy ice, the support vessels 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 (USDOI, MMS, 1982). 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.

The BOP is used to safely shut-in a well if ice conditions force the drillship to temporarily abandon drilling. If, near the end of the drilling season, ice conditions prevent the return of the drillship, the BOP also can be used to shut-in the well during the winter and spring. The well could then be reentered and drilling resumed the next season.

The other type of floating unit that has been used in the Canadian Beaufort Sea is the Conical Drilling Unit (CDU). This unit is designed to operate in waters 24 to 180 meters deep. In the presence of sea ice, drilling can be maintained until first-year ice attains a thickness of about 1.2 meters and the velocity of the winds reaches about 16 meters per second and the currents about 30 centimeters per second (Park, 1984). Operations with the CDU began in August 1983 at a site in the Canadian Beaufort Sea about 160 kilometers northwest of Tuktoyaktuk (Tuk), Northwest Territories (Park, 1984).

With greater ice-strengthening and icebreaker support, the CDU, or a similar type of vessel, would be able to operate in the sea-ice environment of the Beaufort Sea Planning Area for longer periods of time than would ice-strengthened drillships. In 1984, with similar ice-management support, the CDU was able to operate from about mid-June to mid-November whereas the drillships operated from about late July to mid-October.

In addition to the operational units, designs have been proposed for a number of (1) bottom-founded mobile units (with a large surface area at the waterline) for water depths from 4 to 40 meters, (2) bottom-founded mobile units with a monopod/monocone configuration for water depths from 6 to 50 meters, and (3) floating units (Han-Padron, 1985). These units would be constructed and outfitted outside Alaska and towed to the Sale 97 area. In addition, the units would carry enough supplies to drill 2 or 3 wells without major resupply.

(2) Development and Production: If economically recoverable petroleum resources are discovered, structures designed for the recovery of oil will be placed in the lease-sale area. The experiences gained from exploration units will contribute to the design and construction of these production platforms. Production platforms will be larger than exploration units because space must be provided for: (1) drilling a number of production and service wells; (2) locating facilities to separate oil, gas, and water that is produced from the wells; and (3) locating the equipment and wells that may be needed to inject gas and water. Production platforms may be larger versions of the units used for exploratory drilling.

Structures contemplated for year-round use in the stamukhi and pack-ice zones would have to resist the forces exerted by thick, first-year and multiyear ice floes and sheets, ridges, floebergs, and ice islands. 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.

The first offshore-production facility in the Alaskan Beaufort Sea is being constructed to recover oil from the Endicott hydrocarbon reservoir located east of Prudhoe Bay; the reservoir underlies State lease tracts (USDOD, U.S. Army COE, 1984); also, see Appendix B.

Concepts also are being developed for Arctic production platforms that are monolithic, multi-sided 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: Transportation of oil from the production sites to refineries may be by pipeline, tankers, or a combination of the two systems. A considerable amount of experience has been derived from these systems in many other offshore areas. As with other techniques, some of this experience will be used to design, construct, and operate petroleum-transportation systems in the planning area. Experience with Arctic petroleum-transportation systems is very limited and, thus, a number of new problems will have to be solved.

(a) Offshore Pipelines: The threat that sea ice poses to a marine-pipeline system in the Sale 97 area is indicated by the presence of ice gouges. The area of most intense gouging is the stamukhi zone; the frequency of ice gouging decreases shoreward and seaward of this zone. Burial of the pipeline beneath gouge depth will afford protection from moving ice.

Offshore pipelines can be laid during the open-water period by a variety of existing pipelaying techniques. These methods include laying pipe from a conventional lay or reel barge or by bottom or surface tows. Most present-day techniques for laying marine pipe were developed in an ice-free environment. 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 will probably be installed by the bottom-pull method. Longer pipelines will probably be installed by a vessel that can lay pipe at a rate of about 2 kilometers per day.

Pipeline-burial depth will depend on the deepest gouge that is expected to be cut into the seafloor during the operational life of the pipeline. As with many other sea-ice phenomenon, it is difficult to predict maximum gouge events that will occur within some time interval for specific segments of the seafloor. However, several methods are being developed to predict depths and rates of ice gouging. One of these methods uses ice-gouge data obtained from a repetitive sonar mapping of the seafloor; this is the principal quantitative method used today. Another method uses ice-ridge drift rates and keel-depth distribution.

Pipeline trenches may be excavated by cutter-suction dredges or mechanical plows (Han-Pardon, 1985). However, because existing cutter-suction dredges are limited to dredging depths of 30 meters and have forward speeds that are too slow for the short open-water season, specially designed new equipment will be required.

Design studies indicate that trenches as deep as 1 to 2 meters can be cut by a single pass of a large mechanical plow but that cutting trenches deeper than 2 meters will probably require multiple passes (Brown and Palmer, 1985). Since 1975, 13 large plows have been constructed to cut trenches in other parts of the world. The trenching depths of these plows range from 0.6 to 2 meters. The trenching rate and number of passes will depend in part on size of the plow, the power of the pulling system, and the geotechnical characteristics of the seafloor. In the Beaufort Sea, Brown and Palmer (1985) estimate that trenching to a depth of 1 meter can be done at an average of 4.8 kilometers per day.

In addition to burial, a pipeline may be routed around areas of known intensive gouging, such as the northern sides of shoals.

Those segments of offshore pipelines that cross the shoreline must also 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 will 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 will be site-specific and depend on the length and orientation of the causeway. In the Beaufort Sea, the net effect that a causeway will have on the net longshore-sediment transport is probably small because of low wave energy and the short open-water season. The method selected to protect pipeline that crosses the shoreline will be site-specific and must also take coastal erosion into consideration.

(b) Marine-Transportation System: A marine-transportation system is a possible alternative to a pipeline system for the transportation of oil from production sites to refineries. This system would include icebreaking tankers, offshore storage and loading terminals, and icebreaking support vessels. These components are discussed briefly in the following paragraphs to indicate some of planning, testing, and operating experiences that have gone into developing marine-transportation systems for the Arctic.

Tankers: The most economic-size crude oil tanker for a particular trade route depends on a number of factors that include time in port, cruising speed in open waters and various concentrations and thicknesses of ice, the amount of oil loaded into the tanker, physical restrictions along the trade route, and terminal limitations (Han-Pardon, 1985). It is assumed that the icebreaking tankers could transport the crude oil to an ice-free transshipment terminal on the Alaska Peninsula. Conventional tankers would then be used to carry the oil to refineries outside Alaska.

Although limited, there is some Arctic operational experience with icebreaking tankers. In 1969, the S.S. Manhattan, equipped with an icebreaking bow, made successful westbound and eastbound transits of the Northwest Passage in a route from the east coast of the U.S. to Barrow, Alaska, and return. The "Lunni" class of icebreaking tankers (16,000 deadweight tonnage [DWT]), currently in service in Finland, was designed to operate in 1-meter-thick level ice and through 10-meter-thick ridges. Two icebreaking tankers, the Lunni Class Sotku and the 6,900 DWT Kiisla, were used in a series of full-scale ice-resistance and -maneuvering tests in the Baltic Sea in 1984 to demonstrate the accuracy of model tests and to provide data on icebreaking-hull forms that may be expanded to larger ships for the Arctic (Sucharski and Gordin, 1985).

To demonstrate the feasibility of Arctic-oil transportation by tanker, 100,000 barrels of crude oil were shipped from the Bent Horn Field on Cameron Island in the Canadian Arctic Islands to Montreal during the summer of 1985 (Arctic News Record, 1985; OGJ, 1985e,f). The MV Arctic, a converted Ice Class 2 icebreaking bulk carrier, was used to transport the oil from Cameron Island 118 kilometers south to Rea Point on Melville Island where the ice conditions are less severe. At Rea Point, the Bent Horn oil was transferred to the icebreaking tanker MV Imperial Bedford for the remainder of the 5,285-kilometer journey through the Northwest Passage, Baffin Bay, Davis Strait, Labrador Sea, and St. Lawrence River to Montreal.

More recently, the VLCC Gulf Beaufort transported 300,000 barrels of oil from the Canadian Beaufort Sea past Point Barrow in early September 1986; the oil was from an extended flow test at the Amauligak discovery well northwest of Tuktoyaktuk. The Gulf Beaufort has a hull that is reinforced with a double skin to operate safely in the sea ice.

Based on the average sea-ice conditions in the Beaufort and Chukchi Seas, it is assumed that the tanker's power and structural specifications will be equivalent to Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR) Ice Class 8. The maximum tanker size considered is 250,000 DWT. A tanker of this size would have a draft of about 24 meters, an overall length of 390 meters, and a beam of 55 meters (Han-Padron, 1985). (An Ice Class 8 vessel would have sufficient hull strength and propulsion power to maintain a steady speed of 3 knots in 8 feet [2.4 m] of level ice.)

Offshore Storage and Loading Facilities: In the Beaufort Sea Planning Area, the structures used for storage and loading would be gravity- or pile-founded units; and they would have to resist the same ice forces as the production platforms. Although a single structure that combines the storage and loading functions may be used, separation of the crude-oil-storage and mooring/loading facility may consist of a large concrete/steel caisson-type structure that is divided into compartments for oil storage, seawater or sediment ballast, and operating equipment. The mooring/loading facility would incorporate some means of mooring the tankers, and a loading crane or arm supports the hoses carrying oil to the tankers.

Open-water mooring and loading systems are common in other offshore areas; but in the Arctic, winter loading may have to be accomplished in moving ice fields. The mooring and loading systems would allow the tanker to point toward the oncoming ice and have a quick-disconnect capability. A number of concepts have been developed for offshore-loading terminals in the Arctic. These include the Artificial Production and Loading Atoll (APLA) and the Arctic Single Point Mooring (ASPM).

Production platforms may also serve as offshore-loading terminals. The use of the production platform for offshore loading must provide the following: (1) for a loading system that will permit the moored tankers to weathervane,

(2) sufficient fendering to prevent a castastrophic collision between an approaching tanker and the platform, and (3) a means of clearing ice rubble in shallow water (Han-Padron, 1985).

Icebreaking Support Vessels: Icebreakers and work/supply boats with ice-breaking capabilities would be required to support tanker operations. From time to time, these vessels may be needed to assist tankers transiting the northern part of the Bering, Chukchi, and Beaufort Seas. Also, icebreaking vessels should be available to assist the tankers during mooring and for ice-management duties during loading. Icebreaking support vessels would probably need to be Ice Class 8 or greater.

b. Other Constraints:

(1) 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 is usually 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 those activities that disrupt the thermal balance of the permafrost. These activities include: (1) drilling wells through existing permafrost layers, (2) laying and maintaining crude oil pipelines, (3) placement and operation of 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. Surface settlements that result from the drilling of a single well have not created any engineering problems of significance, but 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 is shut-in and the flow of hot oil stops, the pore water in the surrounding sediments may refreeze. The freezeback expansion generally does not restore the permafrost to its previous condition, but the volume expansion of the refrozen pore water may cause large radial pressures against the well casing. High-strength casing steel is designated to prevent damage from thaw subsidence and freeze-back, and casing insulation is designated to reduce the magnitude of these changes. 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 (Heuer, Caldwell, and Zamsky, 1983). 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 over-excavation and backfill. Pipeline parameters that can be adjusted to reduce thawing include (1) increasing the thickness of insulation or pipeline separation (if more than one line) and (2) decreasing pipeline temperature, pipe diameter, or depth of cover (Heuer, Caldwell, and Zamsky, 1983).

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 (Heuer, Caldwell, and Zamsky, 1983).

Artificial islands and causeways will be subject to seasonal freezing and permafrost formation as are the natural geomorphological features of the Arctic environment. Freezing increases the strength of the soil; but it also causes the material to expand and, in many cases, forces the surface upward.

Fine-grained soils are more susceptible to frost heave than are coarse-grained soils. Thaw subsidence or frost heave may result in the uneven settling or uplifting of the foundations of structures, which could endanger the operation that the structures were designed to perform.

(2) Natural Gas Hydrates: Natural gas hydrates have been encountered in bore-holes 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 well-bore, gasification of the drilling mud, and the possible loss of well control. If the release of the hydrate gas is 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 may also be detected by seismic surveys prior to drilling.

In addition to permafrost thaw, the flow of hot petroleum hydrocarbons past a hydrate layer will result in hydrate decomposition around the well-bore 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: Waves have the potential to cause flooding of low-lying structures and could induce erosion of shorelines and unprotected structures built from sand and gravel. Currents can cause erosion of material from natural and artificial islands, coastal areas, and around the foundations of bottom-founded structures. A storm surge results from meteorological and oceanographic events that produce increased wind velocities, wave heights, and wave- and wind-induced current velocities. The presence of sea ice in open-water areas at the time of a storm surge increases the severity of the hazard. However, the presence of more than one-tenth ice coverage reduces the buildup

of waves and surge and thus limits potentially damaging surges to late summer and fall (LaBelle et al., 1983).

There is a considerable amount of coastal and offshore engineering experience from other areas that can be adapted to the Arctic environment. Excluding storms, available information indicates that waves and currents should not be a major problem affecting offshore operations. In the absence of long-term measurements, it is possible to statistically hindcast the characteristics of wind-driven waves, currents, and storm surges at potential operating sites. The hindcast results are used as input for statistical extrapolation procedures to determine wave heights and periods, storm-surge heights, and current velocities that could interact with structures of a given site during the operational life. Through careful analyses of regional and site-specific environmental data, protective measures can be taken to reduce the effects of moving water.

(4) Faults and Earthquakes: Faults and earthquakes are considered to be a high hazard for all the facilities that rest on the seafloor because of the potential for differential movement of rock masses along the fault surface or the ground motion caused by earthquakes originating within or outside the planning area. Such movement could, if it is severe enough, 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 extends to the surface or a blowout if the rupture is at or near the surface.

Because fault surfaces can be detected by seismic surveys, facilities can 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 is much more difficult. Such a determination would have to be made, at least in part, by correlating faults with known earthquake epicenters.

As noted in Section III.A.1.b, seismic activity in the Sale 97 area occurs mainly off Camden Bay in the eastern part of the Alaskan Beaufort Sea. 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.

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. Mass movement includes, slides, slumps, flows, and subsidence. On the continental shelf inshore of the 50-meter isobath, the slope of the seafloor is generally very low, except in the vicinity of the Barrow Sea Valley. Except in the vicinity of Camden Bay, ground motions associated with earthquakes are generally low. Thus, mass movement in waters less than 50 meters is generally not a hazard that would significantly affect offshore operations. Hazards associated with mass movement are most likely to be found: (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.

Summary: The environmental hazards that affect petroleum exploration in the Beaufort Sea Planning Area are related to sea ice, permafrost, storm surges, faults and earthquakes, hydrate and shallow gases, and factors affecting the geotechnical characteristics of the seafloor sediments; sea ice is the hazard of major concern. However, the potential severity of the hazard varies with each activity, and measures can be taken to lessen its effects. These measures include (1) scheduling activities to minimize exposure to a hazard, (2) conducting surveys to locate potentially hazardous areas and locating facilities away from known hazards, and (3) designing facilities to withstand a range of environmental forces. The use of these strategies necessitates being able to (1) identify the hazards, (2) locate or predict where and when they will occur, and (3) estimate their effects.

Artificial islands, ice islands, caisson-type structures, and bottom-founded mobile drilling units have been constructed that can withstand, on a year-round basis, the physical forces of the Beaufort Sea environment in waters as deep as 30 meters and can function as platforms from which wells can be successfully drilled and completed. Also, floating drilling units, such as ice-strengthened drillships and the Conical Drilling Unit, can operate during the open-water season and, with the assistance of icebreakers, in the sea ice during the latter part of the breakup period and part of the freezeup period. Drilling and completing wells in the lease-sale area can be accomplished with proven techniques.

The interaction of sea ice with fixed and moving structures is an important subject for continuing research, additional field observations, and analytical studies. Additional environmental data, particularly for sea ice, also is needed to improve the reliability of predicting extreme events at specific sites.

Exploration-drilling units and production platforms that can operate in the deeper parts of the lease-sale area are being planned. Methods to transport produced hydrocarbons--tanker systems, including icebreaking tankers and loading facilities, and pipelines--are also being planned.

4. Major Projects Considered in Cumulative-Effects Assessment: Table IV-A-7 summarizes the information on projects included in the analysis of cumulative effects. Graphic 6 depicts the location of these activities. A more complete description of these projects can be found in Appendix B.

Table IV-A-7
Major Projects Considered in Cumulative-Effects Assessment

Project Name[1]	General Location	Resource Estimate[2]	Developmental Timeframe[3] Exploration	Development Construction	Peak Production/Day[4]	Current Status (1985)
Existing Development						
1. Trans-Alaska Pipeline (TAP)	Prudhoe Bay to Valdez	Not relevant	Not relevant	1973-1977	Design capacity: 2,000,000 bbls	The 800-mile pipeline and related facilities occupy 16.3 square miles. Current flow rate is 1.8 million barrels per day.
2. North Slope Borough Capital Improvements Program (CIP)	North Slope Borough	Not relevant	Not relevant	1983-1985+	Operation: 1983-1985+	Included among the village projects are industrial park projects at Prudhoe Bay and Kuparuk.
3. Prudhoe Bay Unit (PBU) Oil Production	Prudhoe Bay onshore	9.6 (oil)	1965-1969	1969-1985	1977-2006 1,500,000 bbls	Peak production ongoing until 1987; declining thereafter. Tertiary recovery began in December 1986.
4. Lisburne Field	Prudhoe Bay Unit	0.35-0.45 (oil)	1968-1983	1984-1991	1987-2017 100,000 bbls	Development of onshore portion is underway.
5. Kuparuk River Field	Approx. 25 mi west of Prudhoe Bay, onshore	0.4-1.3 (oil)	1970-1979	1981-1986	1982-2002 250,000 bbls	Phase I production commenced in December 1981 at 80,000 barrels/day. Full field waterflood began in 1986.
6. West Sak	Within Kuparuk River Unit	2.0-4.0 (oil)	1970-1975	1984 - Post 1986	1985-2015+ 200,000 bbls if developed; 2,500 bbls during pilot project	Pilot project determined that the field is commercial if the price of oil is higher and more stable.
7. Endicott Development	12 mi east of Prudhoe Bay offshore	0.3-0.98 (oil)	1977-1982	1985-1987	1988-2000+ 100,000 bbls	Roads and islands are constructed. Pipeline should be completed in 1987.
8. Milne Pt.	North of Kuparuk River Unit	Milne Pt.: .03-.08 (oil)	1970-1984	1984-1985	1986-2000+ 25,000 bbls	Production began in 1985 and was suspended in 1986. Milne pipeline ties into the Kuparuk pipeline.

Table IV-A-7
Major Projects Considered in Cumulative-Effects Assessment (continued)

Project Name[1/]	General Location	Resource Estimate[2/]	Developmental Timeframe[3/] Exploration	Development Construction	Peak Production/Day[4/]	Current Status (1985)
Exploration and Potential Development						
9. Discovered Resources (Oil Fields, Gas Fields, and Mining)	Mid-Beaufort and Chukchi	NA	NA	NA	NA	Until gas infrastructure is available, gas fields such as Pt. Thomson and Gubik will not be developed. Others such as Gwydyr Bay, Ugnu, and Simpson Lagoon need either technological advances or changes in oil prices before they can be developed. Construction of the port for the Red Dog Mine began in 1986.
10. Seal Island	Beaufort Sea	.3 (oil)	1981-1986	1987-1990	1989-2014 5,000 bbls	Drilling from Northstar Island has been suspended.
11. National Petroleum Reserve in Alaska (NPR-A)	Northwest Alaska, west of Colville River	1.85 (oil) 3.26 (gas)	1944-1989	1987-1989	1990-1991 132,000 bbls	No commercial reserves have been discovered. In 1985, drilling began on areas leased under the DOI program. Annual lease sales are scheduled.
12. Arctic National Wildlife Refuge	North of Brooks Range, east of Canning River	NA	1983 and thereafter	prohibited	prohibited	Three wells are being drilled on ASRC lands. ANILCA prohibits development or additional exploratory drilling until authorized by Congress.
13. Previous State Sales	Uplands and offshore in mid-Beaufort Sea region	1.0 (oil)	1983-1988	1988-1993	1989-2014 47,800 bbls 1990-2016 425 MMcf	Seal Island and Endicott are primarily on State-leased land.
14. Previous Federal Offshore Lease Sales	Barrow to Canada within 200-m isobath	0.6 (oil)	1981-1992	1992-1995	1995-2014 50,000 bbls	Exploration drilling is underway.
15. Arctic Slope Regional Corporation (ASRC) leasing	Northwest Alaska south and west of NPR-A and ANWR	NA	1973 and thereafter	NA	NA	Low-level exploration ongoing; no discoveries. Drilling up to three wells in ANWR.
16. Canadian Beaufort Sea (ESSO, Dome, Gulf Acreage)	Offshore Mackenzie Bay, Canada	9.2 (oil)	1973-1990	1982-2000 and thereafter	1987-2000+ 180,000 to 1.3 million bbls	Major discoveries subject to delineation. EIS on development and production completed, but no development announced yet.

Table IV-A-7
Major Projects Considered in Cumulative-Effects Assessment (continued)

Project Name1/	General Location	Resource Estimate2/	Developmental Timeframe3/ Exploration	Development Construction	Peak Production/Day4/	Current Status (1985)
Future Lease Sales						
17. Future State of Alaska Leasing	North Slope and offshore Beaufort Sea	moderate to high petroleum potential	1986 and thereafter	NA	NA	State Lease Sales 50, 51, 52, 54, 55 57, 64, and 65 are both onshore and offshore. Little information is available.
18. Future OCS Leasing						
a. Chukchi Sea	Offshore Chukchi Sea	2.7 (oil)	1988 and thereafter	1992-1997	1998-2000+ 450,000 bbls	Future OCS sales scheduled in 1988 and 1991; post-sale activity speculative.
b. Beaufort Sea	Offshore Beaufort Sea					Information for the proposal applies to Beaufort Sea Sale 124, scheduled for 1991.
c. Sand and Gravel	Beaufort Sea					None scheduled at this point.

NA = Not Available

1/ The numbering of projects in this table corresponds with the listing and further description of projects in Section IV.A.4 of this EIS.
2/ Resource estimates for oil are expressed in billions of barrels of recoverable oil; gas estimates are expressed in trillions of cubic feet.
3/ Developmental timeframes are approximate. Dates are fixed with timing of first commercial field development. Timeframes for subsequent fields are not indicated.
4/ Production estimates, when available, are expressed in barrels of oil per day.

MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION
BEAUFORT SEA (Sale 97)
GRAPHIC 6
MAJOR PROJECTS INCLUDED IN THE CUMULATIVE ASSESSMENT
Potential Mine
Exploratory Well
Land Leased Under Public Law 96-514
State of Alaska Oil and Gas Unit Boundaries
1 KUPARUK BAY
2 MILNE POINT
3 PRUDHOE BAY
4 HEMI SPRINGS
5 GWYDYR BAY
6 DUCK ISLAND
7 POINT THOMSON
Arctic Slope Regional Corp. Lease Sales
Existing State of Alaska Lease Sales
Proposed State of Alaska Lease Sales
1987
50 CAMDEN BAY (JUNE)
1989
52 BEAUFORT SEA (JAN.)
1988
54 KUPARUK UPLANDS (JAN.)
55 DEMARCATION POINT (JUNE)
1990
57 NORTH SLOPE FOOTHILLS (JUNE)
1991
64 KAVIK (JAN.)
65 BEAUFORT SEA (JUNE)
BEAUFORT SEA PLANNING AREA
PROPOSED SALE 97 AREA
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
MACKENZIE BAY
Blocks Previously Leased
NATIONAL PETROLEUM RESERVE - ALASKA
POINT BELCHER PIPELINE (HYPOTHETICAL)
TRANS-ALASKA PIPELINE
PUMP STATION No. 2
ARCTIC NATIONAL WILDLIFE REFUGE
ALASKA
CANADA
USA
NORTH SLOPE BOROUGH
LIK MINE
RED DOG MINE
RED DOG MINE TRANSPORTATION CORRIDOR
Barrow
Point Barrow
Wainwright
Pt. Belcher
Atqasuk
Alaktak
Teshekpuk Lake
Nuiqsut
Prudhoe Bay
Deadhorse
Pt. Bullen
Kaktovik
Umiat
Kivalina
Point Hope
Pt Lay
Herschel I
Richards Island
SCALE 1:2,050,000
MILES
KILOMETERS
MODIFIED TRANSVERSE MERCATOR PROJECTION
NATIONAL GEODETIC VERTICAL DATUM OF 1929
WATER DEPTH IN METERS
Sources: International Petroleum Encyclopedia, 1984 and 1985; Oil and Gas Journal, February 11 and February 18, 1985; State of Alaska, Dept. of Natural Resources, January 1985; U.S. Army Corps of Engineers, Alaska Division and Environmental Research and Technology, Inc., 1984; U.S. Dept. of Interior, Bureau of Land Management, 1984.

DEFINITIONS ASSUMED FOR EFFECTS ASSESSMENT: The definitions shown in Table S-2 (ref.) at the beginning of this EIS were developed to help determine the relative extent of effect. The words MAJOR, MODERATE, MINOR, and NEGLIGIBLE defined on the table appear in capital letters in Section IV to ensure a common understanding of the terms. These words are not capitalized to emphasize the level of effect but to designate their more precise application in this context.

B. Alternative I - Proposal

1. Effects on Lower-Trophic-Level Organisms

This discussion summarizes and incorporates by reference the discussion of effects on lower-trophic-level organisms contained in the Sale 87 FEIS (USDOI, MMS, 1984a) and the Sale 100 FEIS (USDOI, MMS, 1985d), with augmentation by additional information as cited. Exploration and development of oil resources in the Sale 97 area could have several potential effects on lower-trophic-level organisms. These effects include responses to petroleum hydrocarbons released into the environment; seismic surveys; the discharge of drilling fluids; dredging or related construction activities; and the presence of platforms, pipelines, and gravel islands. A discussion of each of these potential effects follows.

Marine plants and invertebrates of greatest concern, due to their abundance, or trophic relationships, are: (1) planktonic and epontic communities--with special emphasis on primary production and trophic linkages; (2) the abundant epibenthic invertebrates in nearshore waters that are fed on extensively by anadromous and some marine fishes; and (3) the Stefansson Sound Boulder Patch, an apparently unique, kelp-dominated community.

Aside from the Boulder Patch community, which is vulnerable because of its extremely restricted distribution, marine plants and invertebrates assume importance as primary producers (transforming energy from the sun into organic carbon) and as sources of food for other organisms. In the Beaufort Sea, the length of the food chains in the food web is short (Graphic 2); and a number of marine mammals (including the endangered bowhead whale), as well as birds and fishes, depend on invertebrates as their primary food sources. These invertebrates are, in turn, dependent on primary producers. Since both marine plants and invertebrates can occur in different habitats, consideration is given to effects on pelagic, benthic, and epontic communities.

a. Effects of the Proposal:

(1) Oil Spills: Oil has been observed to cause both lethal and sublethal effects to marine plants and invertebrates. Although lethal effects may be initially more obvious or compelling, sublethal effects of oil may also be important and generally develop at much lower concentrations than lethal effects (Steele, 1977; Rossi and Anderson, 1978). These effects include reduction in growth and/or fecundity, increased physiological stress, and behavioral changes. These sublethal effects may increase the probability of death, or may lead to reductions in future population size.

Concentrations of oil used in lab experiments are usually higher than those observed following natural and experimental spills (see Sec. IV.B.14); however, concentrations less than 1 ppm have produced a variety of negative effects in marine organisms ranging from phytoplankton to fish (see Table B-18, National Research Council [NRC], 1985).

Effects of oil on marine plants and invertebrates are briefly summarized here:

(a) Effect of Oil on Marine Plants: Both lethal and sublethal effects of oil have been observed in marine plants (phytoplankton, macroscopic algae, and seagrasses). Effects vary with the species of plant, type and concentration of oil, and timing and duration of exposure. Sublethal effects include alterations in chlorophyll a content, photosynthesis, growth, and reproduction. When exposed to low concentrations of oil, many phytoplankton and macroscopic algae show stimulation of photosynthesis and growth; at higher concentrations, these functions are inhibited. The mechanism whereby low concentrations of oil stimulate algal photosynthesis is unknown (Hsiao, Kittle, and Foy, 1978). Arctic macrophytes (Laminaria saccharina, a brown kelp, and Phyllophora truncata, a red alga) showed inhibition (15-20%) of photosynthesis after exposures to whole crude-oil concentrations as low as 4 ppm, while concentrations of 4,000 ppm caused a 40- to 60-percent decline in photosynthesis (Hsiao, Kittle, and Foy, 1978). Experiments using samples of natural Arctic marine phytoplankton taken from the Beaufort Sea and Eskimo Lakes area showed that photosynthetic production varied with the type of oil the samples were exposed to, phytoplankton density, species composition, and environmental conditions. In samples with similar species composition, higher concentrations of oil (43 to 147 ppm) inhibited primary production more than did lower concentrations (3 to 4 ppm; Hsiao, Kittle, and Foy, 1978). In situ experiments testing the effect of 10-ppm concentrations of four different types of oils produced variable results ranging from stimulation to inhibition of primary production. A mixture of oil plus the dispersant, Corexit, proved to be more toxic than the oil by itself (Hsiao, Kittle, and Foy, 1978).

Reproduction of both phytoplankton and macrophytes may be affected by exposure to oil. For unicellular phytoplankton, growth equals reproduction, so reductions in chlorophyll-a content, photosynthesis, and growth following exposure to oil may all result in a reduced reproductive rate.

In addition to direct effects caused by petroleum hydrocarbons, marine plants may show indirect effects, such as alterations in population sizes of particular species through changes in competition or predation (Teal and Howarth, 1984; Howarth, 1985; Foster, Neushul, and Zingmark, 1971; North, 1973).

In the Sale 97 area, the marine plants of greatest concern are: (1) the phytoplankton and epontic algae, and the relation between these primary producers and consumers; and (2) the brown kelp, Laminaria solidungula, which predominates in the Boulder Patch community.

Since effects on phytoplankton and zooplankton are interrelated, the likely effects of oil on the plankton are discussed later in this section in Effect of Oil on Pelagic Communities. The effect of an oil spill on phytoplankton is most likely to be MINOR.

Effects of oil on the kelp, Laminaria solidungula, have not been examined directly. As mentioned earlier in this section, tests with the kelp, Laminaria saccharina, from Liverpool Bay and the Eskimo Lakes in the Canadian Beaufort Sea, indicated that primary production was significantly inhibited by all types and concentrations of oil tested. Exposures to whole crude-oil concentrations as low as 43 ppm caused about 25-percent inhibition of photosynthesis, while concentrations of 4,000 ppm caused a 45- to 60-percent decline in photosynthesis (Hsiao, Kittle, and Foy, 1978). Shiels, Goering, and Hood (1973) found that 7 ppm of Prudhoe Bay crude oil inhibited the photosynthesis of L. saccharina, as well as two green algae, Cladophora stimpsonii and Ulva fenestrata.

An oil spill contacting areas of the Beaufort Sea containing macroscopic algae would be expected to have a short-term effect on kelp and other macroscopic algae, particularly since these plants are all subtidal and thus are not likely to be coated by oil. Photosynthesis might be reduced; and this effect could be translated, if it persisted long enough, into reduced growth and/or reproduction. Laminaria solidungula shows maximum growth in late winter or early spring; thus a reduction in photosynthetic rate during the open-water season might later become manifested in reduced growth or reproduction the next year. Thus, the most likely effect of an oil spill on kelp and other macroscopic algae in the Beaufort Sea is expected to be MINOR. The probability of a spill of 1,000 barrels and greater occurring during the open-water season and contacting Land Segment 36 (the closest to the Boulder Patch) within 10 days is one percent, so effects from spills are unlikely. If a large (100,000 barrels or more) or continuous spill were to occur in the immediate vicinity of the Boulder Patch, MODERATE effects are possible because the population is restricted and reproduction and/or recruitment could be affected. However, such a spill is highly unlikely to occur and contact this area (the probability is less than 0.5 percent for a 100,000-barrel spill).

Thus, the effect of spilled oil under the proposal on phytoplankton and macroscopic algae is expected to be MINOR, although MODERATE effects could accrue to macroscopic algae in the Boulder Patch if a large or continuous spill occurred in the near vicinity.

(b) Effect of Oil on Bacteria: Various effects of oil on bacteria are expected depending on the species involved. Those microorganisms that degrade oil may increase in numbers and biomass after contamination with oil (Atlas, 1985). In the Beaufort Sea, oil-degrading bacteria constitute only a small proportion of the bacterial assemblage, a fraction of 1 percent (Atlas and Griffiths, 1984). Oil degradation in the Beaufort Sea will be slow, due to a combination of factors, but primarily because of nutrient limitations (of nitrogen, phosphorus, and oxygen; Atlas, 1985). Experiments by Atlas (1974) indicated that heavy oils were more resistant to biodegradation than lighter oils and that light volatiles were toxic to bacteria at low temperatures. He also found that biodegradation was enhanced by nutrients.

An oil spill contacting bacterial populations is expected to have localized effects, with the majority of species contacted being negatively affected, and the small fraction of oil-degraders increasing in abundance. Since bacterial populations are not evenly distributed in all habitats throughout the Beaufort Sea (see Sec. III.B.1.c[1][b]), a more pronounced effect on bacteria could be expected in areas where bacteria are more abundant (e.g., river plumes). Since the relative importance of bacterial populations to trophic dynamics in the nearshore zone is not understood, localized effects from bacteria to other organisms cannot be extrapolated at this time.

The effect of oil spills on bacterial populations in the Beaufort and Chukchi Seas is expected to be MINOR, since effects are expected to be very localized and the distribution of bacteria is very broad. "Within heavily oiled localized regions, however, the normal contributions of microorganisms to ecological functions, which include energy transfers and nutrient cycling reactions, are likely to be disrupted" (Atlas, 1985). Microbial populations may adjust rapidly to the presence of crude oil (Griffiths and Dillinger, 1981, cited by Atlas, 1985) as indicated by a declining effect of crude oil on glucose uptake with time. This suggests that the severity of localized effects to bacteria may become dampened with time.

(c) Effect of Oil on Invertebrates: Oil spills have often resulted in extensive mortality of marine invertebrates, which has been particularly observable in the intertidal (Teal and Howarth, 1984). Sublethal effects, as observed in both the laboratory and in the field, include effects on physiology, growth, development, and behavior (see Johnson, 1977; Cowles and Remillard, 1983; Cowles, 1983; NRC, 1985). Effects may be linked, e.g., reduced feeding may lead to reduced reproductive effort, etc., and alterations in behavior may increase the probability of death. Of great concern is the potential for disruption of chemically mediated behaviors, which are common among invertebrates and which appear to be disturbed by very low concentrations of hydrocarbons (as low as 1 ppb) (Johnson, 1977; Takahashi and Kittredge, 1973; Jacobson and Boylan, 1973). If such disruption occurred, feeding, mating, and habitat-selection activities could all be affected. Both reproduction and recruitment of benthic invertebrates and zooplankton may be affected by exposure to sublethal concentrations of petroleum hydrocarbons (Cowles and Remillard, 1983; Berdugo, Harris, and O'Hara, 1977; Johnson, 1977; Teal and Howarth, 1984). Invertebrate larval forms are generally more sensitive to toxic agents than are adults (Johnson, 1977; Lewbel, 1983), with eggs often somewhat less sensitive than larvae (Lewbel, 1983).

In the Sale 97 area, invertebrates of greatest concern include (1) zooplankton, especially as a trophic link between phytoplankton and higher order consumers; and (2) nearshore epibenthic invertebrates, which are an important food of seasonally abundant anadromous fishes. Since effects on phytoplankton and zooplankton are interrelated, the likely effects of an oil spill on the plankton are discussed later in this section, in Effect of Oil on Pelagic Communities.

Among the important invertebrates are crustacean members of the plankton (especially copepods and euphausiids--primary prey of bowhead whales) or the epibenthos (prey of fishes and other animals; see Graphic 2). Crustaceans and other invertebrates that are benthic as adults but that occur in the plankton while they are larvae are susceptible to the surface slicks of spilled oil, dissolved fractions of oil that move through the water column, and oil that becomes entrained in sediments. Lab studies have indicated that oil concentrations ranging from 1 to 4 ppm can cause significant mortality to both adult and larval crab and shrimp after 96 hours of exposure (Starr, Kuwanda, and Trasky, 1981).

Within the plankton, copepods and euphausiids figure importantly because of their abundance and as primary prey of the endangered bowhead whale. Copepods are the predominant zooplankton group, both in numbers and biomass (see Sec. III.B.1.a[2]). A number of studies have examined the effects of oil on copepods (see Wells and Percy, 1985; NRC, 1985; and Gilfillan, Vandermeulen, and Hanson, 1986). Petroleum hydrocarbons can be acutely toxic to copepods, and a variety of sublethal effects have been identified (e.g., narcosis, decreased feeding and defecation rates, disrupted phototaxis, and altered feeding activity). The WSF of various oils can quickly paralyze copepods at concentrations of 0.2 to 0.5 parts per million. Often, recovery from sublethal effects can occur if exposures are of short duration (Wells and Percy, 1985).

Laboratory studies with the euphausiid, Thyssanoessa raschii, have indicated that sensitivities of this species to the WSF of Prudhoe Bay crude oil were within the range expressed by other species of Alaskan marine crustacea. However, unlike other marine crustacea tested, the larvae appear to be less sensitive than older lifestages. Also, gravid females were the most sensitive lifestage (Fishman, Caldwell, and Vogel, 1985).

Sensitivities to oil may vary among invertebrate species; Rice et al. (1978) found that although subtidal species were in general more sensitive to oil than intertidal species, among the subtidal species, mysids were considered tolerant. In the Beaufort Sea where mysids are an important component of nearshore and inshore environments, such a difference in sensitivity or tolerance could affect local species composition following a spill, leading in turn to some changes in fish diets.

Amphipods are another important group in the inshore environment as well as in fish diets. Amphipods, in particular ampeliscid amphipods, seem sensitive to oil; and some species have suffered great mortality following spills (Teal and Howarth, 1984; Howarth, 1985). Both laboratory and field experiments have investigated the effect of oil on amphipods (see reviews in Wells and Percy, 1985, and NRC, 1985; also Busdosh and Atlas, 1977; Atlas et al., 1978; Busdosh et al., 1978; and Anderson et al., 1979). Amphipods that come into contact with oil have high mortality rates (Busdosh and Atlas, 1977; Percy, 1974). However, amphipods did not die when exposed to the asphaltic fraction of Prudhoe Bay crude oil, which is the portion of spilled oil most likely to be left after weathering and biodegradation, and which would sink to the bottom and coat sediments. If nonweathered oil contaminated sediments, then recruitment of larvae or emigration of amphipods and other epibenthic invertebrates could be affected for some time, depending upon the degree of contamination and the sensitivity of the species involved. Effects are more likely in nearshore areas where water depths are shallow. Field experiments by Atlas, Horowitz, and Busdosh (1978) have shown that contamination of sediments by oil led to mortality of or emigration by indigenous invertebrates (primarily the amphipods). Although recolonization of oiled sediments began shortly after contamination, the species composition of oiled versus control (unoiled) sediments differed at 2 months. Amphipods declined in the oiled sediments, the isopod, Saduria entomon, seemed unaffected, and the response of polychaetes seemed species-dependent. An oil spill contacting organisms or sediments in nearshore areas could cause the mortality or emigration of some invertebrates (notably, amphipods). Isopods and mysids would be expected to be less affected (see also Table 1 in Wells and Percy, 1985).

Anadromous fishes move into the warm, brackish-water zone nearshore seasonally to feed, but recent studies (Craig and Haldorson, 1981; Moulton, Fawcett, and Carpenter, 1985) suggest that, in general, food does not appear to be limiting to these fishes (see discussion of fish feeding in Sec. III.B.2). Thus, a local reduction in invertebrate biomass following a spill might not have large consequences for these fishes. Fish might be affected through effects on their prey if a very large spill occurred and contacted the nearshore area, especially if the oil contaminated sediments.

Under the proposal, the probability of one or more oil spills of 1,000 barrels or greater occurring and contacting land in the open-water season within 10 days is 23 percent (Appendix F, Table F-19). For particular land segments, the probability is less than or equal to 7 percent for both open-water spills (to contact within 10 days) or winter spills (over the entire season). A spill of 100,000 barrels or greater has only a 1-percent chance of occurring and contacting land and less than 0.5-percent chance of contacting land segments of particular interest. Thus, there is a low probability that spilled oil would reach nearshore areas. A spill of 1,000 barrels or greater (for discussion purposes a size of 10,000 barrels is chosen) after 3 days (when it is unweathered and still highly toxic), would cover an area of 1.1 square kilometers. A 100,000-barrel spill after 3 days would cover 5.1 square kilometers (Appendix C, Table C-1). Given the generally broad distributions of most invertebrate species in the Beaufort Sea and the relatively small area likely to be contacted by spilled oil, the effect of oil on invertebrates is expected to be MINOR.

(d) Effect of Oil on Communities: The effects of oil on pelagic, epontic, and benthic marine communities as discussed in the Sale 100 FEIS (USDOI, MMS, 1985d) are summarized and incorporated by reference. Effects on benthic and pelagic communities are also discussed in Teal and Howarth (1984), Howarth (1985), Clark (1982), and NRC (1985). Examination of communities following oil spills and laboratory and mesocosm experiments have indicated that major shifts in species composition can take place. These shifts appear to take place when the predominant species are more sensitive to oil than other species in the community. Changes in species composition or predominance may qualitatively change food-web dynamics and could also lead to a decreasing efficiency of energy transfer to higher trophic levels if the number of linkages is increased. Indirect effects can also occur when the interactions between or among species are altered.

Pelagic Communities: Because of the fluid, mobile environment of planktonic communities, the broad distributions of the species components, and the believed ease of recolonization, persistent effects of oil are unlikely for these communities unless chronic discharges occur. If a spill occurred nearshore, or in more open-ocean areas, then plankton abundance and dynamics within the plankton could be affected. The effects of an oil spill will depend on (1) whether species composition within either the zooplankton or phytoplankton changes due to differing relative sensitivities to oil and (2) whether zooplankton or phytoplankton are relatively more sensitive.

In the Beaufort Sea, with its relatively simple food web, effects on plankton could immediately affect important consumers such as bowhead whales and arctic cod. Regional populations of planktonic organisms are unlikely to be affected, however, given the low probability of oil spills of 1,000 barrels or greater occurring in the Sale 97 area, the likelihood that only a portion of the sale area would be affected (see Appendix C, Table C-1), and the broad distributions of most planktonic species. An oil spill of 100,000 barrels or greater is unlikely to occur and also is unlikely to affect regional populations of planktonic organisms. Under the proposal, the effect of oil spills on planktonic communities is expected to be localized and MINOR.

Epontic Communities: Epontic (under-ice) communities are transient in the nearshore areas of the Beaufort Sea, and effects of accidental oil spills are believed to be very localized. Oil spilled onto the surface of the ice would reduce the light reaching the epontic algae, probably resulting in lowered productivity. If oil were spilled under the ice and trapped directly beneath it, those epontic organisms that were not highly mobile would probably be smothered and killed. The oil would probably become encapsulated within the ice with increasing time. The areal extent of these effects would be small. An area covering 1.6 hectares would be affected assuming a 1,000-barrel spill and homogenous spreading to a thickness of 1.0 centimeter on the undersurface of the ice. Likewise, 160 hectares would be affected by a 100,000-barrel spill. If oil on, in, or under the ice should be released during ice breakup, then effects could spread. Since the ice algae are thought by some to serve as an important source of food in early spring, when food is presumably in short supply in the pelagic environment, effects on the epontic community could extend to the open-water community. If a spill of 1,000 barrels occurred, only a small portion of the regional community would be affected, and effects are expected to be MINOR. A 100,000-barrel spill is also expected to have a MINOR effect, even though a larger area would be affected, since only a relatively small portion of the regional community would be affected.

Benthic Communities: Changes in species composition have been observed following a number of spills due to massive kills of species present, followed by colonization or proliferation of species that are more resistant and/or opportunistic. Shifts in composition in benthic communities may be persistent, especially if sediments (which are the major substrate in the Sale 97 area) become contaminated with oil. Most macroscopic benthic organisms are longer-lived than species in planktonic and epontic communities, and shifts in species composition may be very long-lasting if the newly predominant species inhibit recruitment or recolonization of previously predominant species. Many epibenthic invertebrate species that predominate in the nearshore Beaufort Sea are good colonists, since the zone less than 2 meters in depth, where shorefast ice occurs, is probably repopulated on an annual basis. Thus, persistent effects in these shallow waters are not likely unless sediments become contaminated and emigration or settlement is affected. Such effects, if they occurred, would be very localized and are not expected to cover a large areal extent (see Appendix C, Table C-1).

Amphipods, especially ampeliscids, are very sensitive to oil pollution and have disappeared from areas as a result of spills and chronic pollution (Elmgren et al., 1980; Sanders et al., 1980; d'Ozouville et al., 1979; Cabioch et al., 1981; Elmgren and Frithsen, 1982). In the Sale 97 area, amphipods may be important in the diets of other invertebrates, as well as fish. However, a number of epibenthic invertebrates, as well as some fishes, serve as prey to fishes abundant in the nearshore zone. So, although the local demise of some prey due to a spill could affect some fish, resulting in increased mortality, populations of fishes are not expected to be significantly affected. Since many of the epibenthic invertebrates apparently are good colonists, affected areas might be rapidly recolonized unless sediment contamination were too great. Since anadromous fishes in the nearshore zone do not appear to be food-limited (Craig and Haldorson, 1981; Moulton, Fawcett, and Carpenter, 1985), some local effects on their prey are not expected to significantly affect fish populations.

Under the proposal, the effect of spilled oil on benthic communities is expected to be MINOR. Greater detail is given in Section IV.B.1.a(1)(b), Effect of Oil on Invertebrates, and Sec. IV.B.1.a(1)(a), Effect of Oil on Marine Plants and Bacteria.

Trophic Interactions: Although trophic considerations have been discussed within the framework of pelagic, epontic, and benthic communities, it is important to remember and consider that all of these communities are linked. To some extent, the linkages have been explored in the preceding sections, but some elaboration and summarizing is pertinent.

Certain aspects of the Beaufort Sea environment and communities make its constituents perhaps more vulnerable to effects deriving from oil-related activities. For one, the environment is highly seasonal. Timing and synchronization of events can be exceedingly important. Pulses of primary production, whether resulting from epontic or open-water activity, may be critical to the success of zooplankton and to the reproductive activities of these and other consumers. Activities that significantly reduce primary production or alter timing in such a way that utilization of resources is affected could have significance beyond the expected magnitude of effect. Epontic production may be more important as an early pulse of energy available to larval or overwintering forms than for the magnitude of its production. Invertebrates are dependent upon very seasonal production for garnering the energy necessary for growth, maintenance, reproduction, and perhaps overwintering. MacGinitie (1955) was struck by the preponderance of zooplankton with natural oil obviously sequestered in their bodies (probably energy-rich lipids), which presumably was used in reproduction or as a future energy reserve (for overwintering).

A broad-scale disruption of the link between primary producers and secondary producers could have dramatic effects on higher-order consumers, as well as the secondary producers. Zooplankton consumers such as arctic cod and bowhead whales could be readily affected. Frost and Lowry (1984) believe that a number of vertebrate consumers may be competing for food during years of lower primary production. Although the effects on plankton under the proposal are expected to be MINOR, due to the small area likely to be affected and the presumed ease of recolonization, if a large spill occurred, then zooplankton consumers or the balance among the myriad of plankton consumers (see Graphic 2) could be affected. This becomes more of a concern in the cumulative case (see later discussion). In general, activities or events associated with the proposal are not expected to have significant, broad effects on trophic interactions due to the small areas expected to be affected.

(2) Seismic Surveys: The sources of acoustical energy used in seismic surveys have included explosives of different sorts; airguns, which capitalize on compressed-air releases to generate sounds; and waterguns, which use the release of water pressure to create a seismic pulse. Since most algae do not contain critical gas chambers, effects of seismic exploration on

marine plants are expected to be NEGLIGIBLE. In general, even high explosives (e.g., dynamite) have relatively little effect on marine invertebrates, presumably due to lack of air-containing chambers, such as the swim bladder of fish (Falk and Lawrence, 1973). Airguns, which are much more innocuous for fish than explosives, were shown to have no effect on caged oysters placed close to the airgun (Gaidry, unpublished, cited by Falk and Lawrence, 1973). Effects of waterguns on marine organisms have not, to our knowledge, been assessed, but their effects are expected to be as low or lower than those of airguns since a lesser amount of energy is involved. Due to the prevalent use of airguns and waterguns in Alaskan OCS waters, seismic surveys are expected to have NEGLIGIBLE effects on invertebrates as well as on marine plants.

(3) Drilling Discharges: The "Fate and Effects of Exploratory Phase Oil and Gas Drilling Discharges in the Beaufort Sea Planning Area, Lease Sale 97" have been analyzed by the Environmental Protection Agency in Appendix L. Probable effects on phytoplankton, zooplankton, and benthic communities are discussed in that appendix.

In the exploratory phases of the proposal, a total of 13,200 dry metric tons of drilling muds and 21,100 dry metric tons of drill cuttings would be released (Table IV-B-3). During the production phases, 39 wells are expected to be drilled from 2 platforms, with the release of 2,724 dry metric tons of drilling muds and 56,620 dry metric tons of drill cuttings. Details of extent and timing of water-quality effects are presented in Section IV.B.14, Effect on Water Quality.

For phytoplankton and zooplankton, the effect of discharging drilling muds and cuttings is expected to be MINOR, primarily because of the low levels of toxicity demonstrated and the small area (0.6 km^2 during exploration) that should be affected. Benthic communities are also expected to incur a MINOR effect; however, effects will probably be longer-lasting (but localized) due to the deposition of drilling muds and cuttings. Further details are presented in Appendix L.

Formation waters are produced from wells along with oil (see Roberts, 1987). Toxic effects on marine plankton and benthos could be produced by the hydrocarbons, metals, or chlorides (brine content) in the formation waters. Discharges of formation waters differ from those of other drilling fluids in that almost all such discharges would occur during development and are likely to be continuous through production. Such discharges should increase in volume as the oil reservoir is depleted. The production of formation waters over the life of the field can be estimated at 130 to 975 million barrels, with up to 120 million barrels of this quantity produced during the final year of field production (see Sec. IV.B.14, Effect on Water Quality). Reinjection of formation waters back into the reservoir as an enhanced oil-recovery mechanism would lower the total amount discharged. Complete reinjection would produce no effects on marine life.

Formation-water discharge as a result of the proposal will likely produce only small effects. Factors that suggest this are: 1) the low toxicity of formation waters (LC_{50} values of 1,850-408,000 ppm; Menzie, 1982); 2) the rapid dilution of these discharges a short distance from the source; and 3) the relatively small area that would be affected by these discharges (1,000-m radius).

Acute toxic effects appear to be low (Menzie, 1982). Chronic lethal and sublethal effects may present more of a problem because of the continuous nature of the discharge and the potential for accumulating hydrocarbons in the sediments. The latter could produce long-term effects on benthic organisms.

Dilutions greater than the toxicity values reported would probably be achieved within several hundred meters of a platform. Assuming a 1,000-meter radius for all effects in both water column and sediments around each of two production platforms, a total of 6 square kilometers could be affected.

The effects of formation waters on planktonic and benthic organisms would very likely occur through the development and production phases, assuming no reinjection. These effects, as well as those from drilling-fluid discharges, are expected to be MINOR.

(4) Construction Activities: Construction activities, as well as release of drilling muds and cuttings, could alter habitats of benthic or epibenthic animals and plants. Activities relating to installation and construction of platforms, pipelines, and gravel-islands are expected to be very localized. The discussion of effects of gravel-island construction on marine plants and invertebrates in the Arctic Sand and Gravel FEIS (USDOI, MMS, Alaska OCS Region, 1983) is summarized and incorporated by reference. In the Sale 97 area, two platforms are expected to be installed in conjunction with the oil activities of the sale. Platforms add a three-dimensional structure to the environment, which may provide habitat for refuging fishes or for invertebrates and plants requiring hard substrate for settlement. In general, one would expect organisms relying on soft-sediment areas altered or preempted by platforms, pipelines, or gravel islands to be negatively affected, whereas organisms utilizing hard substrate may be favored by the installation of platforms. Due to the small number of platforms (two) expected to be installed for the oil-related activities of Sale 97, the small area expected to be affected, and the apparently broad distributions of most adult and larval marine organisms in the Beaufort Sea, regional populations are not expected to be affected. However, the localized effects are expected to be long term for those benthic organisms that are affected.

One gravel island is projected to be built during the oil-exploration activities expected for Sale 97. According to the current scenario, this gravel island would be constructed in water about 15 meters deep; gravel for this production island would be mined onshore and taken out to the construction site on ice roads, where it would be dumped; and the basal area of the island should be approximately 48,300 square meters (or the equivalent of the area of a circle with a 248-m diameter). Effects on marine plants, invertebrates, and fishes could result from habitat disruption, increased turbidity, and introduction of pollutants associated with the gravel (e.g., trace metals). The preemption of bottom habitat by the gravel island would produce very localized, but long-term, effects for sedentary benthic invertebrates. MINOR effects are expected for benthic and epibenthic invertebrates, fishes, and planktonic organisms. Increased turbidity associated with dumping the gravel may reduce primary production and may negatively affect organisms passing through the immediate vicinity of the island site, but overall effects are expected to be MINOR and very localized. The most vulnerable community in the Sale 97 area to effects of construction activities is expected to be the Boulder Patch community. Since available lease blocks are not close to the Boulder Patch community, effects of construction activities from the proposal are expected to be NEGLIGIBLE. In general, effects of gravel-island construction are expected to be MINOR for marine plants, invertebrates, and fishes, since effects would be very localized and regional populations of these organisms are not expected to be significantly affected.

Under the proposal, a total of 14 bottom-founded mobile drilling units and floating units are expected to serve as bases for drilling operations. These units are expected to have a MINOR effect on marine plants and invertebrates because only an extremely small area would be affected.

During development and production, oil is assumed to be transported between local facilities (offshore and onshore) via buried pipelines. An estimated 320 kilometers of pipeline will be laid in conjunction with Sale 97 activities, 160 kilometers of it offshore. Trenching would be involved in laying the pipeline, with an estimated 19.65 square kilometers of offshore benthos disturbed. Trenching can affect marine organisms by physically altering the benthic environment; increasing sediments suspended in the water column, thereby decreasing water quality; displacing sediments and, in so doing, smothering some benthic organisms; altering water currents by modifying benthic topography; and killing some organisms directly through mechanical actions (Starr, Kuwada, and Trasky, 1981; Lewbel, 1983).

Effects of pipeline installation are expected to be localized but may be long term for benthic invertebrates, since pipelines would be in place for years. Since regional populations of marine plants and invertebrates should not be affected, and only a very small portion of the benthos would be affected, effects are expected to be MINOR.

In summary, effects of installation and construction activities would vary depending on the species involved. Some sessile marine organisms would be killed or displaced by these activities, but effects are expected to be extremely localized. Those species that require hard substrate for settlement and growth may increase in abundance because platforms increase the available substrate. Construction activities should benefit these species. In general, effects on marine plants and invertebrates are expected to be MINOR. Regional populations of these organisms are not expected to be affected.

(5) Summary: Marine plant and invertebrate resources of greatest concern, due to their abundance or trophic relationships, are: (1) planktonic and epontic communities--with special emphasis on primary production and trophic linkages; (2) the abundant epibenthic invertebrates in nearshore waters that are fed on extensively by anadromous and some marine fishes; and (3) the Stefansson Sound Boulder Patch, an apparently unique, kelp-dominated community.

Oil spills are more likely to cause widespread negative effects to marine plants, bacteria, and invertebrates than are other activities associated with exploration, development, and production of oil resources. In general, oil spills are expected to have MINOR effects on marine plants and invertebrates, since the distributions of most of these organisms are quite broad and recolonization of affected areas is quite likely unless sediments become too contaminated. Benthic and epibenthic organisms living in nearshore shallow environments where contact with oil is more probable are at greater risk. However, the oil-spill-risk analysis indicates that nearshore areas are very unlikely to be affected by spilled oil. If nearshore areas or sediments were contacted by oil, effects would be expected to be very localized. Even if the abundant epibenthic invertebrates in nearshore environments were affected locally, it is most likely that fish populations would not be significantly affected and that recolonization by invertebrates could be rapid. A very large spill contaminating nearshore sediments could locally affect populations of benthic invertebrates, perhaps for years. In this situation, some fish populations might also be negatively affected. Oil-spill effects on the planktonic and epontic communities are expected to be MINOR due to the limited area likely to be affected. Effects in these communities are not expected to be noticeably translated to higher trophic levels.

Effects from other activities (seismic surveys; discharge of drilling fluids, cuttings, and formation waters; and construction activities) should be very localized. The effect of seismic surveys is expected to be NEGLIGIBLE. Effects from the other activities are expected to be MINOR.

The Stefansson Sound Boulder Patch community is more vulnerable to effects from oil-related activities, since it is a very restricted community spatially. If oil contacted the community, then effects are expected to be MODERATE, since productivity and successful recruitment could be affected. However, MINOR effects to this community are expected.

(6) <u>Conclusion</u>: Under the proposal, effects on lower-trophic-level organisms are expected to be MINOR.

b. <u>Cumulative Effects</u>:

(1) <u>Oil Spills</u>: Since resource levels are higher for cumulative leasing, and development and production activities are expected to be greater, potential effects are also more probable. Because the probability of oil spills increases, effects from a spill are more likely.

Multiple oil spills are projected for the cumulative case. Twenty-four spills of at least 1,000 barrels are most likely, including one of at least 100,000 barrels. Both the increased number and increased magnitude of projected spills increase the probability that a sensitive resource or area would be contacted at a more vulnerable time. The precise effects would vary depending on the extent and timing of the spill, the location and state of marine plants and invertebrates, etc. Most cause for concern in nearshore environments rests with the Stefansson Sound Boulder Patch, and those epibenthic invertebrates that seasonally constitute the bulk of the diet of anadromous fishes.

he Stefansson Sound Boulder Patch is located close to Land Segment 36. The probability of at least one oil spill of 1,000 barrels or greater occurring and contacting this land segment does not change under the cumulative case (winter and open-water probabilities are identical for both the proposal and the cumulative case at 1%). If a spill did contact the Boulder Patch community (an even less-likely event than a spill contacting the area, given that the community is subtidal), MODERATE effects are expected; however, the probability of this occurring under the cumulative case is still slight.

Epibenthic invertebrates in the shallow, nearshore environments have a higher probability of being contacted by oil under the cumulative case than under the proposal, since the probability of at least one spill of 1,000 barrels or greater contacting land within 10 days during the open-water season is 77 percent (versus 23% for the proposal). The probability that oil would actually reach the sediments where the animals live is much lower than that. Even if epibenthic invertebrates in an area were contacted by oil and died or emigrated, anadromous fishes are not expected to be affected much since the areal extent of such a spill should be so small (1.8 km^2; Appendix C, Table C-1), and they do not seem to be food-limited (Moulton, Fawcett, and Carpenter, 1985; Craig and Haldorson, 1981).

Other marine plants and invertebrates of concern are found in the plankton, which is widely distributed throughout the Sale 97 area. The effect of an oil spill on plankton is not expected to change from that of the proposal (MINOR), even though effects are more likely to occur. Effects are judged to be MINOR due to the broad distributions of most constituents of the plankton and the believed ease of recolonization should a local community be affected.

Although oil spills in general are predicted to have a MINOR effect on marine plants and invertebrates, those species with potential for MODERATE effects (e.g., kelp in the Boulder Patch community) are more likely to incur them in the cumulative case.

There is also some increased risk from spills originating from or associated with the Chukchi Sea Planning Area (Sale 109), but this may be relatively slight because trajectories in the Chukchi Sea would tend to move oil westward, away from more vulnerable coastal habitats.

Thus, under the cumulative case, the expected effect of oil spills is MINOR for marine plants and invertebrates; but MODERATE effects are more likely to occur for the Boulder Patch community than under the proposal.

(2) Shallow-Hazards Surveys: Under the proposal, 1,571 kilometers of seismic surveys are projected (Table IV-A-1) versus 3,818 kilometers for the cumulative case. The effect of seismic surveys on marine plants and invertebrates is discussed previously and is judged to be NEGLIGIBLE for the proposal. Even though there would be an increased level of seismic surveying under the cumulative case, effects are still judged to be NEGLIGIBLE since airguns and waterguns are not known to have lethal effects on marine plants and invertebrates found in the Beaufort Sea.

(3) Drilling Discharges: Under the proposal, 15,924 dry metric tons of drilling muds and 77,730 dry metric tons of cuttings are expected to be discharged into the marine environment, for a total of 93,654 dry metric tons. The corresponding figures for the cumulative case are 49,239 dry metric tons of drilling muds and 195,300 dry metric tons of cuttings, for a total of 244,539 dry metric tons (Table IV-B-3). See Appendix L for details

of the effects of exploratory drilling discharges for the Sale 97 area. The quantity of drilling muds discharged during development drilling should be five times less than during exploration, while the quantity of drill cuttings should be over twice that discharged during exploration (Table IV-B-3; Sec. IV.B.14). The effect of these discharges on marine plants and invertebrates in the Sale 97 area is generally expected to be MINOR, given the relative volumes involved, the large sediment loads regularly and normally introduced into the environment, the low toxicity of drilling fluids to marine organisms, and the anticipated localized effects. The Boulder Patch community is viewed as being the most sensitive to potential effects of drilling-fluid discharge, in part because of its restricted distribution. If drilling fluids were discharged nearby and recruitment of kelp were affected, then a MAJOR effect is expected to accrue to this community.

In general, the effect of drilling-fluid discharge on marine plants and invertebrates in the Sale 97 area is expected to be the same as for the proposal, MINOR.

(4) Construction Activities: Construction activities, as well as release of drilling muds and cuttings, could alter habitats of benthic or epibenthic animals and plants. Activities relating to installation and construction of causeways, pipelines, and gravel islands are expected to be very localized but long term. The discussion of effects of gravel construction on marine plants and invertebrates in the Arctic Sand and Gravel FEIS (USDOI, MMS, 1983) is summarized and incorporated by reference. In the cumulative case, at least three gravel islands, approximately 720 kilometers of offshore pipeline, and at least three causeways would be constructed (see Table IV-A-1). Three-dimensional structures may provide habitat for refuging fishes or for invertebrates and plants requiring hard substrate for settlement. In general, organisms relying on soft-sediment areas altered or preempted by platforms, pipelines, gravel islands, or causeways would be negatively affected. Due to the relatively few number of such structures expected to be built for oil-related activities, the small area expected to be affected, and the apparently broad distributions of most adult and larval marine organisms in the Beaufort Sea, the effect of such construction activities is expected to be MINOR. Regional populations are not expected to be affected; however, the very localized effects expected should be long term for those benthic organisms involved.

In addition to habitat disruption, effects on marine plants, invertebrates, and fishes could result from increased turbidity associated with gravel structures and introduction of pollutants associated with the gravel (e.g., trace metals). Increased turbidity associated with the dumping of gravel could reduce primary production and could negatively affect organisms passing through the immediate vicinity of the construction site. Effects of gravel construction resulting from both habitat disruption and turbidity are expected to be MINOR and very localized. The most vulnerable community in the Sale 97 area to effects of construction activities is expected to be the Boulder Patch community. Ken Dunton (personal communication, 1985) reports that increased turbidity resulting from erosion of a gravel island already in place reduces the productivity of kelp downcurrent from the gravel island. If gravel structures are situated sufficiently far from the Boulder Patch community, effects are expected to be NEGLIGIBLE. However, since this is such a restricted and unique community, the effect is expected to be MAJOR if gravel structures are situated too close and if they are left in place for many years. An exploration and development plan could require site-specific monitoring to preclude such an effect. Site-specific effects are also possible for other kelp assemblages in the Beaufort Sea, but there are no other communities known to be as well developed as the Boulder Patch.

Bottom-founded mobile drilling units and floating units are expected to serve as bases for some drilling operations. Although some invertebrates will be killed or displaced by the bottom-founded units, the expected effect on marine plants and invertebrates will be MINOR due to the extremely small area that is expected to be affected.

Effects of pipeline installation are expected to be very localized but may be long term for benthic invertebrates, since the 747 kilometers of pipeline would be in place for years. Since only a very small portion of the benthos would be perturbed (with some organisms killed or displaced), regional populations of marine plants and invertebrates are not expected to be affected, leading to a MINOR effect.

In summary, effects of construction activities would vary depending on the species involved. Some sessile marine organisms would be killed or displaced by these activities and are expected to suffer extremely localized, long-term effects. Those species that require hard substrate for settlement and growth could increase in abundance because platforms increase the available substrate. Construction activities should benefit these species. In general, the effect of construction activities on marine plants and invertebrates is expected to be MINOR. Regional populations of these organisms are not expected to be affected.

(5) Conclusion: Under the cumulative case, the effect of oil exploration and development and production on marine plants, bacteria, and invertebrates is expected to be MINOR.

2. Effects on Fishes: This discussion summarizes and incorporates by reference the discussion of effects on fishes contained in the Sale 87 FEIS (USDOI, MMS, 1984a), the Sale 100 FEIS (USDOI, MMS, 1985d), and the Sale 109 DEIS (USDOI, MMS, 1987), with augmentation by additional information as cited. Effects on fishes from activities associated with the exploration and development and production of oil and gas in the Beaufort Sea could come from released oil, seismic surveys, drilling discharges, and construction activities. Potential effects derived from these activities are described in the following section.

Fishes of greatest concern, due to their abundance, trophic relationships, or vulnerability are: (1) the anadromous fishes that are abundant seasonally in the nearshore zone, especially arctic cisco, artic char, least cisco, and broad whitefish; (2) fish species narrowly dependent on conditions in the Stefansson Sound Boulder Patch (e.g., the kelp snailfish); (3) arctic cod, an abundant and trophically-important fish; and (4) capelin, a species that is vulnerable because it comes into nearshore areas to spawn. Some of these species are also important because they figure prominently in subsistence (e.g., arctic char, ciscoes, whitefishes, artic cod, rainbow smelt, capelin, and salmon).

a. Effects of the Proposal:

(1) Oil Spills: Petroleum is a complex substance composed of many constituents. These constituents vary in structural complexity, volatility, and toxicity to organisms. A more detailed discussion of these differences, plus modes of release and factors affecting concentrations of oil, is found in Sections IV.A.2 and IV.B.14.

(a) General Effects: Possible effects of hydrocarbons include short-term lethal effects, sublethal physiological effects, and effects on behavior. Evidence for these effects is discussed rather briefly, emphasizing data for Arctic marine and anadromous fishes; vulnerable aspects of species' life histories, habits, and habitats are then examined.

The death of adult fish has occurred almost immediately following some oil spills (the Florida and Amoco Cadiz; Hampson and Sanders, 1969; Teal and Howarth, 1984); however, lethal effects to adults may pose less threat to fisheries than damage to eggs and larvae or changes in the ecosystem supporting the fishery (Teal and Howarth, 1984). As mobile animals, adults may be able to avoid areas containing spilled oil or dissolved hydrocarbons (although evidence for this is contradictory: see especially the results of Weber et al., 1979, 1981); and, even if fish contact oil and become contaminated (MacLeod et al., 1978; Neff and Haensly, 1981; Mackie, Hardy, and Whittle, 1978), they are often able to quickly purge the oil from their systems after a return to uncontaminated waters (Brocksen and Bailey, 1973; Neff et al., 1976b; McKeown, 1981). Contamination of fishes was observed after the Argo Merchant, Amoco Cadiz, and Bravo spills, but generally there were low levels of contamination in only a small portion of the fish examined (Teal and Howarth, 1984). The significance of "tainted" fish or fear of tainted fish to commercial or subsistence fisheries is not known. Effects of tainted fish on natural predators is also unknown.

Sublethal effects often occur at lower hydrocarbon concentrations and thus are more likely to occur, and to occur over a broader area, than are lethal effects. Some sublethal effects also ultimately lead to the death of the individual. The major types of sublethal effects are behavioral and physiological changes. Within these two major categories are changes that affect the growth, feeding, fecundity, and survival of an animal; thus, they could possibly affect current or future population size. Some support for this contention has come from studies conducted following major oil spills.

(b) Aspects of Habitats and Life Histories Vulnerable to Effects of Oil:

Habitats: Fishes occupying different habitats may be differentially susceptible (i.e., vulnerable) to exposure to hydrocarbons. This variation in vulnerability combined with individual sensitivities determines the potential for effect. Determining effects on a particular species also can be complicated by variation in location and feeding habits of different life stages within the species (Table IV-B-1 and Sec. III.B.2). In comparing fishes that use different habitats, pelagic species appear more sensitive to oil than demersal fishes; however, they may be less vulnerable because they spend less time in estuarine areas where spilled oil tends to accumulate and persist (Rice et al., 1976), or in close association with shallow, soft-bottomed habitats, which are extensive in the Beaufort Sea. Those fishes that rely on

Table IV-B-1
Beaufort Sea Major Fish Species
Potential Oil-Spill-Interactions Analysis

Species	Habitats: Adult	Habitats: Eggs	Larvae/Immature	Effect Potential: Season	Effect Potential: Type
Anadromous Species					
Arctic Char	Coastal	Freshwater	Coastal	Summer	Reduction in food; interference with migration patterns
Arctic Cisco	Coastal	Freshwater	Coastal	Summer	Reduction in food; interference with migration patterns Some adults vulner-able when overwinter-ing in delta areas.
Least Cisco	Coastal	Freshwater	Coastal	Summer	Reduction in food; interference with migration patterns Some adults vulner-able when overwinter-ing in delta areas.
Bering Cisco	Coastal	Presumed Freshwater	Coastal	Summer	Reduction in food; interference with migration patterns Some adults vulner-able when overwinter-ing in delta areas.
Humpback Whitefish	Coastal	Freshwater	Coastal	Summer	Reduction in food; interference with migration patterns
Broad Whitefish	Coastal	Freshwater	Coastal	Summer	Reduction in food; interference with migration patterns
Chum Salmon	Pelagic	Freshwater	Pelagic	Summer	Possible interference with migration patterns
Pink Salmon	Pelagic	Some Inter-tidal Demersal	Pelagic	Summer	Possible inferference with migration patterns; toxic to eggs and larvae
Rainbow Smelt	Coastal	Freshwater	Coastal	Winter	Possible interference with migration patterns; vulnerable when over-wintering in nearshore areas and river mouths.
Marine Species					
Arctic Cod	Demersal	Pelagic	Pelagic	Winter	Toxic to eggs and larvae; eggs float and thus are partic-urlarly vulnerable.
Capelin	Pelagic	Demersal/ attached to sand or gravel on beach or bottom	Possibly Pelagic	July/August	Toxic to eggs and larvae, contamination of spawning substrate
Fourhorn Sculpin	Demersal	Demersal	Pelagic?/Demersal	Summer/Fall	Fry vulnerable when come into the near-shore in huge numbers in late summer/fall.

epibenthic organisms in the nearshore zone could also potentially be affected if their prey were contaminated by oil or killed (see discussion of Effects of Oil on Benthic Invertebrates and Benthic Communities, Sec. IV.B.1.a[1]).

In the Beaufort Sea, two fish habitats can be considered more vulnerable to effects from oil-related activities: the nearshore zone and the Boulder Patch community. The nearshore areas in the Beaufort Sea appear to have a greater abundance of fishes than offshore areas (see references in Sec. III.B.2, Fishes). During the open-water season, anadromous fishes extensively use the nearshore brackish-water habitats as feeding and rearing areas. Most of these fishes overwinter and spawn in freshwater habitats (Sec. III.B.2, Fishes). Within the nearshore-brackish zone, fish tend to be concentrated along the mainland and island shorelines rather than in lagoon centers or offshore. Details of variation in extent of coastal distributions, onshore-offshore distribution, and seasonal shifts in distribution are given in Section III.B.2, Fishes. Several marine species are also abundant in the nearshore zone, with some moving in seasonally or sporadically to feed. Some marine species continue to inhabit, feed, and reproduce in the nearshore zone during winter. Thus, the nearshore zone in the Beaufort Sea would be among the habitats considered more vulnerable to effects from oil-related activities. Particular areas of concern are the major river deltas, which are the areas of greatest species diversity and which also harbor some overwintering fishes. Among these rivers and their associated deltas, the Colville figures prominently as an area of high species diversity and the river with the most extensive overwintering habitat for anadromous fishes in the Alaskan Beaufort Sea. Other major rivers include the Sagavanirktok, Meade, Ikpikpuk, Kuparuk, and Canning.

The community associated with the Boulder Patch is also vulnerable to effects from oil-related activities, in large part due to its uniqueness and restricted extent. Three fish species have been reported in the Boulder Patch community: the kelp snailfish, the fourhorn sculpin, and the fish doctor (Dunton, Reimnitz, and Schonberg, 1982; Craig, 1984a). Of these, the kelp snailfish is probably most dependent on the environment and/or community of the Boulder Patch, since it apparently requires hard substrate upon which to lay its eggs. The other two species apparently are not so environmentally limited. Thus, the kelp snailfish could be vulnerable to effects from oil-related activities.

<u>Life Histories</u>: Several aspects of fish life histories may make fish populations vulnerable to effects from spilled oil. In particular, recruitment or reproduction could be affected because:

- Eggs and larvae of fishes are more sensitive to oil than other life-history stages, and those of some species may be more vulnerable due to ecological conditions, such as location.
- Oil may increase the already high mortality of larvae in the plankton by increasing the length of time in the plankton or by decreasing planktonic food.
- Recruitment or survival of fishes could be reduced by oil affecting the spawning of adults, movement and feeding patterns of adults or juveniles, or overwintering juveniles or adults.

(c) Species-Specific Effects: This section considers, consecutively, effects on anadromous species; marine pelagic species; demersal species; and then capelin, a marine species that spawns along the coast. Trophic effects are also considered.

Among the various activities associated with Sale 97 oil development, oil spills apparently pose the greatest threat to fishes. Adult fish are generally unlikely to suffer great mortality as a result of an oil spill; however, anadromous fishes in the nearshore, warm, brackish-water band might be affected by having their movements to feeding, overwintering, or spawning grounds impeded. Effects of an oil spill could include increased swimming activity; decreased feeding; interference with movements to feeding, overwintering, or spawning areas; impaired homing abilities; and death of some adult or juvenile fishes. Fish may also suffer increased physiological stress when making the adjustment from fresh to brackish or marine water and vice versa. 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).

Larvae, eggs, and juvenile fishes are generally more sensitive to oil spills than are adult fishes. In particular, species with floating eggs (e.g., arctic cod) or eggs and larvae in more vulnerable positions (e.g., capelin eggs and developing larvae attached to substrates in the intertidal and/or shallow subtidal) could suffer extensive mortality (dependent on the amount and type of oil spilled, the areal extent of the spill, etc.). In the Beaufort Sea, nearshore demersal eggs or larval fishes spending time in coastal areas are the fish most vulnerable to adverse effects of spilled oil. These vulnerable categories include capelin and larval fishes of species such as fourhorn sculpin and snailfish, which can have great bursts of abundance in nearshore areas (Sec. III.B.2, Fishes; Houghton, 1985, personal communication; and Morrow [1980] citing Andriyashev, 1954, and Westin, 1970).

Anadromous Fishes: Anadromous fishes of importance because of abundance, life history, or use in domestic and commercial fisheries are arctic cisco, least cisco, arctic char, and broad whitefish. A number of anadromous species in the region have complicated life-history patterns that are not fully understood. For the most part, anadromous fishes in the Beaufort Sea, unlike salmon, spend the major part of their lives in freshwater rivers and lakes but undertake seasonal migrations to coastal regions in the ice-free season to feed (Craig, 1987). They generally return to fresh- or brackish-water habitats in the late summer or fall to spawn or overwinter. The details of foraging migrations of the more abundant anadromous fishes appear to vary not only among species but among life-history stages of the same species. These differences in migratory habits lead to spatial and temporal differences in the relative abundance of different species and lifestages in the nearshore zone (Bond, 1987; Cannon and Hachmeister, 1987). Thus, an oil spill contacting the nearshore environment might affect various species and age classes of anadromous fishes as they move to feeding, overwintering, or spawning grounds. Because most anadromous fishes make spawning runs and outmigrations over a period of time, it is not too likely that an entire year-class would be lost as it moved toward a spawning stream or migrated out of a stream. Even if fish were held up because a delta area was contacted by oil, it is unlikely that the major river deltas would be entirely contacted, given the broad expanses of the deltas and the estimated size of a 1,000-barrel-or-greater spill (a 10,000-barrel spill after 10 days would cover 1.8 km^2; Appendix C, Table C-1). The Mackenzie River Delta covers about 210 kilometers of coastline, the Colville about 32 kilometers, and the Sagavanirktok and Canning about 16 kilometers each. It is most likely that not all channels of these rivers would be affected and thus only a portion of the spawning run or a portion of the variously-aged fish in a population would be affected. The probability of a 1,000-barrel-or-greater oil spill occurring and contacting the Colville, Kuparuk, Ikpikpuk, and Mackenzie River deltas in the open-water season within 10 days is less than 0.5 percent, while the Sagavanirktok River Delta has a 1-percent chance of contact, and the Canning River Delta a 1- to 2-percent chance. Thus, the probability of important river deltas being contacted is very low.

Arctic cisco are vulnerable to effects from oil spills because they are believed to make extensive migrations from and to what is believed to be their natal river, the Mackenzie. Various age classes could be vulnerable to spilled oil, but the variation in timing of their movements suggests that severe effects on all age classes are not likely to occur from a single spill. During the year in which they spawn, adults may migrate eastward from as far away as the Colville to the Mackenzie, beginning their movements early in the open-water season. The departure of these spawning-year fish from coastal areas leaves the nearshore habitat occupied by juveniles and mature non-spawners throughout the summer (Bond, 1982). Most studies along the Beaufort Sea coast have found few mature arctic cisco during the summer (Bond, 1982, citing: Griffiths et al., 1975, and Griffiths, den Beste, and Craig, 1977; Galbraith and Hunter, 1975; Jones and den Beste, 1977; and Lawrence, Lacho, and Davies, 1984). Young-of-the-year arctic cisco moving westward from the Mackenzie to the Colville appear in western Canadian waters about mid-July and start reaching the Colville in late August. In 1985, catches of 0-age arctic cisco increased in number until sampling ceased September 11 (Fawcett, Moulton, and Carpenter, 1986). Thus, an oil spill contacting the nearshore zone may affect an assemblage of variously-aged arctic ciscoes, but is unlikely to decimate the majority of both those migrating to spawn and young-of-the-year. If either one of these groups were greatly affected, then possibly a year class could be reduced significantly. The spatial and temporal spread in movements of a single year class (i.e., they arrive at a location over a period of time) reduces the probability of large effects to an age class.

The USDOD, U.S. Army COE (1984) estimated that 33 to 38 percent of the Mackenzie River arctic cisco become resident in Alaskan waters; however, it is not known how good this estimate is, nor whether fish in Alaskan waters represent the entire stocks of smaller drainages within the Mackenzie. If they do comprise the entire stocks of smaller drainages within the Mackenzie, then effects to fish in Alaskan waters could be magnified locally within the Mackenzie. It is expected that an oil spill contacting the nearshore zone in Alaska would have a MINOR effect on an assemblage of variously-aged arctic ciscoes, since some fish might die, be displaced, or suffer increased mortality later. However, if either the majority of eastward-migrating, spawning-year adults or westward-moving, young-of-the-year arctic cisco were seriously affected, then most of a year class could be affected. This result might be felt for several generations, leading to a MODERATE effect.

Arctic char, which have only recently (Everett and Wilmot, 1987) been found to show genetic dissimilarity between drainages (suggesting the presence of separate stocks), may also be vulnerable to the effects of spilled oil. Arctic char are found in at least 16 rivers in the central Beaufort Sea ranging from the Colville River in the west to the Mackenzie River in the east (Craig, 1984a). The stocks in the Sagavanirktok and Canning Rivers are perhaps the largest (Cannon and Hachmeister, 1987). Since each drainage may contain a separate population, an oil spill affecting the majority of a year class, spawning run, or migration in or out of a particular river could significantly affect that population. The total population in a drainage is not expected to be decimated by an oil spill for several reasons. Young fish from 0 up to 4 years of age remain in freshwater (between ages 2 to 5 char start moving to sea in the summer). In some populations, male char do not migrate to saltwater even though females in the same population are anadromous (Glova and McCart, 1974; Morrow, 1980). Also, the movements of large and small char vary somewhat with time: in the Sagavanirktok River, large, mature fish move out of overwintering areas to deltas early in the summer and by mid-to-late June are dispersing to the coast and through the nearshore environments. Smaller char are slower to move to the delta regions, remain in or near the delta regions for a longer period of time, and are thus slower to disperse into nearshore environments. Large char start staging in delta regions for the return migration upstream in late July or August, and by late August most are moving upriver to spawning locations. Smaller, immature char begin returning to delta regions in mid-August, and large numbers are found in late August and early September in the Sagavanirktok River Delta, where they stage prior to moving upriver (Cannon and Hachmeister, 1987). Perhaps the most vulnerable time for char in nearshore environments would be in mid-to-late August, when some overlap between small char and large char occurs in the delta regions. In general, the variation in timing of movements of these different age classes reduces the probability that both these groups will suffer large effects from an oil spill.

Also, at least a few adult arctic char are known to have overwintered in other than their natal streams (Everett and Wilmot, 1987). Kristofferson (1987) suggests than the evidence for interdrainage exchange is the exception rather than the rule. Thus, depending on the extent to which this occurs, effects on spawning adults from one drainage could be ameliorated.

An oil spill contacting the nearshore environment in midsummer, when arctic char are widely dispersed, is expected to have a MINOR effect on arctic char. However, contact with char while they are in close association with the delta of their home drainage may result in a MODERATE effect, since individuals are aggregated and one or more age classes could be affected, with a resultant effect that could last for more than one generation.

The other two most abundant anadromous species in nearshore environments, the least cisco and broad whitefish, appear less vulnerable to effects from spilled oil than arctic ciscoes and arctic char since they have multiple streams of origin and are not known to show high fidelity to streams of origin (broad whitefish: C. Johnson, personal communication, April 1987). Like arctic cisco and arctic char, anadromous members of these species move into nearshore coastal areas to feed in the summer.

Anadromous least cisco in the Lease Sale 97 area originate from streams and rivers ranging from Wainwright to the Colville River. Although absent from lakes and streams of the central Beaufort Sea, the least cisco is also found in rivers on the northern coast of the Yukon and Northwest Territories.

Broad whitefish in the Alaskan Beaufort Sea occur in close association with the freshwater discharges of the larger rivers from Point Barrow east to the Sagavanirktok River Delta, and they have also been reported from the Canning River. This species is probably present in most of the rivers draining into the Chukchi Sea (Morrow, 1980). Broad whitefish are not very tolerant of saline waters and thus are often found near or within the delta regions and discharges of rivers. Studies in the Colville River have suggested that many broad whitefish use the delta region throughout the open-water season; however, large fish also have been reported to move long distances in the nearshore coastal environment (Fawcett, Moulton, and Carpenter, 1986).

Like the anadromous species discussed above, effects on these species while they are dispersed in the nearshore zone are expected to be MINOR, whereas if they are contacted while concentrated or aggregated in delta regions, then MODERATE effects are possible. For arctic cisco, if a significant number of spawning-year fish or age-0 fish were affected, then the effects are expected to be MODERATE. A MINOR effect is most likely for these species.

Marine Pelagic Species: Fishes having basically pelagic distributions are expected to be little affected by spills; most of them are thought to have broad distributions in the proposed sale area. Even if larvae, which are generally more sensitive, are affected, only a portion of those in the plankton would be harmed; and the effects would be difficult to determine, given the high natural mortality of fish larvae and the unpredictability of recruitment from year to year. If some adults were killed, recruitment into the population might not be affected, since for marine fish species having planktonic larvae, there is little correlation between the size of the adult population and recruitment. Effects on recruitment would be particularly difficult to assess in the Beaufort Sea because very few studies of offshore fishes have been made. Effects might be most noticeable if predators of these pelagic fishes decline in abundance or fail to reproduce, but the cause of such an effect might not be apparent. In general, effects under the proposal are not expected to exceed MINOR for pelagic fishes.

Marine Demersal Species: Demersal fishes in deeper-water areas are not expected to be greatly affected by oil spills, as the likelihood of oil reaching the sea bottom in any appreciable amounts or over an extensive area is very small (see Sec. IV.B.14), especially given that more than one spill of 1,000 barrels or greater is unlikely to occur. However, demersal or coastal fishes in shallow, soft-bottomed areas could be affected by a spill if the water column is mixed and oil comes to contaminate sediments and/or prey. Food in the nearshore environment does not appear to be limiting to most anadromous fishes feeding in the shallows, with the possible exception of arctic cisco (Moulton, Fawcett, and Carpenter, 1985; Craig and Haldorson, 1981). Since most species have broad distributions in the Sale 97 area, and effects of spills are expected to be relatively localized and are unlikely to affect the deeper benthos, effects on the regional populations of demersal fishes are expected to be MINOR.

For arctic cod, a demersal species that is patchy in distribution and has floating eggs, it may be extremely difficult to determine the effect of an oil spill. Adult arctic cod have been reported to suffer 50-percent mortality (LC_{50}) at concentrations of 1.569 ppm ±0.004 oil over an 8-day period (Northwest and Alaska Fisheries Center [NWAFC], 1979). Although arctic cod can be extremely abundant in nearshore, lagoonal environments (comprising 8-78% of all fish caught in Simpson Lagoon during two summers; Craig et al., 1982), the importance of nearshore versus offshore environments to the life cycle is not known (Craig et al., 1982). If larvae were concentrated in nearshore environments or occurred in patches in the open ocean, then they would certainly be more vulnerable to effects from an oil spill. Even though arctic cod are more vulnerable to effects from oil spills because they have floating eggs, the effect of the proposal on this species is expected to be MINOR since only one spill of 1,000 barrels or greater is projected to occur over the production life of the Sale 97 area.

Capelin: Capelin spawn in coastal sandy areas in the Beaufort Sea in July and August and thus are susceptible to negative effects from an oil spill, especially if the spill is large and affects a large portion of their spawning area. Hatching of capelin eggs has been shown to be negatively affected by concentrations of 10 to 25 micrograms per liter (100-250 ppb) of crude oil (Johannessen, 1976). Capelin are not abundant in the Beaufort Sea, and the areal extent of their spawning is not known (Peter Craig, 1985, personal communication). Thus, it is difficult to assess the most probable effect of an oil spill on capelin populations in the Beaufort Sea. If capelin spawn along a broad extent of coastline, then an oil spill is expected to have a MINOR effect on the populations, since the probability of a spill of 1,000 barrels or greater occurring and contacting the coastline is extremely low (Appendix F, Tables F-17 and F-21). A spill of 100,000 barrels or greater is even less likely to occur and contact land (Appendix F, Tables F-28 and F-29). If such a spill did occur during or just after spawning by capelin, and encompassed most of the spawning area of the regional population, then the effect is expected to be MODERATE. However, this effect is not anticipated. In other regions, it is thought that capelin spawn at about 3 years of age and that most individuals die after spawning (Jangaard, 1974). If this is the case, and if an oil spill occurred and decimated a year-class of young from one area, then the effects could be felt in successive years. In this case, effects on capelin are expected to be MODERATE.

Trophic Effects: Fish populations may be affected indirectly, through effects on food sources, either planktonic or benthic, but these effects are little studied and are extremely difficult to predict. Since no evidence suggests significant biomagnification of oil through trophic linkages (Varanasi and Malins, 1977; Cimato, 1980), adult fish may be little affected by tainted food. However, larval or juvenile fish may be affected by increased food-limitation, slower growth rates, and increased predation.

Trophic effects could occur indirectly through contamination of sediments in the nearshore zone or the shallow subtidal zone. In shallow depths less than 2 meters (which freeze to the bottom each year), contaminated sediments might affect the seasonal immigration of epibenthic invertebrates, which constitute the major prey of fishes in the nearshore zone during the open-water season. If sediments in depths greater than 2 meters were contaminated, both immigration and recruitment of epibenthic invertebrates could be affected, and their fish predators as well. Effects to the benthos would be expected to be fairly localized [see discussion in Sec. IV.B.1.a(1)]; and, since food does not appear to be limiting to fishes in the nearshore zone (Craig and Haldorson, 1981; Moulton, Fawcett, and Carpenter, 1985), effects to fishes are expected to be MINOR.

(d) Site-Specific Effects: Under the proposal, the most likely number of spills of 1,000 barrels or greater occurring during the projected production life of the Sale 97 area is one. The probability that one or more spills of at least 1,000 barrels would occur and contact land in the open-water season within 10 days during the production life of the Sale 97 area is 23 percent. The probability of a spill occurring and contacting individual land segments adjoining areas of particular interest to fishes (e.g., river deltas, lagoon systems) is considerably less: for land segments from Point Hope to the Mackenzie River Delta, the probability of contact within 10 days is less than or equal to 4 percent for spills in the open-water season (Appendix F, Table F-21) or less than or equal to 7 percent for spills over the entire winter (Appendix F, Table F-17). The probability of a 1,000-barrel-or-greater spill occurring and contacting the Colville, Kuparuk, Ikpikpuk, and Mackenzie River Deltas in the open-water season within 10 days is less than 0.5 percent, while the Sagavanirktok River Delta has a 1-percent chance of contact, and the Canning River Delta a 1- to 2-percent chance. Thus, the probability of important river deltas being contacted is very low. This combination of factors suggests that effects to fishes in nearshore waters are expected to be MINOR. MODERATE effects are possible for some anadromous species and capelin if spawning-year individuals, aggregated multi-age assemblages, or a year class of young were affected. However, since delta areas are unlikely to be contacted, these MODERATE effects are not expected to occur. For pelagic species or those in offshore waters, effects of an oil spill are expected to be MINOR, given the small number of spills projected, the broad distributions of these fishes, and the relatively small area (see Appendix C, Table C-1) that a spill would cover.

The probability of at least one spill of 100,000 barrels occurring and contacting land over the expected production life of the Sale 97 area is 1 percent for open-water spills and 2 percent for winter spills, and the probability of spills contacting land segments of particular interest to fishes is negligible (less than 0.5%). Thus, effects from a large spill of this magnitude are considered highly unlikely. If such a spill occurred, a MINOR effect is expected for fishes, including anadromous fishes dispersed in the open-water season, since some individuals in a localized area and/or over a short time period would probably be affected. The broad dispersal of anadromous species in the nearshore zone and the variation in the timing of movements of species and age classes suggest a MINOR effect is most likely. However, in the unlikely event that a large spill contacted the nearshore zone, MODERATE effects are more likely to occur for anadromous fishes and capelin than from a smaller spill since a broader area of the nearshore could be affected, movements of fishes might be effectively impeded, and the probability of most of an age class being affected is increased.

In general, then, the effect of spilled oil on fishes under the proposal is expected to be MINOR for most fish species, although MODERATE effects are possible for some anadromous species (e.g., arctic cisco, arctic char, least cisco, and broad whitefish) and capelin if spawning-year individuals, aggregated multi-aged assemblages, or a year class of young were affected. These MODERATE effects are not expected to occur.

(2) Seismic Surveys: This subject was introduced in Section IV.B.1.a, Effect on Lower-Trophic-Level Organisms. Within the Sale 97 area, only air- and waterguns will be used for seismic testing. Falk and Lawrence (1973) have compiled a review of several types of seismic surveys and their effects on fish.

High explosives can be quite lethal to fish, but they will not be used in the Beaufort Sea. Experiments testing the effects of airguns on caged coho salmon smolts found no harmful effects (Weaver and Wienhold, 1972, cited by Falk and Lawrence, 1973). Kostyuchenko (1973) examined the effect of airguns (as well as electric-pulse generators and TNT charges) on fish eggs and larvae in the Black Sea. Airguns had little effect on even the most sensitive fish eggs at distances of 5 meters from the discharge source. Even at a distance of 0.5 meters from the source, the survival rate of eggs was 75.4 percent compared to the control's rate of 92.3 percent. Airguns were not observed to have any effect on larvae; however, only limited numbers of larvae were examined. Airguns have been found to have few harmful effects, especially as compared to high explosives. Waterguns, which use the rapid release of water to generate a seismic pulse, release less energy than airguns. Effects of waterguns on marine organisms have not, to our knowledge, been assessed, but effects are expected to be as low or lower than those of airguns. Due to the expected prevalent use of airguns and waterguns for seismic surveys in the Sale 97 area, MINOR effects on fish are anticipated.

(3) Drilling Discharges: The general types of effects that discharged drilling fluids and cuttings could produce are reviewed and discussed in Appendix L of this document and in Appendix F of the Sale 100 FEIS. This referenced material discusses lethal, as well as chronic or sublethal effects, and effects on populations and communities.

Only 12 fish species have been tested for acute lethal concentrations of drilling fluids (see Table 19, NRC, 1983). In general, fish appear less sensitive to drilling fluids than invertebrates, but this may reflect the fewer number of tests done with fish and a lesser examination of effects on different life stages.

Pink salmon fry were found to be moderately sensitive to drilling fluids, exhibiting 96-hour LC_{50} values of 3,000 to 29,000 ppm (Dames and Moore, 1978). (LC_{50} values indicate the concentration of test substance that caused 50-percent mortality of the experimental organisms.) Toxicity increased when experimental solutions were well-stirred. The increased toxicity observed might relate to gill damage (whole muds were used in the acute lethal bioassay test); gill histopathology was observed in pink salmon fry exposed to a 30,000-ppm suspension of used high-weight chromium lignosulfonate from Cook Inlet (Houghton, Beyer, and Thielk, 1980). Tests with coho salmon have resulted in 96-hour LC_{50} values of 15,000 to 190,000 ppm for whole-mud suspensions (Monaghan et al., 1977).

A few studies suggest that fish do not accumulate trace metals in their tissues (Payne et al., 1982; Tillery and Thomas, 1980). Other tissues than those tested, however, may be more likely to accumulate trace metals.

An area of special vulnerability that should be kept free of discharged material is the Boulder Patch. Fishes that depend on or are largely restricted to this habitat may be vulnerable to effects from discharged material, as would be demersal fish eggs laid within the Boulder Patch. Fish could die, or could suffer gill damage or other sublethal effects, while eggs could be smothered or otherwise be damaged. Effects to this community from drilling-fluid discharge are highly unlikely, since available lease tracts are situated far from the Boulder Patch; the EPA Beaufort Sea NPDES Permit does not allow discharges within 1,000 meters of the Boulder Patch.

Under the proposal, a total of 15 exploration and delineation wells are expected to be drilled from a number of different locations. In the process, a total of 13,200 dry metric tons of drilling muds and 21,100 dry metric tons of drill cuttings would be released (Table IV-B-2). During the production phases of the proposal, 39 wells are expected to be drilled from 2 platforms, with the release of 2,724 dry metric tons of drilling muds and 56,620 dry metric tons of drill cuttings. Effects should be very localized. Details of extent and timing of water-quality effects are presented in Section IV.B.14, Effect on Water Quality.

The amounts of drilling muds and cuttings expected to be released are small relative to the natural suspended-sediment load of the Sale 97 area. (See Sec. III.D.6 in the Sale 87 FEIS, USDOI, MMS, 1984a, and Sec. IV.B.14, Effect on Water Quality, of this EIS.) Sediments are contributed by rivers, coastal erosion, runoff from breakup, and mixing of inshore waters. Most fish (except for demersal eggs and planktonic forms) should be able to avoid areas of active discharge. Demersal eggs in those areas could be buried by discharged material (see Appendix L and Jones and Stokes, 1983).

The overall effects of drilling discharges on the fish fauna of the Sale 97 area are expected to be MINOR because (1) fish are mobile; (2) in general, fish do not seem to be very sensitive to discharged drilling fluids and cuttings; and (3) the area projected to be affected will be so small (0.06 km^2; see Sec. IV.B.14, Effect on Water Quality).

(4) Construction Activities: Construction activities, as well as the release of drilling muds and cuttings, could alter the habitats of demersal fishes. The discussion of effects of gravel construction on fishes in the Arctic Sand and Gravel Lease Sale FEIS (USDOI, MMS, Alaska OCS Region, 1983) is summarized and incorporated by reference. On-land construction of roads and bridges that could affect fish populations or habitats would be regulated by Federal agencies such as the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service or by the State of Alaska.

In the Beaufort Sea, 1 gravel island and a total of 14 bottom-founded units and floating units are expected to be involved in the exploration activities of Sale 97. The 2 bottom-founded structures projected for development and production activities are likely to be in place for a number of years and hence could have a sustained effect. Platforms add a three-dimensional structure to the environment, which may provide increased habitat for refuging fishes. Activities relating to installation and construction of platforms, pipelines, and gravel islands are expected to be very localized. In general, demersal fishes would be expected to move during construction activities but to reutilize their habitat upon completion of the construction if substrate type were not altered and the habitat were recolonized by their prey. However, demersal fishes are not expected to recolonize those areas where gravel replaces soft sediments. Due to the small number of production platforms (2) expected to be installed, the presumably broad distributions of most adult and larval marine fishes in the Beaufort Sea, and the ability of fish to move from an area of disturbance, regional populations are not expected to be affected. Therefore, platform installation is expected to have a MINOR effect on fishes.

One gravel island is projected to be built during the proposed sale's oil-exploration activities. The basal area of the island should be approximately 48,300 square meters. Effects on marine plants, invertebrates, and fishes could result from habitat disruption, increased turbidity, and introduction of pollutants associated with the gravel (e.g., trace metals). Habitat disruption and increased turbidity are expected to have a MINOR effect on fishes, so the overall effect of gravel-island construction on fishes is expected to be MINOR.

During development and production, oil is expected to be transported between local facilities (offshore and onshore) via buried pipelines. An estimated 160 kilometers of pipeline will be laid offshore in conjunction with the activities of Sale 97. A certain amount of trenching would be involved in laying the pipeline, and an estimated 11.8 square kilometers of the offshore benthos would be disturbed in the process. Trenching can affect marine organisms by physically altering the benthic environment; increasing sediments suspended in the water column, thereby decreasing water quality; displacing sediments and, in so doing, smothering some benthic organisms; altering water currents by modifying benthic topography; and killing some organisms directly through mechanical actions (Starr, Kuwanda, and Trasky, 1981; Lewbel, 1983).

Effects of pipeline installation on fishes are expected to be very localized and of temporary duration. Since the epibenthic invertebrates that serve as food for many fishes annually recolonize shallow environments that are seasonally disturbed, disruption of the bottom substrates should not significantly affect their abundance. The general effect is expected to be MINOR. A very short shore-approach causeway or jetty may be built in conjunction with the pipelines. Such a jetty is not expected to appreciably alter watermass characteristic in the nearshore zone, unlike the long West Dock and Endicott Causeways. Thus, the effect on fishes of such a causeway is expected to be similar to that of gravel-island construction: MINOR.

In summary, the effect of construction activities on fishes in the Sale 97 area is expected to be MINOR.

(5) Summary: Of all the potential direct effects of oil and gas development on fishes in the Sale 97 area due to this proposal, oil spills pose the greatest threat. Adult fish are not likely to suffer great mortality due to an oil spill, 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) or eggs in more vulnerable

positions (e.g., capelin eggs and developing larvae attached to substrates in the intertidal and/or shallow subtidal) could suffer extensive mortality (dependent on the extent and amount of spilled oil, etc.). Capelin spawn in coastal sandy areas and thus are susceptible to negative effects from an oil spill. The effect of an oil spill on capelin is expected to be MINOR. However, a MODERATE effect is possible if spawning capelin or eggs attached to beach substrates are contacted and if most individuals die after spawning (as apparently occurs in other regions; Jangaard, 1974), since multiple generations could be affected.

An oil spill that occurred near shore could also affect the movement patterns of anadromous fishes. If an oil spill occurred in the open-water season and affected a segment of the nearshore region, then 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 effects of an oil spill on fishes in the Beaufort Sea region are expected to be MINOR, since some individuals in a localized area and/or a short time period would probably be affected. However, MODERATE effects are possible for some anadromous species (e.g., arctic cisco, arctic char, least cisco, broad whitefish) if spawning-year individuals, aggregated multi-aged assemblages, or a year class of young were affected. These MODERATE effects are unlikely to occur.

In conclusion, the effect of an oil spill on fishes in the Beaufort Sea is expected to be MINOR, although for some species (capelin and some anadromous species), MODERATE effects are possible.

Effects from other activities (seismic exploration, discharge of drilling fluids, and construction activities) should be very localized. The effect of these activities on fishes is expected to be MINOR.

(6) Conclusion: Activities associated with the exploration and development and production of oil as anticipated under this proposal are expected to have a MINOR effect on fishes in the Sale 97 area.

b. Cumulative Effects:

(1) Oil Spills: Since resource levels are higher for cumulative leasing, and development and production activities are expected to be greater, potential effects are also more probable. Because the probability of oil spills increases, effects from spills are more likely. The effects that would result from a spill would not change.

Under the cumulative case, the most likely number of spills of 1,000 barrels or greater is 24. Also, 1 spill of 100,000 barrels is most likely, and the probability of its occurrence is 65 percent. Both of these conditions (increased number and increased magnitude of spills) increase the probability that a sensitive resource or area will be contacted at a more vulnerable time. The precise effects would vary depending on the extent and timing of the spill, the location and state of the fish, etc. Most cause for concern rests with fishes that spawn in nearshore or freshwaters, or in other ways depend on nearshore-water environments during part of their lives (e.g., anadromous fishes and capelin). Thus, although oil spills in general are expected to have a MINOR effect on fishes since individuals in a localized area are most likely to be affected, those species with the potential for MODERATE effects (anadromous species and capelin) are more likely to incur them in the cumulative case. MODERATE effects (by definition, those lasting more than one generation) are more likely: where spawning is tied to nearshore areas (capelin), where multiple year-classes could be affected by a single spill (most coastal anadromous species), or where stocks are restricted in origin and long-term migration patterns could be affected as well as spawning success (arctic cisco).

The probability of a spill of 1,000 barrels or greater occurring and contacting land is higher for the cumulative case than it is for the proposal (see Appendix F, Tables and F-17 and F-19). Although for most land segments the probability of a spill occurring and contacting land is less than or equal to 6 percent, several lagoonal areas and river deltas have a higher probability of being contacted. River deltas are areas of special concern, and the Kuparuk River Delta-Simpson Lagoon area (Land Segment 34) has the highest probability of land contact under the cumulative case: 52 percent for a winter spill and 36 percent for an open-water spill. The Sagavanirktok River Delta (Land Segment 35) has a 13-percent chance of being contacted during the winter (Appendix F, Table F-17). A spill contacting one of these areas might have a MODERATE effect on fishes, since migration patterns, spawning, and overwintering could be affected. However, if continuing causeway construction alters the population distribution, migration, or overwintering of anadromous fishes--especially for arctic cisco--then a spill contacting the Sagavanirktok River Delta could be more severe than otherwise anticipated (see discussion on cumulative causeway construction).

There is also some increased risk from spills originating from or associated with the Chukchi Sea Planning Area, but this may be relatively slight because trajectories in the Chukchi Sea would tend to move oil westward, away from more-vulnerable coastal habitats.

Thus, under the cumulative case, the expected effect of oil spills on fishes is MINOR, but MODERATE effects are more likely to occur for anadromous species and capelin than under the proposal.

(2) Shallow-Hazards Surveys: Under the proposal, 1,571 kilometers of seismic surveys are projected (Table IV-A-1) versus 3,818 kilometers for the cumulative case. Effect of seismic surveys on fishes is discussed previously and is judged to be MINOR for the proposal, due to the low levels of mortality of eggs and larvae and the extremely small spatial extent of the mortality. Even though there would be an increased level of seismic surveying under the cumulative case, effects are still judged to be MINOR for fishes in the Beaufort Sea, since a limited number of almost point-sources of mortality would be added.

(3) Drilling Discharges: Under the proposal, 15,924 dry metric tons of drilling muds and 77,730 dry metric tons of cuttings are expected to be discharged into the marine environment, for a total of 93,654 dry metric tons. The corresponding figures for the cumulative case (for

Federal leases) are 49,239 dry metric tons of drilling muds and 195,300 dry metric tons of cuttings, for a total of 244,539 dry metric tons (Table IV-B-3). See Appendix L for details of the effects of exploratory drilling discharges for the Sale 97 area. The discharge of formation waters also has the potential for affecting fish in the vicinity of the platforms; however, these substances do not appear to be very toxic to fishes (Menzie, 1982). The effect of these discharges on fishes in the Sale 97 area is expected to be MINOR based on the following: the mobility of adult fishes, the apparent low toxicity of drilling fluids and formation waters to fishes (see earlier discussion), and the potential, very local smothering of demersal eggs of fishes. The actual area affected should be relatively small (see Sec. IV.B.14, Effect on Water Quality) and should preclude effects greater than MINOR. The effects on prey of fishes also are expected to be localized and therefore are expected to be limited. The mobility of adult fish and the apparent low toxicity of drilling fluids to fishes further reduces the likelihood that adult fishes will be significantly affected by discharged drilling fluids. For these reasons, the effect of drilling discharges on fishes is expected to be MINOR.

(4) Construction Activities: Although construction activities projected under the proposal are expected to have a MINOR effect on fishes, the cumulative effect of construction activities (from all Beaufort Sea lease areas) could be greater. Of greatest concern is the construction of causeways (two have been permitted and a third is proposed as of this writing). All would be built in the Prudhoe Bay-Sagavanirktok River Delta region. Causeways are of concern because they may affect populations of anadromous fishes: (1) by physically blocking or impeding migrations, and/or (2) by altering the physical environment and affecting migrations. The first causeway constructed, the West Dock causeway, has altered the physical regime (including temperature and salinity) in the warm, brackish-water zone found nearshore, which is extensively used by anadromous fishes (Craig and Griffiths, 1981, citing Bendock, 1977, and Mungall et al., 1978; Cannon and Hachmeister, 1987). An alteration here could be important, since anadromous fishes apparently respond to temperature and salinity regimes (Fechhelm and Gallaway, 1982; Cannon and Hachmeister, 1987; see other references in Sec. III.B.2, Fishes). Migration, feeding, spawning, and overwintering of these fishes could be affected, or further affected, by the additional construction of causeways.

The arctic cisco is the anadromous fish species likely to suffer the greatest adverse effects from the construction of causeways. Gallaway et al. (1983) have proposed that arctic cisco in Alaskan waters originate from the Mackenzie River, with pulses of ciscoes leaving the Mackenzie River Delta and migrating westward at irregular intervals. These fish then reside in Alaskan waters for several years before returning to the Mackenzie River to spawn. Gallaway et. al. (1983) and Gallaway and Gazey (1987) have estimated that Alaskan arctic cisco represent 30 to 40 percent of the Mackenzie River stock. Details of the movements and life history of Alaskan arctic ciscoes are not well known, but age/size data support the above pattern of movement. Arctic ciscoes overwinter in river deltas in Alaskan waters. These aspects of the life history (especially that individuals originate from the Mackenzie River and return there to spawn) make the regional population of arctic cisco more vulnerable to effects of causeways than populations of other anadromous fishes in the Arctic. Other species of anadromous fishes appear to have multiple points/streams of orgin, hence their populations are inherently less vulnerable to construction activities. Arctic char populations may also be vulnerable to local construction activities since stocks in different drainages appear to be distinct (Everett and Wilmot, 1987).

Evidence accumulated from 1969 to the present suggests that the first causeway built in the Beaufort Sea, the West Dock causeway (built in 1975, and extended in 1976 and 1981, Craig and Griffiths, 1981), has already affected the movements and distribution of anadromous fishes in the Beaufort Sea (Cannon and Hachmeister, 1987). In 7 years of study prior to the building of the West Dock causeway, from about 1969 to 1977, arctic cisco were not abundant in Prudhoe Bay; they comprised only about 4 percent of the catch. Historically, least ciscoes predominated in Prudhoe Bay (Craig Johnson [NMFS], 1985, personal communication). Since the construction of the West Dock causeway, arctic cisco have comprised 31 to 70 percent of the fish catch (C. Johnson [NMFS], 1985, personal communication). Those arctic cisco that have overwintered in their first year of migration in the Sagavanirktok River tend to remain and overwinter in the Sagavanirktok River Delta (Moulton et al., 1985; Moulton, Field, and Brotherton, 1986), though there may be a tendency for older and larger fish to move to the Colville to overwinter (Cannon and Hachmeister, 1987). The Colville River has much more extensive overwintering sites than does the Sagavanirktok River (C. Johnson, 1985, personal communication). Delaying or disrupting the migration patterns of arctic cisco such that they spend more, or all, of their time in or near the Sagavanirktok River rather than moving to the Colville has implications for the growth, fecundity, and survival of ciscoes.

Prey density offshore of the Sagavanirktok River is less than in Prudhoe Bay or Simpson Lagoon (C. Johnson, 1985, personal communication). Also, growth rates of arctic cisco are slower in the Sagavanirktok River than in the Colville (Moulton, Fawcett, and Carpenter, 1985). Both of these factors could contribute to lowered fecundity of fishes residing in the Sagavanirktok versus the Colville River deltas. If overwintering sites are limiting in the Sagavanirktok River, then arctic ciscoes attempting to overwinter there could suffer higher mortality. All of these factors assume greater importance if there is a high degree of fidelity to an overwintering stream. Thus, if fish become stalled at the Sagavanirktok River due to causeway construction, rather than continuing on to the Colville, slower growth, reduced fecundity, and increased mortality could result. Slower growth in the Sagavanirktok River and increased abundance in the Prudhoe Bay region have already been documented. The latter may be an effect of the West Dock causeway. Thus, causeway construction could lead to a reduced number of arctic ciscoes in the Colville River area.

Studies conducted in Prudhoe Bay have indicated that movements of arctic cisco and broad whitefish have been impeded somewhat by the West Dock causeway and that movements of least cisco have been altered. The causeway has resulted in some least cisco turning around or going across Prudhoe Bay rather than following the coastline. Small char, arctic cisco, and least cisco are more affected than are large fish, since they are apparently more restricted by low temperature and high salinity than are large fish (Moulton, Field, and Brotherton, 1986). Thus, the effects of the first causeway, the West Dock, are already apparent.

A second causeway, this one associated with the Endicott Reservoir, has now been built; and a third, the Lisburne, is proposed. Effects of the West Dock and Endicott causeways are reviewed by Cannon and Hachmeister (1987).

The cumulative effect of these causeways is likely to affect species differentially because of the variation in their life histories. Causeways are a persistent feature; thus, their effects are likely to persist for more than one generation of fishes. Since causeways can alter the physical regime (temperature, salinity, etc.), migration patterns of anadromous fishes could be affected, resulting in changes in the distribution and abundance of some species. Effects for most species like broad whitefish and least cisco that have multiple points of orgin are expected to be relatively local, but MODERATE. The arctic cisco is most likely to have its regional population adversely affected since the population is thought to originate from one source, and its migration patterns are likely to be affected by causeway construction. Cumulative effects for arctic cisco are estimated to be MAJOR.

In conclusion, the cumulative effect of construction activities on fishes is expected to be MAJOR (due to estimated effects of cumulative causeway construction on arctic ciscoes). Other oil-associated activities are expected, in general, to have MINOR effects on fishes; however, MODERATE effects are possible for some anadromous fishes and capelin from oil spills if spawning-year individuals, aggregated multiyear assemblages, or a year class of young are affected.

(5) Conclusion: The effect of the cumulative case on fishes in the Sale 97 area is expected to be MAJOR.

3. Effects on Marine and Coastal Birds:

a. Effects of the Proposal: Several million migratory birds of about 150 species occur on marine, coastal, and tundra habitats within or adjacent to the proposed Sale 97 area. Oldsquaw, red phalarope, glaucous gull, and common eider are among the most abundant species present. Important coastal habitats are shown in Graphic 3. The primary adverse effects from OCS activities in the proposed sale area on marine and coastal birds could come from oil pollution of the marine environment, noise and disturbance of bird populations, and alteration of habitats.

(1) Effects of Oil Spills:

(a) General Effects: The effects of oil spills on birds are well-documented. (For a detailed discussion of the nature of these effects, refer to Alaska OCS Technical Paper No. 3, Hansen, 1981, which is summarized here and incorporated by reference.) Direct oil contact alone usually is fatal or, in addition to indirect effects, causes substantial bird mortality. Oiling of birds causes death from hypothermia, shock, or drowning. Oil ingestion through preening of oiled feathers significantly reduces reproduction in some birds and causes various pathological conditions. Oil contamination of eggs by oil-fouled feathers of parent birds also significantly reduces egg hatching.

Indirect effects of oil pollution include reduction, contamination, and displacement of food sources, as well as contamination of shoreline habitats. A sudden 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 can also lead to chronic toxicity in birds through the accumulation of hydrocarbon residues that may adversely affect their physiology, reproduction, and behavior.

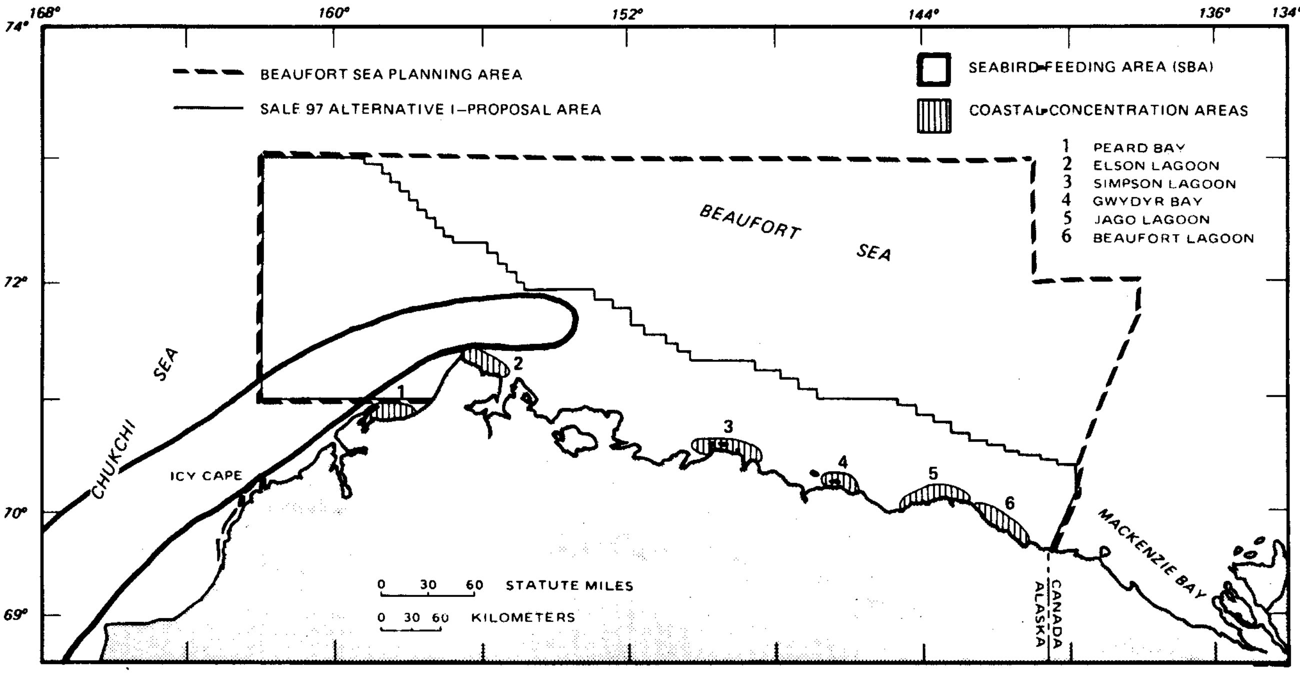
The effects on birds of an oil spill in the Sale 97 area would vary with the season; volume, nature, and duration of the spill; species and numbers of birds occurring in the areas affected; and many other variables. Spills that occur during the winter would have no immediate effects on birds. If any 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.

(b) Site-Specific Effects--Oil Spills: Unless otherwise specified, oil-spill contact and probabilities referred to in this section assume the occurrence of development to the extent estimated herein (Table IV-A-1) and associated spill rates (Sec. IV.A.1). Most attention is devoted to spills greater than or equal to 1,000 barrels, which have a trajectory period of up to 10 days during the open-water period.

For this analysis, the combined probabilities of oil spills occurring throughout the year contacting specific bird-habitat areas during the open-water season are compared in Figure IV-13.

These marine and coastal bird habitats have a range of less than a 0.5 up to a 20-percent chance of being contacted during the open-water period, including contact from overwintering spills. The important offshore seasonal feeding area near Point Barrow referred to as the Seabird-Feeding Area (Bering Sea Intrusion Area, see Sec. III.C.3) has the highest risk of oil-spill contact from the proposal alone (Fig. IV-13). The Elson Lagoon and Simpson Lagoon coastal-concentration areas are at greater risks than other lagoon habitats. However, spill-contact risks to all coastal lagoons are less than 10 percent for the proposal alone, and spill-contact risks to any other lagoon or wetland are less than 10 percent for the proposal (Appendix F, Table F-17, and Fig. IV-1).

Over the life of the proposed field, there is an 82-percent chance of one or more oil spills of 1,000 barrels or greater. For this analysis, at least one such spill is 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-13). If the spill occurred during the winter season, 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-13) after ice breakup. An oil spill contacting nearshore (less than 20-m water depth) or coastal habitats during the open-water period could expose the following average number of birds per square kilometer to contamination: Elson Lagoon-Plover Islands, 100; Pitt Point-Cape Halkett, 145; Harrison Bay, 30; Simpson Lagoon, 70; Gwyder Bay-Flaxman Island, 80; Camden Bay, Jago Lagoon-Hulahula River, and Beaufort Lagoon, approximately 25 (densities taken from Divoky, 1983). Depending on spill size and spreading,



SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS

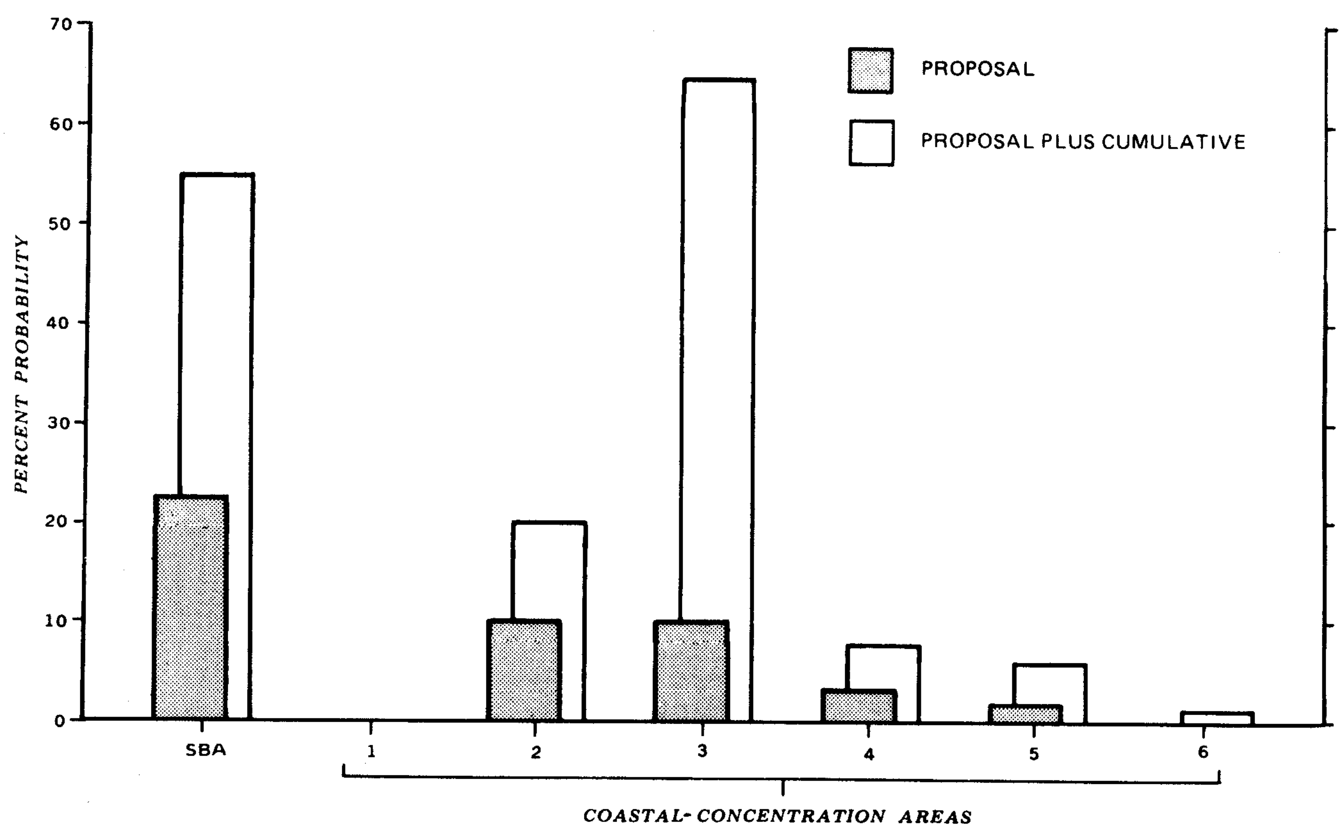


FIGURE IV-13. COMBINED PROBABILITIES OF ONE OR MORE OIL SPILLS OCCURRING AND CONTACTING SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS DURING THE OPEN-WATER SEASON WITHIN 10 DAYS OVER THE PRODUCTION LIFE OF THE LEASE AREA

several hundred or more birds are likely to be affected by a spill in near-shore waters west of Cape Halkett, while probably fewer birds would be contaminated by a nearshore spill east of Flaxman Island. However, if a spill contaminated lagoon waters where large aggregations of several thousand oldsquaw or other bird species were rafting, several thousand birds may 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 per square kilometer (of the common species) could be affected. The contamination or loss of the seasonally abundant crustaceans in the Point Barrow feeding area (the Bering Sea intrusion) due to an oil spill could substantially but temporarily reduce available food sources of thousands of migratory shorebirds and perhaps prey of Ross' gull prior to migration for that season. Bird mortality could increase that year for a portion of the North Slope shorebird populations and perhaps for some Ross' gulls. This is likely to represent a MINOR or MODERATE effect on different species populations.

The direct loss of birds due to one or more oil spills--including a spill of 100,000 barrels or greater--that is not anticipated under the proposal may range from a few to several thousand. Local reduction or contamination of available food sources due to an oil spill may also reduce survival and reproductive rates of a few to several thousand additional migratory birds for that season. A 100,000-barrel oil spill probably would contaminate some local habitats rather than large sections of coastline or the entire seabird-feeding area offshore of Point Barrow. Most migratory species use various Beaufort Sea coastal habitats, depending on food availability. The contamination of some local habitat areas is not likely to affect an entire species population frequenting the Beaufort Sea coast. An oil spill contacting the Point Barrow seabird-feeding area is likely to affect only a portion of this habitat and food source due to dispersion and evaporation of the spill in open water. The death of several thousand oldsquaw, other sea ducks, or other abundant species would not have major long-term effects on the regional population of those species, because natural recruitment within abundant species populations such as oldsquaw would probably replace such losses in one or two generations. Species (such as murres or auklets) with low reproductive rates or species (such as yellow-billed loons) with low or limited population levels are not likely to suffer high mortality as a result of an oil spill occurring in the Beaufort Sea, since murres and auklets are not abundant in the sale area and loon populations are not concentrated. Therefore, effects of oil spills on marine and coastal birds in the Sale 97 area are expected to be no more than MODERATE.

(2) Effects of Disturbance: Human activities associated with OCS exploration and development, especially air traffic near nesting waterfowl and seabirds, could reduce the productivity of some species and may cause 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, 1972). Spindler (1984) reported that snow geese were particularly sensitive to aircraft disturbance during premigratory staging. 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 the proposed sale area, potential disturbance of eiders nesting on barrier islands is a major concern.

Existing aircraft traffic in the Prudhoe Bay area already may have affected common eider nesting success on some of the barrier islands. Waterfowl nesting on the Colville River Delta may also be disturbed by aircraft and boat traffic, and some disturbance of molting and staging oldsquaw on Jago, Elson, and Simpson Lagoons is likely to occur. However, effects studies by Ward and Sharp (1973) and Gollup, Goldsberry, and Davis (1972) indicate that long-term displacement or abandonment of important molting and feeding areas by this species due to occasional aircraft disturbance is unlikely. Disturbance of nesting birds in the sale area is likely to occur locally but probably would not involve disturbance of very large groups or very large colonies of nesting birds, such as may 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 foxes, whose populations increase in association with human development and availability of garbage.

<u>Site-Specific Noise and Disturbance Effects</u>: Primary sources of noise and disturbance of marine and coastal birds would come from the air and marine traffic, onshore-pipeline construction, roads and support facilities, and offshore-pipeline and -platform installation that are assumed to occur with oil development and production. Air support is assumed to be centered out of Deadhorse at Prudhoe Bay, with two helicopter round trips per day per exploration-drilling unit and a total of 90 to 270 helicopter trips/year (out to the unit and back to Deadhorse) for exploration and up to 1,215 helicopter round trips for development. Drillships could be used for exploration in the summer; two concrete or steel bottom-founded structures could be used for production. 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 two production platforms and support facilities at Deadhorse 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 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 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 per day per platform during drilling of the production and service wells) is not likely to disturb more than a few feeding and molting flocks of birds near the coast or near the drill platforms on occasion. Noise and disturbance effects on birds from aircraft traffic are not expected to be more than MINOR.

The noise associated with drilling operations and the movement of barges and supply vessels 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 97 vessel traffic of about one trip to and from Prudhoe Bay per day during development and production 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 and is expected to have NEGLIGIBLE effects. 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 effects of noise and disturbance from aircraft, boat traffic, and drilling activities on marine and coastal birds are expected to be MINOR.

(3) Effects of Exploration and Production Construction Activities: For Sale 97 exploratory drilling, one to three drilling units are expected to be used each year during the exploration phase; one gravel island would be used in water depths of 15 meters or less. Gravel-island construction would require barging and deposition of about 1,196,000 cubic meters of gravel material from an onshore source using 10 barges making 2 round trips per day for 40 days. Construction activities could temporarily displace (one season) several birds near the island construction site as well as near the terrestrial gravel-storage sites. Displacement could occur because of noise and traffic disturbance of birds and temporary disruption or removal of food sources near the island (Proposed Arctic Sand and Gravel Lease Sale FEIS, USDOI, MMS, Alaska OCS Region, 1983). The gravel island would provide additional shoreline habitat and might attract some bird species by providing shelter on the leeward side of the island. However, human presence may limit bird use of the islands, and bird attraction to gravel islands may increase the chances of direct contact between possible oil spills and birds. Disturbance of birds from gravel barging and island construction would be short term, and disruption of food sources would be local and temporary (Proposed Arctic Sand and Gravel Lease Sale FEIS, USDOI, MMS, Alaska OCS Region, 1983). Therefore, specific effects of gravel barging and island construction are expected to be MINOR.

(4) Effects of Pipeline and Onshore Construction: Other factors that may directly affect birds include shoreline alteration, facility siting, gravel mining, and pipeline and road construction.

During the exploratory phases of the proposal, these effects are likely to be MINOR because exploration support is likely to centered out of Deadhorse, Prudhoe Bay, and the existing facilities located at Cape Lonely. Of primary concern during the development and production phase would be permanent loss of onshore habitat from facility sitings, from gravel mining, and from roads in addition to the existing infrastructure at Prudhoe Bay. Road and facility construction reduces nesting and feeding habitats through gravel burial of tundra and through changes in water drainage. Water impoundments can affect the availability of insect prey for some shorebirds near these localities (Conners, 1983). Existing laws and regulations and permitting procedures may serve to minimize these localized effects.

Under the proposal, transportation of oil is assumed to be by 320 kilometers of pipelines connecting with Sales 71 and 87 development and TAP. If oil development occurs east of the Sale 71 and BF areas, pipelines are assumed to be located nearshore along the coast when possible rather than onshore over the Arctic National Wildlife Refuge (see Secs. II.A.2 and 3). Trenching, laying, and burying 160 kilometers of offshore pipeline would have similar effects as dredging, with temporary displacement of some birds during construction activities. If oil development takes place between Harrison Bay and Barrow, pipelines are assumed to be located along the coast offshore. Again, pipelaying activities are likely to have similar temporary (MINOR) effects on birds as dredging and island construction would have. Some birds could be temporarily displaced along the 160-kilometer pipeline route during pipelaying operations. If development takes place west of Barrow, a 140-kilometer pipeline is assumed to be located onshore and connect to possible NPR-A development. This pipeline would probably come ashore at Point Belcher and run along the 600-foot contour line across NPR-A between the Colville River and the lake habitat, crossing the Colville near Umiat and connecting with TAP at Pump Station 3. About a 100-meter-wide corridor of tundra habitat along the approximate 400-kilometer pipeline would be altered during construction of the pipeline and possible maintenance road. This habitat loss would represent less than 1 percent of the overall available tundra habitat on the North Slope and be expected to have a MINOR effect on birds.

(5) <u>Summary</u>: Adverse effects from the proposal on marine and coastal birds would come primarily from (1) one or more oil spills, (2) human disturbance, (3) exploration activities (90 to 270 helicopter round trips per year), and development and production activities (up to 1,215 helicopter round trips per year), and (4) alteration of marine (a few km^2) and terrestrial (about 50 km^2) habitats associated with exploration and development and production. Over the life of the proposal, one oil spill is likely to 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 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 97 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 (one to two generations). Bird species with low regional populations or species with low reproductive rates (such as alcid species) are not likely to suffer high mortality due to an oil spill in the Beaufort Sea. Effects of oil spills on marine and coastal birds such as eiders and Pacific brant are expected to be MODERATE if population recovery takes two or more generations or MINOR if population recovery occurs within one generation.

Human 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 (90 to 270 helicopter round trips per year and 12 supply boats per year) are likely to disturb some local populations 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 would probably have little effect on North Slope bird populations as a whole. Effects of disturbance are expected to be MINOR.

Other industrial activities associated with the proposal that would affect birds include gravel barging, dredging, construction of one gravel island, installation of two production platforms, onshore-gravel mining, gravel storage, and 160 kilometers of both pipeline and road development onshore. Offshore construction and dredging or gravel-deposition activities would temporarily displace some birds near the activity sites and temporarily disrupt or remove food sources near the artificial island and the 160 kilometers of offshore-pipeline-burial sites, representing MINOR effects. Onshore-construction activities would destroy or alter tundra nesting and feeding habitat of marine and coastal birds along the 160 kilometers of onshore pipelines and associated roads. The permanent loss of about 50 square kilometers of onshore habitats from facility construction, pipelines, roads, and gravel mining during the development phase would represent a small portion of the available tundra habitat. Thus, effects on birds from onshore development are expected to be MINOR.

(6) Conclusion: The combined effect of potential oil spills, noise and disturbance, and habitat alteration on marine and coastal birds is expected to be MODERATE.

b. Cumulative Effects: In this section, the additive effects of other ongoing and planned projects, as well as the proposal, are discussed to present an analysis of the potential cumulative effects of proposed Sale 97 on marine and coastal birds. Although the probability of any or all of the planned and ongoing offshore and onshore projects reaching developmental stages generally is unknown, this analysis assumes that all the projects discussed in this section do reach developmental stages. These projects could affect birds by oil spills, noise and disturbance, and habitat destruction or alteration.

(1) Effects of Oil Spills: Oil-spill risks to bird habitats from existing oil and gas activities in the Beaufort Sea were compared with the oil-spill risks of the proposal (Fig. IV-13). Risk of spill contact to the seabird-feeding area offshore of Point Barrow and the Simpson Lagoon Coastal Concentration Area 3 (Fig. IV-13) are far greater than for the proposal alone. Cumulative oil-industry activities also increased oil-spill-contact probabilities for the Elson Lagoon, Gwydyr Bay, and Jago Lagoon seabird-coastal-concentration areas (Fig. IV-13, Areas 2, 4, and 5). Bird habitats east of Jago Lagoon-Kaktovik are at little or no oil-spill risk from the proposal or existing oil activities.

Potential oil spills--including a spill of 100,000 barrels or greater--from offshore oil activities associated with Federal, State, and Canadian 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. If a spill contaminates coastal saltmarshes, Pacific brant may also suffer high losses. If a spill severely contaminated the Sag Delta or Mackenzie Delta, snow geese could also suffer high mortalities. The projected 24 cumulative oil spills are likely to have MINOR or no more than MODERATE effects on common species, such as oldsquaw, because marine and coastal birds are not likely to be exposed to many of these spills, which probably would occur during the winter season, and because recruitment of birds from unaffected parts of the regional populations is likely to replace lost individuals within one to a few generations. The cumulative loss of Pacific brant from potential spills contacting coastal wetlands is likely to have MODERATE effects on the regional population of this species. If a large oil spill of 100,000 barrels or greater occurred within the Mackenzie Delta during the fall, when staging or molting concentrations of snow geese are present, MAJOR oil-spill effects on this species are possible (Dome, Esso, and Gulf, 1982).

(2) Effects of Offshore Construction: About 40 exploration units (gravel islands, mobile bottom-founded drilling platforms, drillships, and ice islands) have been used in the Beaufort Sea (see Table IV-A-7), and a total of several million cubic yards of gravel and dredge material have been used in the construction of 4 gravel islands in Federal OCS waters, 12 in State of Alaska waters, and a number of islands in Canadian waters. This deposition of fill material and dredging activity has had MINOR to perhaps MODERATE effects on some benthic organisms in local areas at or near island sites and dredge sites. However, the local loss of some benthic species has been of little or NEGLIGIBLE effect on the availability of food organisms to marine and coastal birds that prey on a variety of fish and invertebrates.

(3) Effects of Onshore Construction: The construction of hundreds of miles of roads and pipelines associated with developed oil fields in the Prudhoe Bay-Kuparuk area and future oil fields in the NPR-A, ANWR, and the Mackenzie River Delta would destroy some percentage of the available tundra-nesting habitat of several species of marine and coastal birds. The Prudhoe Bay-Kuparuk development encompasses over 800 square kilometers of tundra habitats of which a small percentage was altered or destroyed from the construction of roads, pipelines, gravel pads, and gravel quarries. The loss of bird habitat from any one of the development projects listed on Table IV-A-7 represents a MINOR or NEGLIGIBLE effect on the availability of various tundra habitat types used by nesting and feeding birds on the North Slope. However, the cumulative loss of tundra habitats from all the listed projects, particularly possible NPR-A oil exploration and development in the Teshekpuk Lake waterfowl-concentration area, ANWR oil development, and Mackenzie River Delta oil development in Canada is likely to represent a MODERATE effect on the availability of tundra habitat for several species and may have a MODERATE effect on the distribution and abundance of some species for more than one generation or over the life of the oil fields.

(4) Effects of Noise and Disturbance: Considerable amounts of air and vessel traffic have been associated with petroleum exploration in the Beaufort Sea. For example, up to 1,215 helicopter trips/year associated with OCS development and an estimated 25 to 30 helicopter and fixed-wing aircraft flights per day have been projected for Canadian Beaufort Sea oil activities in 1986 (Dome, Esso, and Gulf, 1982). 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 MINOR 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 are 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 such as that 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 somewhat after construction is complete, some individuals of the species population would continue to be disturbed by lower traffic levels throughout the life of the field.

Noise and disturbance from air, vessel, and on-ground-vehicle traffic from any one exploration and development project are likely to have MINOR effects on marine and coastal birds. However, cumulative aircraft and ground-vehicle disturbance of snow geese, Pacific brant, and other species associated with NPR-A, Endicott, ANWR, and Canadian Mackenzie River Delta oil development are likely to cause these species to avoid parts of their nesting, feeding, and molting habitats on the Arctic slope for more than one to several generations, representing MODERATE effects.

(5) Overall Cumulative Effects: Direct or indirect loss of several thousand birds from oil spills, including a 100,000-barrel-or-greater spill, is expected to have MODERATE effects on some species such as oldsquaw, common eider, and Pacific brant because population recovery would take more than one generation. 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 MINOR or NEGLIGIBLE 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 all birds that feed on a variety of abundant fish and invertebrates. Cumulative habitat alteration and destruction from onshore facility-construction activities (such as gravel mining, roads, pipelines, and drill pads) are likely to have MODERATE effects on the distribution or abundance of several species through the loss of several hundred square kilometers of nesting, feeding, and molting habitat. 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, Endicott, ANWR, and the Mackenzie River Delta 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 more than one to several generations, representing MODERATE effects.

(6) Conclusion: Cumulative exploration and development and production activities from the above projects and the proposal are likely to have MODERATE effects on marine and coastal birds (particularly the oldsquaw, common eider, snow goose, and Pacific brant).

4. Effects on Pinnipeds, Polar Bears, and Beluga 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 beluga whales--commonly occur year-round or seasonally in a portion of or throughout the Beaufort Sea Planning Area and are very likely to have some interaction with OCS industrial activities. Oil pollution, noise and disturbance, and alteration of habitats could adversely affect marine mammal populations found in the proposed Sale 97 area.

a. Effects of the Proposal:

(1) Effects of Oil Spills:

(a) General Effects of Oil Pollution: This section briefly discusses the nature of effects of oil and disturbance on marine mammals that commonly occur in the sale area. The reader is directed to OCS Report MMS 85-0031 (Hansen, 1985) 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.

(b) 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 animal's 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 resulting in hypothermia. Adult ringed, spotted, and bearded seals and walrus 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). 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. In case histories, the few recorded mammal deaths attributed to oil spills occurred during winter months (Duval, Martin, and Fink, 1981), a season of increased natural stress.

Although species-specific effects of oil contact on beluga whales are uncertain, studies of hydrocarbon effects on dolphins and porpoises as representative odontocetes by Geraci and St. Aubin (1982) provide sufficient insight on potential effects of oil-spill contact on belugas.

The findings of these experiments suggest that smooth-skinned cetaceans such as beluga whales, dolphins, porpoises, and killer whales could suffer some minor skin damage if they were confined to a small surface area contaminated with oil (such as an ice lead). However, such effects on the skin are likely to be short term or transient (oil is unlikely to adhere to the skin), with recovery occurring within a few days (Hansen, 1985).

Oil ingestion by marine mammals through consumption of contaminated prey and by grooming or nursing could have pathological effects, depending on the amount ingested, species involved, and the animal's physiological state. Death would be likely to occur if a large amount of oil were ingested or if oil were aspirated into the lungs. Ingestion of sublethal amounts of oil can have various physiological effects on a marine mammal depending on whether the animal is able to excrete and/or detoxify the hydrocarbons. Geraci and Smith (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).

(c) Oil-Spill Avoidance: Seals, walruses, polar bears, and beluga 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). 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.

(d) Indirect Effects of Oil: Indirect effects of oil pollution on seals, walruses, polar bears, and beluga whales would be those associated with changes in availability or suitability of various food sources. The Arctic-marine ecosystem consists of a relatively simple food web with top-level consumers such as ringed seals, beluga and bowhead whales, and marine birds feeding primarily on a few species of abundant invertebrates 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, 1981a).

If a major spill occurred during such a period, the local short-term loss of plankton and benthic invertebrates could, in theory, reduce some marine mammal food sources during a critical period for one season and result in local decreased productivity of breeding ringed seals. The local reduction in ringed seal numbers as a result of direct or indirect effects of oil could in turn temporarily affect polar bear distribution.

However, ringed, spotted, and bearded seals; walruses; and beluga 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 MINOR effect.

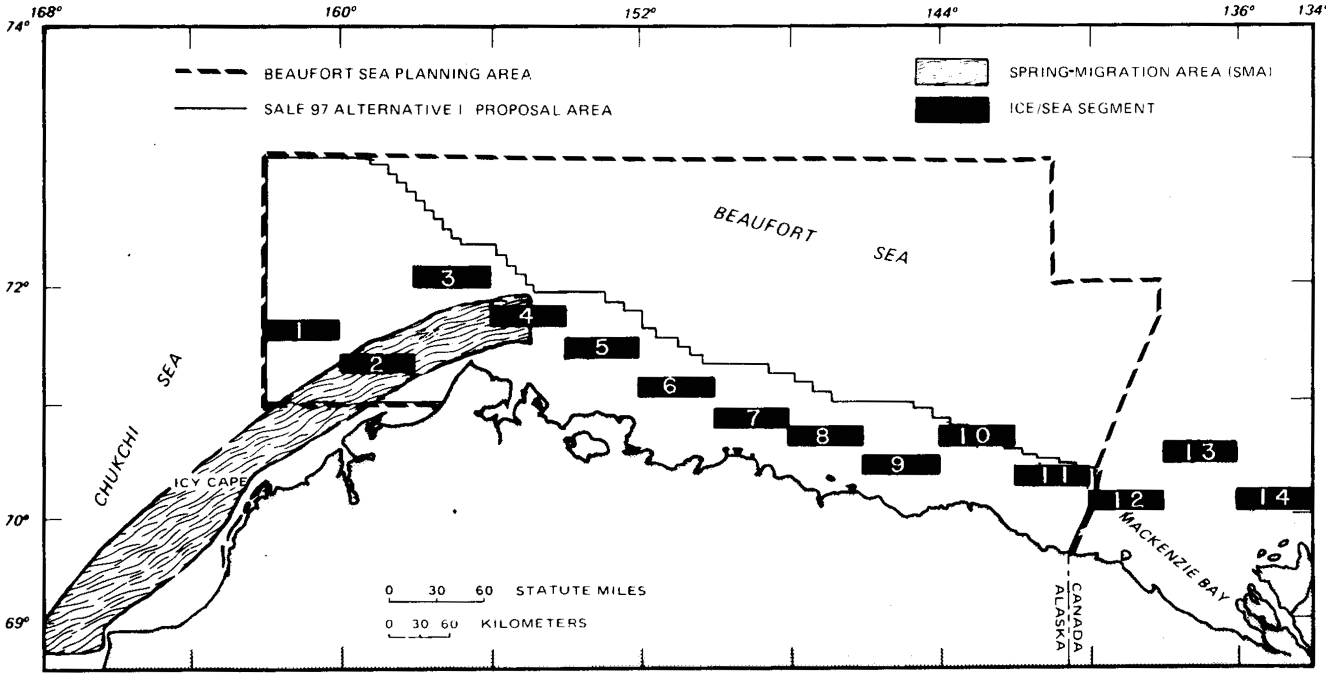
(e) Site-Specific Effects of Oil Spills: Unless otherwise specified, oil-spill contact and probabilities referred to in this section assume the occurrence of development to the extent estimated in Section II.A and the associated spill rates (Sec. IV.A.1). Most attention is devoted to spills equal to or greater than 1,000 barrels that have a trajectory period of up to 10 days during the open-water period. There is an 82-percent chance of one or more spills of 1,000 barrels or more occurring under the proposal.

For this analysis, the combined probabilities of oil spills that occur at any time of the year contacting marine mammal-habitat areas within 10 days (segments of the ice-flaw zone and the whale-migration corridor) during the open-water season are compared with combined probabilities of spills that occur during winter contacting the same habitat areas (Fig. IV-14). Spill risk to these habitat areas is described as follows: The portion of the whale-migration corridor off Point Barrow (Spring-Migration Area [SMA] A) has some risk of spill contact during the spring (April 15 to June 15) period due to the net westward movement of oil-spill trajectories during the winter and spring. The ice-flaw zone represented by the sea segments numbered 1 through 14 in Figure IV-14 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. Winter spills contribute most of the risk from the proposal to all sections of the flaw zone (Fig. IV-14).

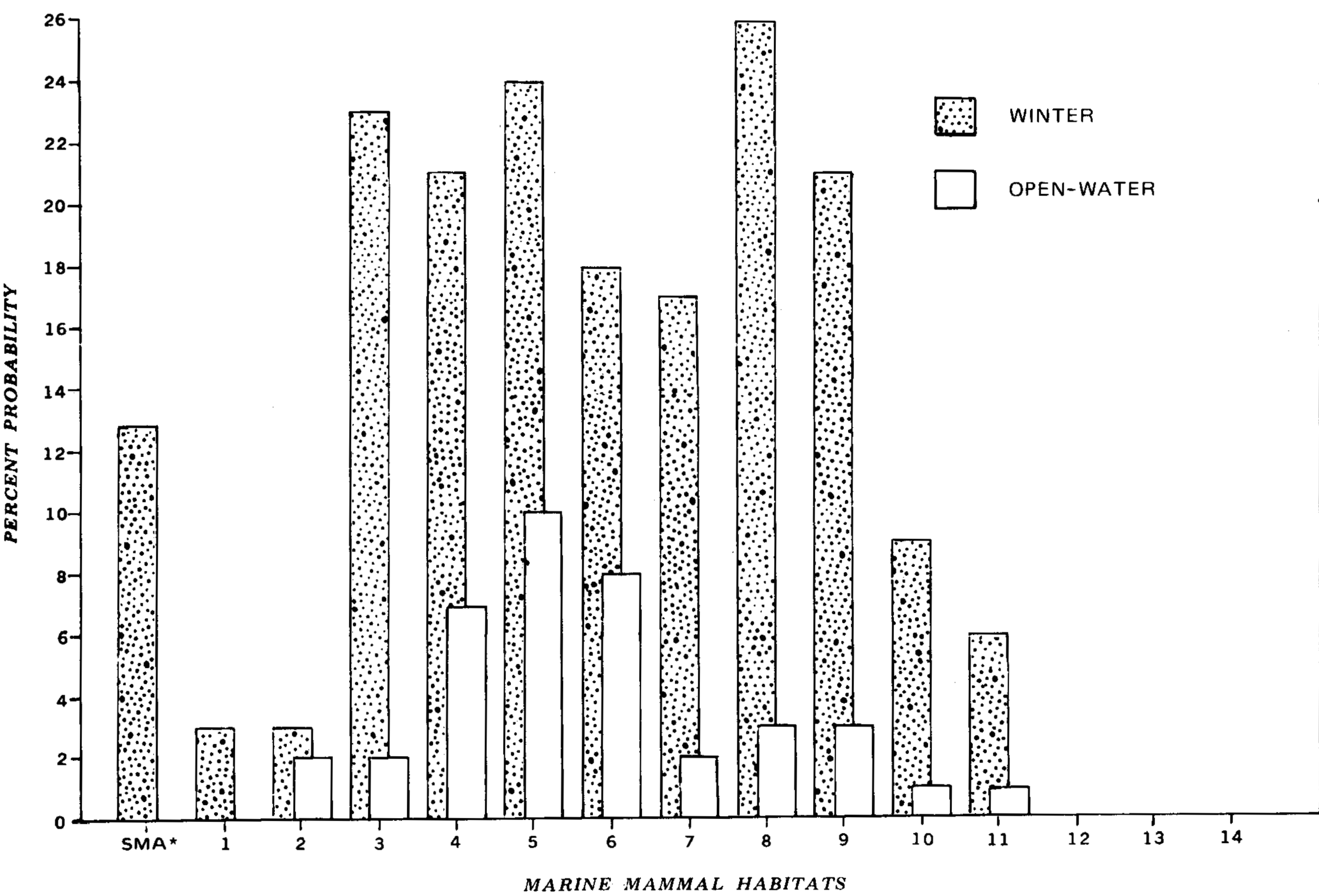
Other than the SMA, the highest risk of spill contact from the proposal with seals and polar bears within the flaw-zone habitat is with the area offshore of Smith Bay east to offshore of Camden Bay (Fig. IV-14, Segments 3-9). This higher risk reflects the greater amounts of oil transported by pipeline to onshore stations connecting with TAP (see the transportation scenarios, Sec. II.A) and the westward movement of spill trajectories from the eastern portion of the sale area. The flaw-zone habitat east of Camden Bay has less spill-contact risk due to the net movement of offshore winter spills westward prior to ice breakup. Therefore, marine mammals using the flaw zone and pack-ice edge offshore of Smith Bay east to Camden Bay and in the Point Barrow area are at higher risk of oil-spill contamination than marine mammals in other offshore habitats.

Winter spills that occur within the 20-meter-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 under fast ice would occur. The number of ringed seal pups and adult seals contaminated is likely to be small (one or fewer seals/km^2 in fast ice). Oil spills occurring in the open-water period or occurring during winter in the offshore flaw zone may contaminate larger numbers of seals. Aggregations of hundreds of seals do occur in open water.

The net westward movement of spills and the chance of spill contact for the SMA during the spring (Fig. IV-14) indicates that extensive walrus feeding habitat northwest and west of Point Barrow could be at risk of oil-spill contact. 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 perhaps young calves, causing some deaths. Contamination of benthic food organisms and bottom-feeding habitats could reduce the availability of some benthic prey for that season at the spill location if benthic habitats are highly contaminated. Presently, the walrus population is believed to be near the carrying capacity of its habitat. Therefore, the seasonal temporary loss or contamination of benthic food sources could have noticeable effects on walrus



MARINE MAMMAL HABITATS



*SMA – Spring–Migration Area (contact probability for April 1 to June 15 only)

FIGURE IV-14. COMBINED PROBABILITY OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS (SMA AND ICE/SEA SEGMENTS) DURING THE ENTIRE WINTER SEASON COMPARED WITH THE OPEN-WATER SEASON PROBABILITIES OF CONTACT WITHIN 10 DAYS OF SUMMER SPILLS OR MELTOUT OF OVER-WINTERING SPILLS DURING THE EXPECTED PRODUCTION LIFE OF THE LEASE AREA productivity and survivorship for the following winter and spring seasons. However, the amount of benthic prey killed or contaminated by the spill is likely to be a very small proportion of the prey and benthic habitat available in the Chukchi Sea. This represents a MINOR effect on the availability of food to walruses.

Polar bears would be most vulnerable to oil-spill contamination along the ice-flaw zone between Smith Bay to Camden Bay and in the Point Barrow area (Fig. IV-14). However, the number of bears likely to be contaminated or indirectly affected by local reduction or contamination of 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 (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 likely to have a MINOR effect on the regional population of polar bears, with annual recruitment probably replacing lost bears within less than one generation.

Beluga whales would be most vulnerable to oil contact during spring migration off Point Barrow (Fig. IV-14). 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 (SMA, Fig. IV-14) during the April 15 to June 15 migration 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, belugas 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 beluga whales are likely to be seriously affected even in a severe situation.

(2) 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 beluga whales.

(a) Airborne Noise: Major sources of mobile airborne-noise disturbance are low-flying aircraft and high-speed motorboats as well as other high-frequency, high-pitched sounds. Low-flying aircraft are known to panic hauled-out seals and walruses (Johnson, B.W., 1977; Salter, 1979). If walrus nursery herds in the far western portion of the sale area were hauled out on the ice, disturbance may result in the death or injury of walrus calves from trampling by disturbed adults. If disturbance of hauled-out seals occurs frequently during molting, the successful regrowth of skin and hair cells may be retarded, thus increasing physiological stress on seals during a normally stressful period. Increases in physiological stress may possibly decrease fertility and longevity of affected seals. Aircraft-noise disturbance of beluga whales from flyovers generally is very transient, with events lasting no more than a few seconds (Stewart, Aubrey, and Evans, 1983). Such brief disturbances are not likely to have any serious consequences to beluga whales.

Major stationary sources of airborne noise include construction of artificial islands and dredging and drilling operations. These activities may disturb hauled-out seals, walruses, and polar bears occurring within a few kilometers of the noise sources. However, underwater noises borne from these sources could influence marine mammals over a greater area. Land-based industrial activities and human presence near polar bear dens pose a potentially serious disturbance, although female polar bears apparently den more frequently on sea ice within the sale area than on the coast (Amstrup, 1985). Experience with captive female polar bears suggests that these bears can be especially sensitive to noise and human presence during maternity denning. However, preliminary results of noise measurements taken within a simulated polar bear den suggest that on-land seismic activities would only be detected by denning bears if such activities occurred very near the dens (Lentfer, J., personal communication, Barrow Arch Synthesis Meeting, 1983). Nevertheless, human scent and other noises near maternity dens also may disturb the bears.

(b) Underwater Noise: Sound is more efficiently transmitted and travels at a greater velocity in water than in air. Underwater-sound-propagation loss is higher in shallow water than in deep water (Greene, 1981). Bottom material, structure, and the undersurface of ice cover strongly influence sound transmission. Propagation of most sound frequencies is greater in summer than in winter (Greene, 1981). Mobile sources of industrial-underwater noise primarily include support vessels, icebreakers, seismic boats, and aircraft; stationary sources include active dredges, drilling units, and offshore-production and -processing facilities.

Underwater noise may alarm beluga whales and pinnipeds, causing them to flee the sound source. For example, Fraker, Sergeant, and Hoek (1978) reported the startled response and flight of beluga whales from barges and boats traveling through a whale-concentration area. Finley and Davis (1984) reported strong fleeing reactions by beluga whales when icebreaker ships approached at distances of 35 to 50 kilometers in two documented cases. The whales were displaced or moved over 80 kilometers along the ice edge, or they stopped moving within 20 kilometers when they reached coastal waters (Finley and Davis, 1984). Stewart, Aubrey, and Evans (1983) reported that beluga whales respond to outboard-motor noises by immediately moving downriver away from the source, but whale exposure to playback recordings of drilling sound had little effect on the movement and general activity of the whales. Reactions of beluga whales or pinnipeds to noise sources, particularly mobile sources, such as marine vessels, are likely to be highly variable depending on the animals' prior exposure to the disturbance source and their need to be in a particular habitat area where they are exposed to the noise and visual presence of the disturbance sources; for example, beluga whales foraging within the busy fishing grounds of Bristol Bay may be more tolerant of boat traffic with shorter recovery times and shorter displacement distances from passing fishing vessels than migrating belugas that reacted to icebreaker traffic in Lancaster Sound (high Arctic of Canada) as reported by Finley and Davis (1984). The latter whales may be "naive" with respect to vessel noise (Finley and Davis, 1984).

Underwater noise may interfere with or mask reception of marine mammal communication, or it may interfere with reception of other environmental sounds used by marine mammals for navigation (Terhune, 1981). Noise produced by outboard motors operating at high speeds may have the greatest potential for interfering with beluga whale communication and some echolocation signals (Stewart, Aubrey, and Evans, 1983), but exposure to this interference source is likely to be very transient. Low-frequency noises from drilling platforms would not mask the high-frequency echolocation signals of beluga or other toothed whales (Gales, 1982). Theoretically, very noisy drill platforms may slightly mask low-frequency whale sounds out to a range of 35 miles (56 km), but the possible masking range would more likely be limited to about 3 miles (4.8 km) (Gales, 1982). If the distance between communicating whales does not exceed their distance from the platforms, no appreciable interference is likely to occur (Gales, 1982). Experiments exposing captive beluga whales to recorded drilling sounds suggest that whales can acclimate quickly to typical oil-drilling sound levels (Aubrey et al., 1984). Informal observations of beluga whales near drilling platforms in Cook Inlet support this suggestion (McCarty, 1981).

Intense noise could damage the hearing of marine mammals or cause other physical or physiological harm (Geraci and St. Aubin, 1980; Hill, 1978). Probably the most intense noise that was associated with offshore industrial activity was the use of explosives in seismic-survey work (generally no longer used in seismic exploration). The sound pressure from these sources is very high and might physically injure or kill marine mammals near the explosion site. However, if spherical spreading of sound pressure is assumed, the pressure would fall below a harmful level at 2,752 meters (3,000 yards) from the source, and nonauditory effects would be unlikely (Gales, 1982). Loss of hearing or auditory discomfort still may occur at greater distances from this potential noise source. Noise levels measured from various existing drilling platforms are generally well below a level of high sensitivity (for toothed cetaceans such as beluga whales and pinnipeds such as harbor seals) at a distance of 15 meters from the platform (Gales, 1982). This information suggests that drilling operations are not likely to cause any annoyance to nonendangered cetaceans and pinnepeds except perhaps to individuals passing very close to the platforms. The playback of recorded industrial noises in the presence of breeding ringed seals indicated no effect or no reduction in ringed seal vocalizations or other sounds made by the seals (Cummings et al., 1984).

Frequent and/or intense noise that causes a flight or avoidance response in marine mammals could permanently displace animals from important habitat areas. However, the monitoring of beluga behavior and distribution for the past 10 years in the Mackenzie River Delta estuary (in association with marine traffic supporting Canadian oil and gas activities) has not shown any long-term or permanent displacement from the estuary even with present comparatively high levels of industrial activity (Fraker, 1983). The presence of several thousand beluga whales, seals, and walruses in Bristol Bay during intensive commercial fishing activity and their exposure to noise from numerous fishing boats suggests that these species and perhaps other marine mammals can habituate to fairly high levels of human activity.

Noise could cause disruption of reproductive activities such as displacement of ringed seals from important denning and pupping habitats. A comparison of ringed-seal densities between areas of seismic exploration and areas where no on-ice seismic activities occurred (using aerial data collected in June 1975 to 1977 to investigate variation in ringed seal distribution) showed a lower density of seals in areas where there had been seismic exploratory activity (Burns, Shapiro, and Fay, 1980). However, such survey data are only an indication of overall survival through the long winter-spring period and provide no insight into the nature, extent, or causes of changes recorded (Burns and Kelly, 1982). Results of surveys conducted in 1981 were ambiguous as far as determining whether seismic exploration results in displacement of ringed seals (Burns, Kelly, and Frost, 1981). Burns and Kelly (1982) conducted ground examination of ringed seal-den structures to determine the fate of such structures along seismic lines and along control lines. The latter investigators reported no significant overall difference in the fates of den structures between seismic and control lines; however, they reported significant differences in the fates of den structures in relation to distance from seismic lines (within 150 m of the shot line in comparison to beyond this distance). The investigators concluded that displacement of seals in close proximity (within 150 m) to seismic lines does occur. However, based on data from aerial surveys in 1982, there is no large-scale displacement of seals away from on-ice seismic operations as currently conducted in the Beaufort Sea.

(c) Site-Specific Noise and Disturbance Effects: The primary sources of noise and disturbance of ringed, bearded, and spotted seals; walruses; polar bears; and beluga whales would come from the air and marine traffic associated with the proposal and more specifically from the supply boats, icebreakers, and helicopters associated with the assumed one to three exploration-drilling units and two production platforms. Geophysical on-ice equipment, geophysical seismic boats, the onshore pipeline, and additional support facilities assumed for the proposal also would be primary noise sources (see Secs. II.A.2 and 3). Secondary disturbance sources would be low-frequency noises from drilling operations on the production platforms. Aircraft traffic (90 to 270 trips/year during exploration) centered out of Deadhorse, traveling to and from drilling platforms, 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. Exploration drilling would take place from bottom-founded and floating drilling units; depending on ice conditions, the floating units would be supported by one or more vessels with icebreaking capabilities.

Exploration drilling from drillships in the deeper water tracts may coincide with the beluga whale fall migration through the offshore areas along the pack-ice front. Icebreaker traffic has been demonstrated to disturb beluga whales within 35 to 50 kilometers of the vessel (Finley and Davis, 1984). Other than flight responses, the meaning or importance of behavioral changes correlated with the sound and presence of boats is uncertain. Boat traffic could interfere with migration when the vessels are near marine mammal concentrations within a lead system; and it may temporarily interrupt the movements of beluga whales, seals, and walruses or displace some populations 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 MINOR effects on marine mammal migrations or distributions, but the displacement of pinnipeds, polar bears, and beluga 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 exploration drilling units (90 to 270 helicopter trips a year) to and from production platforms (1,215 helicopter trips per year) could greatly 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. If walrus nursery herds hauled out on the ice in the western part of the sale area during the summer through fall period (July through September) are greatly disturbed by low-flying aircraft, injury or death to young calves could result from the stampede of cows into the water. Disturbance of walrus nursery herds also may cause abandonment of calves by walrus cows. Although air-traffic disturbance would be very brief, the effect on individual walruses, particularly calves, could be severe. The number of walruses and seals affected would depend on the number of disturbance incidents (one or two aircraft flights per day to two platforms). The walrus nursery herds are widely distributed along the ice front and along lead systems during spring migration; thus, aircraft traffic to and from the drill platforms is not likely to disturb a major portion of the calving population. However, MINOR effects on portions of the walrus calf population are expected. 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 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 may reduce the longevity of some seals if disturbances were frequent.

(3) Effects of Geophysical Seismic Activities: Approximately 800 to 28,100 kilometers of geophysical seismic surveys using about two vessels per year have been conducted annually over the past 10 years in the Beaufort Sea Planning Area during the open-water season, and 0 to 5,900 kilometers of over-ice surveys were conducted during the winter season. For shallow-hazard site-clearance surveys, an estimated 578 seismic-line kilometers (covering 345 km^2) would be conducted during the exploration-well-drilling phase and an estimated 604 seismic-line kilometers (covering 184 km^2) would be conducted prior to installation of the production platforms (see Secs. II.A.2 and 3).

Ringed seals pupping in shorefast-ice habitats within about 150 meters 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 could possibly be killed as a result of this level of disburbance is likely to be less than a few hundred, considering the low density of breeding seals in the Beaufort Sea, and is expected to have no more than a MINOR effect on the population.

An estimated 800 to 28,000 kilometers of open-water seismic lines at several survey sites (based on past seismic activity), using perhaps two seismic boats per year, could disturb pinnipeds, polar bears, and belugas during the 2 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 beluga 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 not expected, given the expected amount of vessel traffic associated with the proposal. 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.2.a, Effect on Subsistence). Overall, noise and disturbance from air and marine traffic associated with the proposal are expected to have MINOR or short-term effects on marine mammal populations.

(4) Effects of Offshore Construction: Under the assumed development scenario, one to three exploration-drilling units per year (1989-1994) and two oil-production platforms are to be used in the sale area. One artificial island for oil exploration would be built in the sale area within the 20-meter isobath by barging and deposition of about 1,196,000 cubic meters of gravel-fill material. Using 10 barges to make 2 trips per day, construction would take about 40 days. Gravel deposition and dredging during artificial-island construction, platform-site preparation, and pipeline trenching (or dredging) and burial could affect marine mammals through noise and disturbances, habitat alterations (2,370 hectares of benthic habitat representing less than 1% of the benthic habitat in the sale area affected by pipeline trenching), and temporary changes in availability of food sources. Some pinnipeds, polar bears, and beluga whales could be temporarily displaced by noise and disturbance from the gravel barging associated with construction of a gravel island and with support traffic. Displacement could occur within 2 to 3 kilometers of the activity site and along the gravel-barge route during construction operations (USDOI, MMS, 1982). Prey species could be temporarily disrupted or buried by gravel deposition within several kilometers downstream of the gravel-island-construction site and near the pipeline-trenching and platform-preparation sites (see Sec. IV.B.1.a). During construction, some marine mammals could be temporarily displaced for approximately one season near platform-installation sites and along the estimated 160-kilometer pipeline-burial path. In theory, marine mammals could continue to be disturbed and perhaps migration movements and habitat use could continue to be diverted a few kilometers away from the platforms over the life of the field, possibly representing a MODERATE effect. However, the amount of displacement and change in habitat use is likely to be very small in comparison to the natural variability in seasonal habitat use and variations in migration patterns. Noise-disturbance and adverse-habitat effects associated with dredging and artificial-island construction are expected to be MINOR.

(5) Effects of Onshore Construction: Onshore landfall development for pipelines to TAP may take place at Oliktok Point and Point Belcher with 20-kilometer and 160-kilometer-long onshore pipelines connecting with existing and potential onshore pipeline from the Kuparuk Field and NPR-A, respectively. During construction, this development could disturb and perhaps displace a small number of seals and polar bears within a few kilometers of 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. Onshore-development effects on regional marine mammal populations are expected to be MINOR, with any disturbance of seals and polar bears declining after construction activities are complete.

(6) Summary: Oil spills; noise and disturbance due to increased human activity; and habitat alterations from artificial-island, causeway, pipeline, and onshore construction could have some adverse effects on pinnipeds, polar bears, and beluga whales found in the lease-sale area. There is an 82-percent chance of one or more oil spills of 1,000 barrels or greater occurring under the proposal. Potential oil spills pose the greatest risk of contact to all marine mammals in the Point Barrow offshore area (Spring-Migration Area) and in the Smith Bay to Camden Bay offshore ice-flaw-zone habitat (Fig. IV-14). 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 minor sublethal effects. A few breeding ringed seals and their pups are likely to be contaminated by a winter oil spill resulting perhaps in the death of a few pups or no more than 100 (due to their sparse distribution). Polar bears also would be most vulnerable to oil spills in the ice-flaw zone; however, few bears are likely to be affected due to their sparse distribution. 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 expected to be MINOR, because healthy walruses are not likely to die from oil-spill contact. In a severe event, contamination of benthic food sources and feeding habitats could reduce winter survival of several animals the following year and possibly reduce herd productivity for that year. This is likely to be a MINOR effect on the population. Beluga whales are most vulnerable to oil-spill effects during spring migration off Point Barrow. The western Beaufort Sea population of belugas is likely to have some contact with hydrocarbons in the water column or on the surface if an oil spill contaminates the lead system off Point Barrow during spring migration. However, few beluga whales are likely to be seriously affected by probable brief exposure to the spill. 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 few polar bears could die if a spill occurred. This would have no more than a MINOR effect on the Beaufort Sea populations.

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 beluga whales. Helicopter trips and boat traffic to and from drilling units and production platforms could greatly disturb hauled out ringed, bearded, and spotted seals and walruses, causing them to charge in panic into the water and 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 effects are expected to be MINOR.

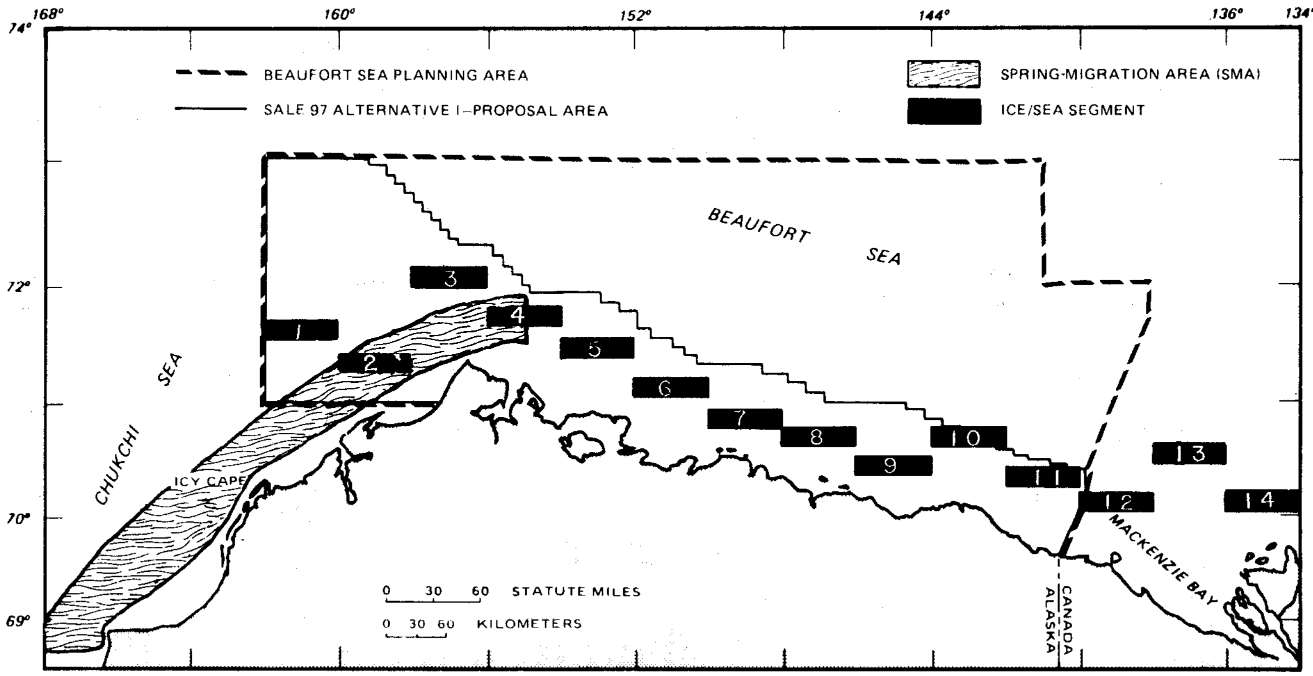
Vessel traffic supporting the drilling units or production platforms and seismic vessels operating during the open-water season could temporarily displace or interfere with any marine mammal migration and distribution for a few hours to a few days. This is expected to have a MINOR effect on pinnipeds, polar bears, and beluga whales.

Industrial noise may have other potential effects such as masking marine mammal communication and interfering with echolocation. It is unclear whether these effects would occur or if marine mammals would adjust to industrial noise. However, the continued presence of dolphins, porpoises, and seals in coastal marine habitats with high levels of industrial activity and continuous marine traffic strongly suggests that nonendangered marine mammals are able to tolerate fairly high levels of manmade noise and disturbance. Present knowledge of the behavior of marine mammals in association with industrial noise sources suggests that effects of disturbance on pinnipeds, polar bears, and beluga whales are likely to be MINOR. Gravel-deposition, dredging, and construction activities associated with the proposal (construction of islands, causeways, and offshore pipelines) are likely to have short-term or MINOR effects on marine mammals. The combined effects of oil spills, noise and disturbance, and habitat alterations are expected to be MINOR.

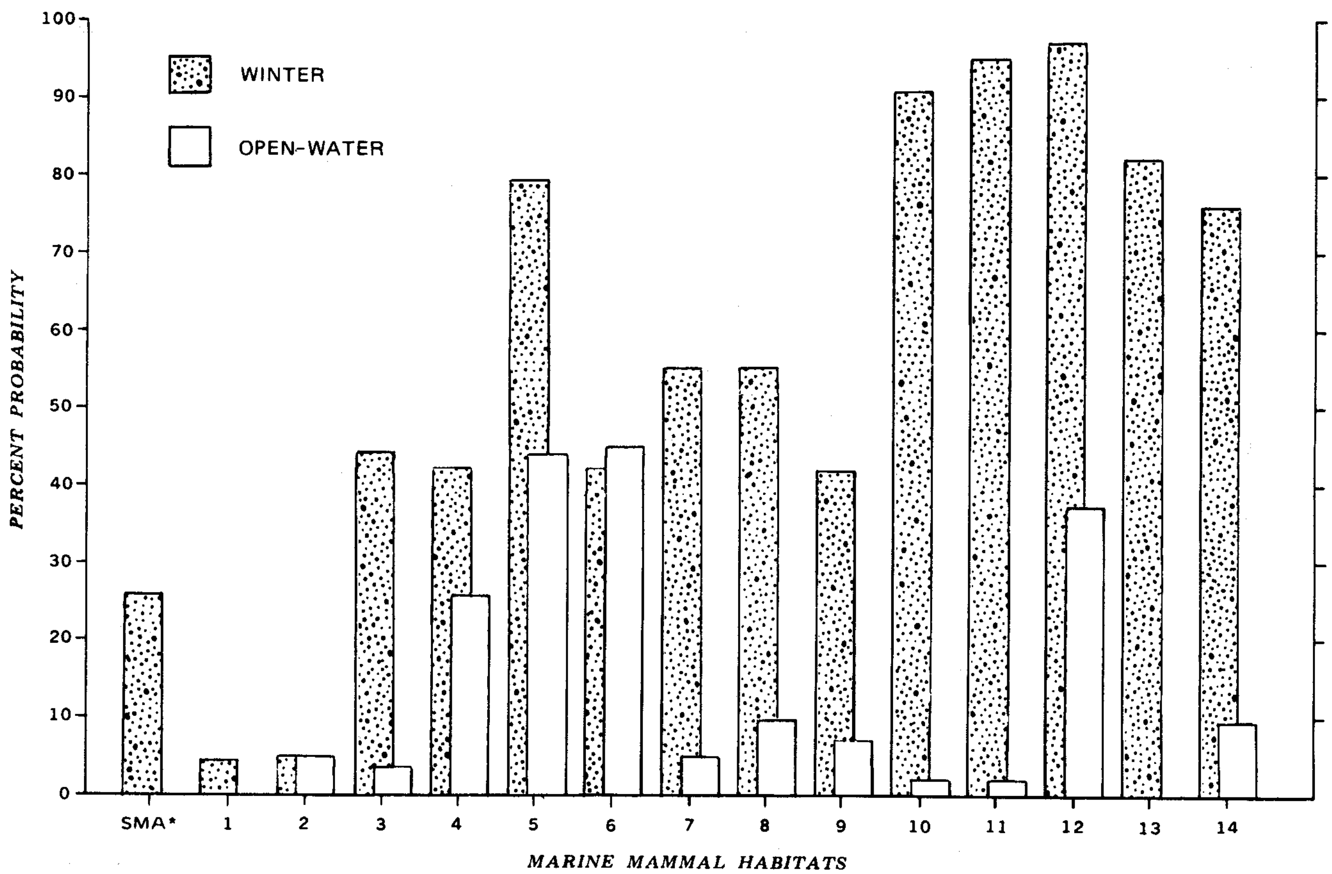
(7) Conclusion: The combined effects on ringed, bearded, and spotted seals; walruses; polar bears; and beluga whales from activities associated with the proposal are expected to be MINOR.

b. Cumulative Effects: The additive effects of other ongoing and planned projects, as well as the proposal, on ringed, bearded, and spotted seals; walruses; polar bears; and beluga whales are discussed in this section. Although the probability of any or all planned and ongoing projects reaching developmental stages is generally unknown, this analysis assumes that all the OCS projects (listed on Table IV-A-7) do reach developmental stages. These projects could affect marine mammals by oil spills, noise and disturbance, and by habitat alteration.

(1) Effects of Oil Spills: Winter and open-water-season oil-spill-contact risks to offshore marine mammal habitats from cumulative oil and gas activities in the Beaufort Sea were compared with spill-contact probabilities from the proposal (Figs. IV-14 and IV-15). Cumulative oil-spill risks to marine mammal habitats increase substantially over the spill risks from the proposal, particularly during the winter season. Cumulative oil-spill-contact risks to ice-flaw-zone habitats (Ice/Sea Segments 10 through 14, Fig. IV-15) east of Camden Bay are attributed primarily from Canadian oil and gas activities. The increase in spill risk to flaw-zone habitats from Camden Bay west to Point Barrow (Ice/Sea Segments 3 through 9, Fig. IV-15) are attributed to oil activities associated with Federal OCS Sales 87, 71, and BF and Endicott and Canadian oil development. Cumulative probabilities of spill contact to the Spring-Migration Area (SMA, Fig. IV-15) include contacts during April 1 to June 15 only. Spills that occur during the open-water season (summer) or that occur during the winter and persist in the sale area after meltout pose the highest risk to marine mammal flaw-zone habitats offshore of Smith Bay, Harrison Bay, and the Herschel Island area (Ice/Sea Segments 5, 6, and 12, respectively, Fig. IV-15). During the winter season, nonbreeding ringed seals, bearded seals, and polar bears could be exposed to cumulative



MARINE MAMMAL HABITATS



*SMA—Spring-Migration Area (contact probability for April 1 to June 15 only)

FIGURE IV-15. COMBINED PROBABILITY OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS (SMA AND ICE/SEA SEGMENTS) DURING THE ENTIRE WINTER SEASON COMPARED WITH EXPECTED PRODUCTION LIFE OF THE LEASE AREA (CUMULATIVE CASE) oil spills that contact the ice-flaw-zone habitat or the SMA 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 beluga whales in the far western Beaufort Sea could be exposed to spills that contact the flaw-zone habitat. Potential oil spills from offshore oil activities associated with Federal, State, and Canadian leases could have the most noticeable effects on pinnipeds--perhaps several thousand pinnipeds and small numbers of polar bears could be contaminated as a result of oil spills over the life of these projects. However, these species are likely to suffer low mortality rates from oil-spill contamination, resulting in the death of only very young seal pups, a few polar bears and walrus calves, and perhaps highly stressed adult pinnipeds; these effects are likely to be MINOR to marine mammal populations. The estimated cumulative oil spills are likely to have MINOR effects on pinniped and polar bear populations and NEGLIGIBLE effects on beluga whales, which are not likely to be affected by oil spills (see above discussion under oil-spill effects of the proposal). Regional populations of marine mammals are likely to replace the small numbers of individuals lost to oil spills within one generation.

(2) Effects of Noise and Disturbance: Cumulative noise and disturbance of breeding ringed seals from on-ice seismic surveys are likely to have MINOR effects on ringed seals, since only a small percentage of the population (perhaps 3-5%) 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 proposal). Noise and disturbance of beluga whales during spring migration from cumulative icebreaker and vessel traffic are likely to have MODERATE effects on the whales if spring migration of a portion of the whale population were delayed due to frequent vessel traffic in the ice-lead system, resulting in reduced availability of summer-feeding and -molting habitats (see Effects of Noise and Disturbance under the proposal). Cumulative noise and disturbance effects on other nonendangered marine mammals occurring in the Beaufort Sea from over 450 helicopter trips per year and perhaps over 200 vessel trips per year are expected to be MINOR because the disturbance reactions of pinnipeds, polar bears, and beluga 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. MODERATE disturbance effects on polar bears are likely (see Effects of Airborne Noise under the proposal) if all coastal denning areas in Alaska and some maternity dens on the sea ice were abandoned because of noise and human presence near denning areas.

(3) Effects of Habitat Alteration: About 40 exploration-drilling units have been installed or constructed in the Beaufort Sea in association with cumulative 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. Dredging and gravel-fill deposition have had MINOR to perhaps MODERATE effects on some benthic organisms but have had NEGLIGIBLE effects on the availability of the widely distributed and abundant prey of marine mammals. Exploration-drilling units and future production platforms throughout the Beaufort Sea 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 very MINOR effects on pinniped distribution. Natural variation in ice conditions and resulting changes in pinniped, polar bear, and beluga whale distribution are likely to reverse or overcome any local reduction in the distribution of these species associated with cumulative exploration and production platforms.

In summary, cumulative habitat alterations associated with platform construction or installation, dredging, pipeline burial, and causeways are expected to have local MINOR to MODERATE effects on some benthic organisms and some fish species but are likely to have NEGLIGIBLE effects on the availability of marine mammal food sources. Exploration-drilling units and production platforms could have very local effects on ice conditions and subsequent MINOR effects on marine mammal distribution.

(4) Overall Cumulative Effects: Pinnipeds, polar bears, and beluga whales are likely to suffer low mortality rates from oil-spill contamination, resulting in the death of only very young seal pups, a few polar bears and walrus calves, and perhaps highly stressed adult pinnipeds and beluga whales. These effects are expected to be MINOR to pinniped and polar bear populations and NEGLIGIBLE to beluga whales. Noise and disturbance reactions of pinnipeds, polar bears, and beluga whales are likely to be brief, with the affected animals returning to normal behavior patterns and distribution within a short period of time after boats and aircraft have left the area. Cumulative noise and disturbance effects are likely to be MINOR, although MODERATE effects on beluga whales from icebreaker noise and MODERATE disturbance effects on denning polar bears are possible. Cumulative habitat alterations associated with platform construction or installation, dredging, pipeline burial, and causeways are likely to have NEGLIGIBLE effects on the availability of marine mammal food sources and MINOR or temporary effects on marine mammal distribution.

(5) Conclusion: Cumulative exploration and development and production activities from the above projects and the proposal are likely to have MINOR effects on pinnipeds, polar bears, and beluga whales occurring in the Beaufort Sea.

5. Effects on Endangered and Threatened Species: The effect of Sale 97 on endangered and threatened species is discussed by reviewing pertinent Endangered Species Act (ESA) consultations and by examining potential effects of oil and gas exploration and development on the bowhead whale, gray whale, and arctic peregrine falcon, listed species likely to be present in the sale area. (Also, see Sec. IV.I for a worst-case analysis on the bowhead whale.)

a. Endangered Species Act (ESA) Consultations: Pursuant to requirements under the ESA of 1973, as amended, the Alaska OCS Region, MMS (formerly the Alaska OCS Office, BLM), has consulted with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) on previous Beaufort Sea lease sales (BF, 71, 87). NMFS returned nonjeopardy opinions for the gray whale in each of these previous sales. Insufficient information was available to render a nonjeopardy opinion on the bowhead whale for Sales BF and 71. For Sale 87, NMFS determined that the bowhead whale is likely to be jeopardized by an uncontrolled blowout or major oil spill when the species is directly affected by the spill, when noise disturbance along its migratory path interferes with migration, or when noise interferes with feeding activity. Consultation for Sale 97 was initiated with the NMFS on July 17, 1985. On May 20, 1987, MMS received the Sale 97 biological opinion from the NMFS. In it, the NMFS concluded that the leasing and exploration phases of Sale 97 would not likely jeopardize the continued existence of any marine species. However, based upon currently available information and technology and the absence of effective mitigating measures, development and production activities in the spring lead systems used by bowhead whales for their migration would be likely to jeopardize the population. Reasonable and prudent alternatives were included that could be adopted to avoid this potential jeopardy situation (see Appendix J).

Consultations with the USFWS on previous lease sales have resulted in nonjeopardy opinions on the arctic peregrine falcon. Consultation with the USFWS for Sale 97 was initiated by MMS on July 17, 1985. A nonjeopardy biological opinion on the arctic peregrine falcon was issued by the USFWS on July 30, 1985 (see Appendix J).

b. Effects on the Bowhead Whale:

(1) Effects of the Proposal: The OSRA is used in this analysis to assess the vulnerability of bowhead whale habitat to contact by oil spills. Appendix F, Tables F-15 to F-30, show the combined probabilities of oil-spill risk to given target areas (the probability of one or more spills occurring and contacting identified resource areas). Combined probabilities assume exploration and development and production over the expected life of the lease area. Unless otherwise noted, combined probabilities during the open-water season referenced in this discussion refer to occurrence and contact by one or more spills of 1,000 or more barrels of oil during a simulated 10-day period following a spill or after meltout of a winter spill. (Refer to Fig. IV-16 for descriptions of spill-launch points and endangered whale-habitat areas.)

Areas of bowhead whale habitat most vulnerable to occurrence and contact by one or more oil spills when bowheads are present (April through mid-June) would include the Bowhead Spring-Migration-Corridor A (13% probability of occurrence and contact) and B (26%) (Table F-15) and the Bowhead Fall-Feeding-Area A (14%) (Table F-19). All other bowhead habitat areas would have less than a 10-percent probability of oil-spill occurrence and contact. The probability of one or more spills of 100,000 barrels or more occurring and contacting the Bowhead Spring-Migration-Corridors A and B and the Bowhead Fall-Feeding-Area A while bowheads are present would be 1 percent, and the probability of contact with other bowhead habitat areas while whales are present would be negligible (Tables F-23 and F-27).

Assuming bowhead whale habitat is contaminated with spilled oil while bowheads are present, some whales could experience one or more of the following: skin contact, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the 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 and duration of the spill, the density of the whale population in the area of the spill, and the whales' ability or inclination to avoid contact with oil. Unless whales stopped to feed in the area of a spill or were trapped in a lead into which oil was

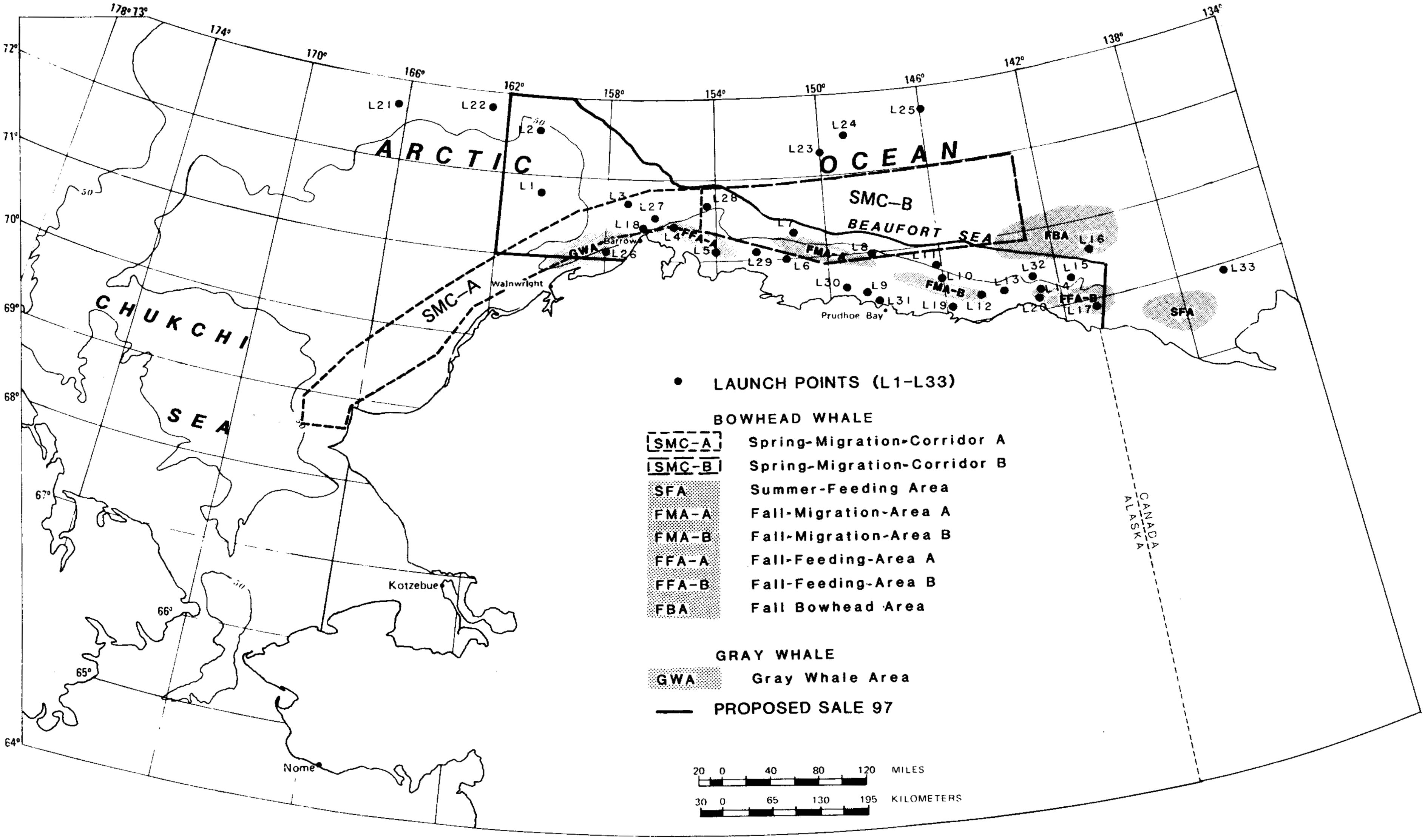


FIGURE IV-16. STUDY AREA, SPILL-LAUNCH POINTS, AND ENDANGERED WHALE-HABITAT AREAS DISCUSSED IN OIL-SPILL-TRAJECTORY ANALYSIS spilled, contact with oil would be brief. Even a large spill of 10,000 barrels under open-water conditions is predicted to produce a slick which, after 10 days, would cover only 1 to 2 square kilometers (Appendix C, Table C-1). Bowheads migrating at an average speed (about 3 km/hour) would be expected to pass through the discontinuous oiled area in less than 4 hours and of this time would pass through or under actual oil slicks for less than 5 minutes. No more than several hundred bowheads would be exposed to lightly-weathered oil from a spill of short duration, since the migration continues for approximately 2 months through any one area; and after several days the spill should have moved out of the whale-migration corridor, and weathering should render the oil relatively harmless to the whales. If a prolonged spill (such as an uncontrollable blowout) were to occur at the start of the bowhead migration, most of the whale population could be exposed to lightly-weathered crude oil. This event would be extremely unlikely. During the period 1971 through 1983 (the period for which statistics are available), over 13,000 OCS wells were drilled; only a fraction of these wells were drilled in the Arctic region. No oil was spilled as a result of drilling blowouts, and less than 1,000 barrels were spilled as a result of nondrilling blowouts (USDOI, MMS, 1984b).

Should oil be released in Alaskan waters being used by bowhead whales, whales are most likely to contact oil as they surface to breathe. Oil is unlikely to adhere to smooth areas of bowhead skin, and any effects are likely to be transient (Geraci and St. Aubin, 1982; Hansen, 1985). Oil may adhere to rough areas on the skin surface of bowhead whales; some oil adherence to preserved skin lesions was reported in lab tests (Haldiman et al., 1981). Albert (1981) suggested that oil adherence to bowhead-skin lesions may aggravate existing localized areas of an epidermatitis condition, possibly resulting in ulceration with subsequent entry of resident bacteria into the bloodstream or, alternatively, crude oil may kill the bacteria in these lesions. The length of time that oil may adhere to rough-skin features would be variable. Within a short period of time, it is probable that most of the oil would be washed off of the skin and body surface. In the very unlikely case that oiled whales had to remain within an oil-slick area because of ice or other conditions, oil might adhere to the skin and other surface features (such as tactile hairs) for longer periods of time and result in the adverse effects previously mentioned (aggravated epidermatitis, ulcerations, etc.) (Hansen, 1985).

Interaction between feeding bowhead whales and oil spills could result in oil fouling of the fine fringe filaments of the baleen plates. In laboratory flow-through experiments, the filtration efficiency of bowhead whale baleen was reduced 5.9 to 11.3 percent after contact with crude oil. Bowhead baleen plates fouled with 10 millimeters of Prudhoe Bay crude oil showed a decrease in filtering efficiency that persisted for as long as 30 days, but 8 hours after fouling, the filtering efficiency began to increase (Braithwaite et al., 1983). If baleen fouling occurred, it could make bowhead feeding less efficient; however, oil would be continually flushed off the baleen if bowheads fed in oil-free waters. Prolonged impairment caused by repeated baleen fouling could affect feeding activity and possibly result in reduced blubber deposition. This could affect the health and survival of bowheads during migration or overwintering or during pregnancy or lactation.

If bowheads contacted an oil slick, it is unlikely that they would inhale oil into the blowhole while breathing (Geraci and St. Aubin, 1980); however, bowheads surfacing in a spill of lightly weathered oil could inhale some petroleum vapors. Inhaled petroleum vapor could result in pulmonary distress. Perhaps the most serious situation that could occur is if oil were spilled into a lead from which bowheads could not escape. In this case, whales could die or suffer pulmonary distress from the inhalation of toxic vapors. The probability of such an occurrence is extremely low; generally only a small fraction of the bowhead population would likely occupy the affected lead at any given time and thus possibly be subject to mortality. Vapor concentrations in the spill area that could be harmful to whales would be expected to dissipate within several hours after termination of a spill (Geraci and St. Aubin, 1982). If the spill were to continue for a long period of time, such as during an uncontrollable blowout, the toxic-vapor effects would be prolonged.

While feeding, bowhead whales sometimes skim the water surface, filtering large volumes of water for extended periods, and consequently could ingest some spilled oil if any were present. The effects of oil ingestion on whales probably depend on the quantity and toxicity of ingested hydrocarbons. Based on studies involving fuel oil ingestion by rats, Geraci and St. Aubin (1986) extrapolated the volume of fuel oil an adult bowhead would need to consume to be at risk. This quantity, about 200 to 625 liters, is well beyond the limit of what might be accidentally consumed by a cetacean at sea. Uninterrupted feeding on contaminated prey for several days could pose a threat; however, bowheads possess enzymes capable of metabolizing or detoxifying small quantities of ingested oil (Hansen, 1985), and within a few days, planktonic organisms lose their burdens of ingested oil without retaining any residual fractions (Neff et al., 1976).

Albert (1981) found baleen filaments in the gastrointestinal tracts of bowhead whales and suggested that ingested oil, and long baleen filaments that break off of the baleen plates and are swallowed, may clump together to form a gastrointestinal obstruction. However, it is likely that any small quantity of ingested oil would be broken down by digestive processes and would not block the intestine (Hansen, 1985).

For the most part, bowhead whales feed on pelagic zooplankton, although they apparently do occasionally feed on benthic amphipods (Hazard and Lowry, 1984; Lowry and Frost, 1984; Wursig et al., 1984). Pelagic zooplankton populations, with the exception of localized population centers, are generally considered to be largely unaffected by oil spills (Richardson et al., 1983); if a spill occurred, the affected food sources would likely recover through recruitment from unaffected areas. If oil were to reach the seafloor in a substantial quantity, bowhead benthic food sources could be reduced through the death of benthic organisms or through sublethal effects such as reduced fecundity and larval settlement or a change in species composition. However, following a spill in offshore areas (such as Georges Bank), the dilution of oil-contaminated sediments could be sufficient so as to cause little harm (Robert W. Howarth, personal communication, 1984). Bowheads could ingest some oil-contaminated prey items, but it is likely these organisms would comprise only a small fraction of the bowheads' food intake. Furthermore, bowheads may be capable of metabolizing and excreting polynuclear aromatic hydrocarbons from oil, so it is possible that petroleum hydrocarbons might not accumulate to harmful levels in bowhead tissues (Edward Overton, personal communication, 1985).

Bowhead whales have not been observed in the presence of an oil spill, so it is uncertain if they would avoid surfacing in the oil. Other baleen whales, possibly including the closely related right whale, were seen surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts. No attraction to or avoidance of the oil, or unusual behavior, was displayed by these whales (Goodale, Hyman, and Winn, 1981).

There could be a number of small habitat alterations as a result of Sale 97. Predictions are that one to two drilling units per year will be used in exploration, and two production platforms are projected for later years. Bowheads should be capable of detecting sounds produced on these structures; consequently, these structures should not pose a collision threat to bowheads feeding in or migrating through the sale area. Discharges of fluids from drilling units and production platforms should not significantly decrease bowhead food resources (Richardson et al., 1983). Artificial-island construction would result in the burial of about 0.1 square kilometer of benthic habitat, which would minimally affect bowhead food resources. Some turbidity would be present in the vicinity of the artificial island during construction; however, it is anticipated that the turbidity plume would, at most, occupy a rather narrow band for several kilometers down-current of the construction site, and no adverse effects on the bowhead are anticipated. Approximately 160 kilometers of offshore pipeline would be laid to transport oil from Sale 97 platforms to a shore base. The pipeline would be buried to prevent damage by the keels of drifting ice masses and current scouring. Trenching for the pipeline would disturb about 24 square kilometers of benthic habitat. It is unlikely that bowheads would experience significant effects as a result of pipeline installation, since benthic-feeding habitat disturbed would be insignificant in comparison with the total amount available. Should pipeline installation continue into the fall-migration period, whales may avoid approaching within a few kilometers of the vessels involved in pipe laying. The fall bowhead migration would likely be affected to a minimal degree by this activity.

Noise-producing activities most likely to affect bowhead whales would include aircraft traffic, icebreaking or other vessel traffic, geophysical-seismic surveys, artificial-island construction, drilling operations, and production.

Bowheads may respond to aircraft presumably from sound transmitted into the water and possibly from the physical presence of the aircraft. The most common response of bowheads to low-flying aircraft is a hasty dive as the aircraft first approaches (Ljungblad et al., 1983; Richardson, Wells, and Wursig, 1985). Other reactions may include changes in orientation and behavior or dispersal (Richardson, Wells, and Wursig, 1985). On occasion bowheads seemed to move away in response to an aircraft circling at altitudes less than or equal to 457 meters (Richardson, Wells, and Wursig, 1985).

Factors that influence the sensitivity of bowheads to aircraft disturbance include the altitude of the aircraft, the ensonification levels in the water, and the behavior the whales are engaged in. Except in shallow water, bowheads generally are undisturbed by aircraft flying at altitudes greater than 457 meters above sea level (Richardson, Wells, and Wursig, 1985). Bowheads present in shallow water or near the shore (some in water less then 10-m deep and less than 1 km from shore) seemed more sensitive to disturbance by aircraft, possibly due to the greater lateral propagation of underwater sound in shallow water (Richardson, Wells, and Wursig, 1985). Bowheads engaged in feeding, socializing, or mating behavior generally seemed less sensitive to aircraft disturbance than those displaying other behaviors (Richardson, Wells, and Wursig, 1985; Ljungblad, Moore, and Clarke, 1984).

Bowheads have occasionally shown disturbance reactions as a result of helicopter overflights, although there are few recorded observations of bowhead behavior in the presence of helicopters. Dahlheim (1981) stated that, during early spring, bowheads were rarely disturbed by Sikorsky H-52A turbine-powered helicopters flying surveys at 152 to 228 meters above sea level. Richardson, Wells, and Wursig (1985) reported no overt bowhead responses to single helicopter passes on five occasions and concluded that single helicopter passes at low altitudes may reduce blow intervals temporarily, as does a fixed-wing aircraft circling at low altitude; however, occasional single passes by helicopters are unlikely to produce significant or long-term reactions by bowhead whales.

Helicopter trips for Sale 97 exploration- and delineation-well drilling are estimated to range from 90 per year during years when 1 well is drilled to 270 per year when 3 wells per year are drilled (an average of 1 round trip per day per drilling unit). Helicopter operations would continue at this same rate during the drilling of production and service wells. Many of these flights would occur during seasons when bowheads are not present. During exploration, helicopter flights would more likely occur during the fall--when ice conditions are less severe--than during the spring-migration period. However, helicopters could be used year-round to support exploration drilling from up to two bottom-founded drilling units and to support development and production. If whales were present, some would probably dive quickly in response to aircraft sound; but this sound generally is audible for only a brief time (less than 90 seconds) (Greene, 1985), and the whales should within minutes resume their normal activities. Because very few whales would likely be overflown on any given day and the aircraft noise and whale behavioral responses would be brief, it is unlikely that bowhead whales would be adversely affected on a long-term basis by the helicopter and aircraft operations projected for Sale 97.

Bowhead reaction to close approach by vessels appears greater than bowhead reaction to other industrial activities. In the Canadian Beaufort Sea, bowheads observed in vessel-disturbance experiments began to orient away from an oncoming vessel at a range of up to 4 kilometers and to move away at increased speeds when approached closer than 2 kilometers. Vessel disturbance caused a temporary disruption of activities and sometimes disrupted social groups, as groups of whales sometimes scattered when a vessel approached. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering persisted for a longer period. Based upon experimental observations, bowheads appear to be more sensitive to vessel traffic than some other whale species and may be displaced by repeated vessel disturbance (Richardson, Wells, and Wursig, 1985).

During exploration, vessel traffic associated with Sale 97 would be limited to routes between the exploratory-drilling units or production platforms and the shore base. Each drilling unit probably would have one vessel remaining nearby for emergency use, and one vessel per month would stop at each drilling well to drop off supplies. Depending upon ice conditions, floating drilling units may have two to three icebreaking vessels standing by to perform ice-management tasks. Units drilling production and service wells would be supplied by vessels about once every 2 weeks during the open-water period. There would probably be two to three support vessels associated with pipeline installation.

Bowhead whales probably would encounter vessels associated with activities that could result from the lease sale during their fall migration or while feeding in the eastern Alaskan Beaufort Sea. Spring-migrating bowheads (April to June) are expected to encounter few, if any, vessels along their migration route since ice at this time of year would typically be too thick for drillships and supply vessels to operate in. 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 (Fraker et al., 1982). In either case, bowheads probably would avoid approaching within several kilometers of vessels attending a drilling unit and probably would move away from vessels that approached within a few kilometers. Consequently, bowhead whales would be expected to adjust individual migration paths in order to avoid closely approaching vessels associated with lease-sale-related operations. Bowheads may also avoid feeding within several kilometers of a drilling unit while attended by vessels. Vessel activities associated with the sale are not expected to disrupt the bowhead migration, and small deflections in individual bowhead-migration paths and a reduction in use of one to several small areas of bowhead-feeding habitat (estimated at less than 150 km^2) should not adversely affect the species.

Sound from seismic exploration is another source of noise disturbance to bowhead whales. Seismic surveys produce loud sounds that can propagate long distances from their source. Seismic surveys can be of two types: low-resolution, deep-seismic and high-resolution, shallow-seismic surveys. Low-resolution surveys are broad-scale surveys used to study deep geologic formations. These surveys typically are conducted using vessels with a seismic array that has 20 or more airguns. Maximum sound-source levels are about 245 to 252 decibels relative to 1 microPascal at 1 meter. These surveys generally are conducted prior to a lease sale in a specific area and permitted under a Geological and Geophysical permit. After a sale, lessees conduct high-resolution seismic surveys on their leases to evaluate potential shallow hazards to drilling. Nearly all seismic systems used for these surveys have sound-source levels below 167 decibels relative to 1 microPascal at 1 meter (Shearer, personal communication, 1986).

Shallow-hazard seismic surveys for exploration-delineation-well sites would be conducted during the ice-free season. The total seismic activity associated with Sale 97 is estimated to take 40 days to cover 963 seismic-line kilometers in an area of 345 square kilometers.

Observations on 21 occasions in the Canadian Beaufort Sea showed that bowheads exposed to noise pulses from seismic vessels 6 to 99 kilometers distant engaged in normal activities including surfacing and diving, calling, and sometimes traveling, socializing, and feeding. There was little evidence that bowheads oriented away from these vessels. There is some evidence that bowhead surface-respiration/dive cycles may have been altered subtly in the presence of noise from seismic vessels farther than 6 kilometers away, but reactions of whales were weak and barely detectable (Richardson et al., 1985a). In five experiments where bowheads were approached by active seismic vessels to within 5 kilometers, the whales reacted by orienting away and moving away from the vessel (Ljungblad et al., 1985a; Richardson, Wells, and Wursig, 1985). The whales began to change their behavior at distances of 3.0 to 7.2 kilometers at sound levels that ranged from 152 to 178 decibels relative to 1 microPascal. The combination of vessel noise and seismic sound may have been primarily responsible for observed behavioral changes (Ljungblad et al., 1985a). In three of six experiments, bowheads oriented away from a vessel with a single airgun deployed (akin to a high-resolution seismic survey) at a range of 0.2 to 4.5 kilometers. There was no reaction to the single-airgun vessel at a range of 3 to 5 kilometers in the other three experiments (Richardson, Wells, and Wursig, 1985). Thirty to 60 minutes following the cessation of seismic disturbance, the whales' surface-respiration-dive characteristics appeared to recover from the effects of disturbance (Ljungblad et al., 1985a).

Because Sale 97 is likely to have few or no associated high-energy, low-resolution surveys, and because of the small amount of the relatively quiet, high-resolution seismic surveys likely to result from the sale, these seismic activities are not likely to adversely affect endangered whales. Behavioral responses (brief flight response, changes in surfacing and dive times, and temporary changes in migration routes) are likely. These short-term responses are not likely to preclude a successful migration or to significantly disrupt feeding or mating activities. Habituation to distant geophysical-seismic activities could occur (and is likely to already have occurred), which would lead to a reduction of adverse reactions. It is unlikely that noise associated with distant geophysical-seismic activities would adversely affect the fitness of the bowhead population. 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.

Another potential source of noise disturbance would be from sound produced by drilling units and production platforms. An estimated 15 exploration and delineation wells would be drilled within the Sale 97 area during the period 1989 through 1994, with 2 production platforms to be installed during 1998. Each year, 2 to 3 exploration and delineation wells would be drilled with a maximum of 2 drilling units operating contemporaneously. It is estimated that 10 exploration wells would be drilled in waters greater than 20 meters by floating or bottom-founded units. One exploration well would be drilled in waters less than 20 meters deep, from an artificial island. Gravel for island construction would be mined onshore and hauled to an offshore barrier island during the winter to be stockpiled until summer. Islands would be constructed during the summer; barges would be used to haul gravel from the stockpile area to the island site, and construction would take about 40 days.

Stationary sources of offshore noise (such as drilling, dredging, and production platforms) 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 kilometers of operating drillships, well within the zone where drillship noise is clearly detectable. In playback experiments, using drillship noise at a level comparable to that which would be present several kilometers from an actual drillship, some bowheads showed a weak tendency to move away from the sound source; and calls and dive durations may have decreased. Bowheads farther than 2 kilometers from the sound source did not respond adversely to the drillship noise (Richardson, Wells, and Wursig, 1985). 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 (Greene, 1985). It is likely that bowhead avoidance would be less around an unattended structure than one attended by support vessels (Richardson, Wells, and Wursig, 1985).

Spring-migrating bowheads could be exposed to drilling noise from one, or possibly two, drilling operations from bottom-founded drilling units. Fall-migrating bowheads could be exposed to a maximum of two drilling operations resulting from Sale 97. If oil is discovered in a commercially producible quantity within or near a bowhead-migration corridor, bowheads could be exposed to production-platform noise during their spring or fall migration or both--depending upon where the platform is located. Under open-water, mean ambient-noise conditions, it has been estimated that bowheads might respond to drilling noise at 5.5 to 11.0 kilometers from a drillship but only 1.3 to 1.7 kilometers from an artificial-island drilling site (Miles et al., 1986). If migrating bowheads react to drilling and production noise in the same manner as migrating gray whales off the California coast (Malme et al., 1984), their response to production-platform noise would by expected to be much less than their response to drillship noise. Bowheads would be expected to respond to noise from drilling units and production platforms by slightly changing their migration speed and swimming direction so as to avoid closely approaching these noise sources. Response to drilling units along the spring-migration corridor probably would be less than that expected for drillships in open water--this is because the quieter bottom-founded units unattended by vessels would be utilized for springtime drilling. Also, it is anticipated that ambient-noise levels in the area of the spring lead system could be quite high due to cracking, crushing, and capsizing associated with moving ice and the release of air from melting ice. This elevated ambient-noise level would more easily mask drilling and production noise which in turn would likely result in less industrial-noise detection and avoidance by bowhead whales.

Bowhead reactions to dredge noise have been observed to be similar to their reactions to drilling noise. Whales were seen on a number of occasions less than 5 kilometers from active dredging operations on their summer-feeding grounds, well within the ensonified area. However, in playback experiments, some whales 0.1 to 2.25 kilometers from the sound source responded to the onset of strong dredge noise by moving away from the sound source. During one dredge playback, near-bottom feeding ceased; in another, surfacing and respiration behavior changed. In playback experiments, whales may have reacted to the rather sudden increase in the noise level of the playback as compared with a more gradual increase in the sound level from an actual dredging operation (towards which bowheads might be swimming). Bowheads seen in the vicinity of dredging operations may have habituated to the activity (whereas the sound playback was a new stimulus). Alternatively, 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 be the more tolerant individuals (Richardson, Wells, and Wursig, 1985).

(a) Summary: There is a low probability of one or more oil spills of 1,000 barrels or more occurring and contacting bowhead whale habitat when bowheads are expected to be present. The bowhead Spring-Migration-Corridor B north and east of Point Barrow has the greatest probability of occurrence and contact (26%); other areas have less than a 15-percent probability of occurrence and contact. The probability of oil-spill contact with whales would actually be less than the probability of contact with bowhead habitat. If an uncontrolled, uncontained oil 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. Habitat alterations could disturb or eliminate a small amount of benthic habitat that bowheads may use as a secondary food source. The effect of these factors on the bowhead whale population is expected to be MINOR. Bowhead whales could be affected by noise-generating activities such as aircraft and vessel traffic, geophysical-seismic activity, drilling units, production platforms, and artificial-island construction. Reactions would likely be short-term and temporary in nature, consisting of movements away from the sound source; however, many whales might avoid approaching or feeding within a range of several to over 10 kilometers of drilling units and production platforms. It is not anticipated that late summer-/early fall-feeding activities would be precluded or seriously impaired by acoustic disturbance from operations associated with Sale 97, and effects are expected to be MINOR.

(b) CONCLUSION (Effects on Bowhead Whales): The combined potential effects on bowhead whales of activities associated with the proposal are expected to be MINOR.

(2) Cumulative Effects: Bowheads winter in the central Bering Sea and summer in the eastern Beaufort Sea and are most likely to be affected by noise and potential oil spills from OCS development in these regions. Onshore development would not affect bowheads. State of Alaska offshore sales have the potential for affecting bowheads in the same manner as Federal OCS sales, although State sales would probably have a lesser degree of effect, since the bowhead migration generally occurs farther offshore in Federal waters. Canadian OCS activity probably would affect bowheads in the same manner as U.S. operations. The level of effect may be greater because should adverse effects occur, they would take place during the brief period when a bowhead must consume enough prey to satisfy its energy requirements for the migration and overwintering period. Data from 1976-1984 provide some evidence of reduced bowhead utilization of the main oil-exploration area north of the Mackenzie River Delta. However, some bowheads continue to be seen in the exploration area, and year-to-year fluctuations in abundance occur in most parts of the bowheads' summer range. It is therefore uncertain as to whether or not there is a long-term trend toward reduced utilization of the main area of exploration and whether or not the fluctuation in bowhead use is the result of increasing levels of exploratory activity or the result of natural fluctuations in food resource availability (Richardson et al., 1985). There is no

evidence to date of bowheads abandoning summering areas in the Canadian Beaufort Sea in which seismic exploration has occurred (Richardson et al., 1985).

Oil spills have a greater potential to adversely affect bowhead whales in the cumulative case than for the proposal. Under the cumulative case, areas of bowhead habitat most vulnerable to occurrence and contact by one or more oil spills of 1,000 barrels or greater when bowheads are likely to be present would include the Bowhead Spring-Migration-Corridors A (26% probability of contact) and B (96%) (Table F-15), Bowhead Summer-Feeding Area (73%), Bowhead Fall-Feeding-Area A (32%) (Table F-19), and Bowhead-Migration-Areas A (22%) and B (21%) (Fig. IV-16). All other bowhead-habitat areas would have less than a 10-percent probability of contact. The most likely number of spills to contact the Bowhead Spring-Migration-Corridor B is 3, whereas other areas have a most likely number of 1 or less. The potential for oil-spill contact with the Bowhead Spring-Migration-Corridor B and the Bowhead Summer-Feeding Area is substantially higher in the cumulative case than in the proposal as a result of the estimated 12 spills from Canadian production and tankering. Other areas have increased probabilities of contact primarily as a result of increased U.S. production and the estimated 12 spills from U.S. production under the cumulative case. Oil spills projected to contact bowhead-habitat areas would not necessarily contact whales, since bowheads are generally sparsely distributed through their habitat and may actively avoid oil contact. In most cases, it is likely that oil contact by whales would be brief and noninjurious.

It is assumed that about 64 platforms could be located in areas in which bowheads winter and summer and through which they migrate (the Bering, Chukchi, and the U.S. and Canadian Beaufort Seas); and bowheads would be exposed year-round to the potential for contact with spilled oil. If bowheads contact spilled oil and their baleen becomes fouled, whales could experience a reduction in filtering efficiencies and an associated decrease in nutrient-assimilation capability. Bowheads could be temporarily displaced from small sections of migratory routes, wintering areas, or feeding areas as a result of spilled oil. Food resources could be reduced in localized areas; or, if in the unlikely case prolonged contact with oil occurs, bowheads could be injured or killed. If petroleum hydrocarbons are ingested and stored in the blubber, they are most likely to be released when the whales use their blubber reserves. Hydrocarbons released during periods of fasting or lactation might also react synergistically with stress-related factors to cause adverse effects; however, there is currently no data to support this concept.

Up to 2 additional drilling units per year, 2 production platforms, and 160 kilometers of offshore pipeline could be expected as a result of Sale 97. Up to an additional 62 production platforms and 2,300 kilometers of offshore pipeline could be expected in other sale areas throughout the bowheads' range. Although the effects of dredging and emplacement activities for a single island, pipeline, or platform are likely to be minimal, the effects of these activities in the cumulative case could be significant. Because of the potential adverse effects from the number of spills likely to occur throughout the species' range, the overall cumulative effect of nonacoustic factors on the bowhead whale population is expected to be MODERATE.

Increased noise levels from aircraft, supply vessels, drilling units, tanker traffic, production platforms, geophysical-seismic surveys, and dredging and construction would accompany development. A scenario for cumulative development in the Bering, Chukchi, and Beaufort Seas from Canadian and U.S. Federal OCS lease sales within the region occupied by bowhead whales, based upon the mean-case resource estimates from this region, could include the drilling of about 1,475 wells, the installation of about 64 production platforms, the laying of 2,650 kilometers of oil and/or gas pipeline, and the completion of 800 to 1,000 tanker trips per year. However, based upon the experience of previous OCS lease sales, the probability that all of these areas would experience this great a level of development is rather small. Bowheads would most likely alter their behavior for loud, startling, or threatening sounds (i.e., direct overflight by aircraft at low altitudes, close approach by vessels, start-up of engines or noise-producing operations, etc.). This type of disturbance also would be associated with aircraft and vessels that support drilling units and platform operations. Bowheads probably will habituate to industrial noise sources that (1) are stationary, (2) produce sound at moderate levels, and (3) are relatively constant in volume and frequency (i.e., drilling units, dredges, production platforms, etc.); but some bowheads may continue to avoid approaching within several kilometers of these sources. Taking into account the various potential sources of noise disturbance throughout the bowheads' range, most of which is projected to occur in the Navarin Basin and in the U.S. and Canadian Beaufort Sea, some small changes in migration routes and feeding or winter areas could occur. Cumulative effects from noise disturbance are expected to be MODERATE, as compared with MINOR effects for the proposal.

CONCLUSION: Under the cumulative case, the combined effects from OCS activities throughout the bowhead whales range are expected to be MODERATE.

c. Effects on the Gray Whale:

(1) Effects of the Proposal: Nonacoustic effects on gray whales include effects of oil spills and habitat alteration. Direct effects of oil spills or petroleum-industry pollution on endangered gray whales can be divided into two parts: (1) the vulnerability of the whales to pollutant contact; and (2) assuming contact is made, the potential sensitivity of individuals to pollutants.

The OSRA was used in this analysis to assess the vulnerability of gray whale habitat to contact with oil. Appendix F, Tables F-15 to F-30, show the combined probabilities of oil-spill risk to given target areas (the probability of spills occurring and contacting identified resource areas). Combined probabilities assume exploration and development and production over the expected life of the lease-sale area. Unless otherwise noted, combined probabilities referenced in this discussion refer to contact by spills of 1,000 barrels or more during a simulated 10-day period following a spill or within 10 days of meltout of a winter spill in the open-water season.

The Gray Whale Area (Fig. IV-16) has a low probability (4%) (Table F-19) of being contacted by spilled oil during the summer gray whale-feeding period. The probability of contact during the fall period (month of October) while gray whales are present is even lower (2%) (Table F-15). The probability of a spill of 100,000 barrels or greater contacting the Gray Whale Area is negligible (Tables F-23 and F-27).

Assuming gray whale habitat is contaminated with spilled oil when whales are present, some gray whales could experience one or more of the following: skin contact with oil, baleen fouling, inhalation of sublethal concentrations of hydrocarbon vapors, a localized reduction in food resources, the consumption of some contaminated prey items, and local displacement from some feeding areas. The effect of oil contact on gray whales would be similar to that previously described for bowhead whales. The number of whales contacted would depend on the size of the spill, the number of the whales in the area of the spill, and the whales' ability or inclination to avoid contact with oil.

Should oil be released in waters being used by gray whales, whales would probably contact oil as they surface to breathe. In the event gray whales encounter oil in the sale area, they would likely react in a manner similar to gray whales observed off the California coast; some whales changed their swimming direction, thus avoiding surface oil, while others maintained their swimming direction but took fewer breaths, remained submerged for longer periods, and swam faster while in oiled waters (Kent, Leatherwood, and Yohe, 1983). Prolonged contact with skin or eyes may result in irritation or ulceration (Geraci and St. Aubin, 1982); however, brief contact should not result in serious long-term harm to the whales. In 1969, the entire northward migration of gray whales passed through or near the area contaminated by the Santa Barbara Channel spill with no documented mortality resulting from this event (Brownell, 1971).

Gray whales that feed or pass through oiled areas with their mouths open may be susceptible to oil fouling of baleen. In an experiment, waterflow through gray whale baleen fouled with light- and medium-weight oils was reduced for less than 1 minute. Fouling with a heavy residual oil (Bunker C) restricted waterflow for up to 15 minutes before normal flow was restored (Geraci and St. Aubin, 1982). Consequently, spilled crude oil should not significantly obstruct waterflow through gray whale baleen, and filtering efficiencies should return within minutes after feeding in oil.

Should an oil spill occur in an area where gray whales are present, it is possible that the whales could inhale toxic hydrocarbon vapors. Inhaled petroleum vapor may result in respiratory distress. Animals already stressed by liver and lung parasites and adrenal disorders might be particularly vulnerable to the effects of even low levels of hydrocarbon vapors. Within 24 hours of the spilled oil being exposed to the air, most of the toxic vapors will have dissipated (Geraci and St. Aubin, 1982). Due to the short-lived and highly localized nature of this phenomenon, it is unlikely that more than a few gray whales would be exposed to toxic hydrocarbon vapors, and no mortalities are expected.

Some feeding areas may be precluded from use or made less desirable by the presence of oil; however, only a small portion of gray whale-feeding habitat is within the sale area, and the vast majority of this habitat probably would remain unaffected by an oil spill. Gray whale-food sources may undergo a localized reduction as a result of an oil spill. Gray whales may also consume some contaminated prey items or benthic substrate; however, bioaccumulation of petroleum hydrocarbons would appear to be a localized condition. If whales remain to feed in the same general area for most of the summer, only a few individuals may be affected. Alternatively, if whales forage over a large area, the percentage of contaminated prey items consumed is likely to be small, although more of the population will be exposed to contaminated prey.

It is assumed that one to two drilling units per year will be used for exploration. If located in a gray whale-feeding area, these units could temporarily occupy several hectares of habitat and could possibly displace a few whales from several hundred meters to a few kilometers from the drilling unit for one season. One or both of the two expected oil-production platforms may be located within gray whale-feeding areas. Effects of production platforms on the gray whale would be similar to the effects of the drilling units but would last for a greater length of time. A few whales may be excluded from feeding within a few hundred meters of the production platforms. Discharges of fluids from drilling units and production platforms are not expected to significantly reduce gray whale-food resources. Pipeline installation should have little effect on gray whales, although a small amount of benthic feeding habitat (up to 24 km^2) may be temporarily disturbed by pipeline trenching.

Noise-producing activities most likely to affect gray whales would include aircraft and vessel traffic, geophysical-seismic surveys, drilling operations, and production platforms. Most observations of gray whale behavior in the presence of disturbance factors have occurred along the whales' migration route or on their wintering grounds rather than on summer-feeding areas within Alaskan waters.

Gray whale reaction to aircraft and vessel noise in Alaskan waters may be quite variable. Factors that affect gray whale reaction include the activity of the whale, environmental conditions, and the type of aircraft or vessel. Other factors could include aircraft altitude, distance between the whales and the vessel, the frequency of disturbance, and previous exposure. Gray whales often dive to avoid approaching aircraft and, when repeatedly exposed to low-flying aircraft, they dive and remain submerged for longer periods than normal (Bird, 1983). In playback experiments, migrating gray whales demonstrated an avoidance reaction to helicopter noise by deflecting around the sound source at levels above 115 decibels (Malme et al., 1984). Noise levels measured in the Beaufort Sea from helicopters passing overhead at an elevation of 152 meters have ranged from 95 to 109 decibels relative to 1 microPascal at 1 meter (Greene, 1984). If gray whales are no more sensitive to helicopter noise on their feeding grounds than along their migratory route, there should be little disturbance due to helicopter operations. In 1982, response to aircraft at an altitude of 305 meters was most dramatic when calves were present (Ljungblad, Moore, and Van Schoik, 1983). However, gray whale response is generally low when aircraft remain on a direct course or at altitudes of 305 meters or higher (Ljungblad, Moore, and Van Shoik, 1984).

Gray whale reactions to vessels are generally minimal so long as the whales are not closely approached or pursued. Feeding gray whales appeared undisturbed by vessels which maintained a distance of at least 550 meters (Bogoslovskaya, Votrogov, and Semenova, 1981), and have been known to remain feeding in areas of heavy vessel traffic.

Effects of sale-related aircraft and vessel traffic on gray whales are likely to be low, but the degree of effect may depend on well location. During the period July through September, when exploratory drilling is likely to occur, gray whales are generally found in low numbers in the Chukchi Sea portion of the sale area. Aerial- and vessel-support activity associated with drilling units located east of Barrow may disturb small numbers of gray whales. Gray whales, overflown by aircraft at altitudes less than 450 meters, may dive in response to the noise and visual stimulus of the aircraft. However, if the aircraft remains on a direct course, the whales should continue with their normal activities. Vessels that approach no closer than several kilometers to gray whales should not disturb the whales. Likewise, vessels that maintain a constant speed and course probably will cause little disturbance to gray whales. More serious effects could occur if aircraft and vessel operators begin to regularly alter their direction of travel in order to observe whales at close range. In this case, normal whale behavior, such as feeding or migration, could be disrupted substantially and cause whales to abandon the area. In the most likely case, a low number of whales would be exposed to aircraft or vessel traffic on the order of once or twice per day. This disturbance would likely cause them to briefly cease feeding but resume normal behavior in less than an hour.

Areas in which high-resolution seismic activity associated with Sale 97 will take place will depend on where exploration units are proposed to be located. Available information indicates that gray whales display a high degree of tolerance to distant geophysical-seismic noise. Extensive geophysical exploration has been conducted off the California coast (an area through which gray whales migrate) for more than 35 years, yet the gray whale has recovered to population levels near or above precommercial whaling levels. A report to the California State Lands Commission (CSLC) determined that no evidence was found to suggest that airguns and other nonexplosive-acoustic sources cause injury to marine mammals, including gray whales (CSLC, 1982). In Alaskan waters, none of 36 gray whales exposed to seismic-sound levels of approximately 154 decibels displayed any overt fright or flight responses, and a gray whale calf among the group continued nursing (Ljungblad et al., 1982). In experiments conducted along the California coast during the gray whale migration, the distances between the airgun-array vessel and whale groups that showed responses (obvious at the time of observation), were consistently on the order of 2 kilometers (Malme et al., 1983, 1984).

Gray whales are expected to be present in the northern Chukchi Sea throughout the ice-free season when seismic activity is planned. Seismic activities associated with Sale 97 are not expected to physically injure gray whales. Seismic-survey activity conducted west of Point Barrow would have the greatest potential for adverse effects on gray whales. Avoidance responses (brief flight responses, changes in surface and dive times, and temporary changes in migration routes) can be expected within several kilometers of the survey vessel. These short-term responses are not expected to seriously disrupt feeding activities.

Stationary offshore-noise sources such as drilling, dredging, and production platforms appear to be potentially less disruptive to gray whales than moving sound sources. Gray whales have been observed to migrate normally past a drillship and drilling units along the California coast (Lecky, Brvesevitz, and Gavining, 1979; Gales, 1982). In playback experiments, migrating gray whales deflected around the source of drillship noise at 1.1 kilometers (Malme et al., 1983, 1984). Stationary noise sources may mask whale vocalizations within several kilometers of the source; however, the degree of interference would depend upon background noise levels in the vicinity of the receiving whales (Gales, 1982).

Stationary sound sources would have very minor effects on gray whales due to the fact that in any one year only one to two exploration-drilling units and a total of two production platforms are expected as a result of the sale. As a result of noise and visual disturbance at drilling units and production platforms, gray whales might avoid feeding within several hundred meters of these sources.

Considering the combined factors of seismic noise, aircraft and vessel traffic, and noise from drilling units and production platforms, the effect on gray whales is expected to be MINOR.

(a) Summary: As a result of an oil spill, a low number of gray whales may experience one or more of the following: skin contact with oil, baleen fouling, respiratory distress caused by inhaling sublethal concentrations of hydrocarbon vapors, a localized reduction in food resources, the consumption of some contaminated prey items, the possible abandonment of a localized portion of their summer-feeding range, and/or avoidance of an oil-contaminated area. A few individuals may be discouraged from feeding within several hundred meters of drilling units and production platforms. Overall effects on the gray whale population are expected to be MINOR. Gray whales would be affected by noise-generating activities such as seismic activities, aircraft and vessel traffic, drilling units, and production platforms. Reactions generally would be short-term and temporary in nature, consisting of localized movements away from the sound source. Whales may avoid feeding within several hundred meters of drilling units and production platforms. It is not anticipated that summer-feeding activities would be precluded or seriously impaired by noise activities in the Sale 97 area during oil and gas exploration, and effects are expected to be MINOR.

(b) CONCLUSION (Effects on Gray Whales): The effects of activities associated with proposed Sale 97 on gray whales are expected to be MINOR.

(2) Cumulative Effects: In this discussion, the term "cumulative effects" refers to the sum of all effects from OCS Sales BF, 57, 70, 71, 83, 87, 89, 92, 97, 100, 107, and 109; from those projects listed in Section IV.A; and from other nonpetroleum-industry sources of oil spills or disturbance.

A scenario for cumulative development in Alaskan waters from Federal OCS lease sales would include the installation of about 47 production platforms, the laying of 2,700 to 4,300 kilometers of oil and/or gas pipeline, the completion of 800 to 1,000 tanker trips per year south of Bering Strait, and an expected 34 oil spills of 1,000 barrels or more (including 1 spill of 100,000 barrels or greater).

Most likely, cumulative effects to endangered gray whales would include an increase in noise and vessel disturbance and pollution (including oil spills) due to an increase in shipping activity and additional OCS lease sales. Effects on gray whales would appear to be potentially greatest along the Alaska coast from Unimak Pass to the Sale 97 area.

Of concern is the cumulative effect of oil spills and other pollution associated with the projects described in Section IV.A. Probabilities for the cumulative case assume oil discovery as well as probable development and transportation scenarios, reflecting the overall unrisked probability of oil spills occurring and contacting particular locations. Unless otherwise mentioned, all probabilities under the cumulative case refer to the occurrence of one or more spills of 1,000 barrels or more and contact within a 10-day period following a spill or meltout of a winter spill during the open-water season. The probability of contact with the Gray Whale Area is 6 percent during the open-water period (Table F-19, Fig. IV-16) and 1 percent during the month of October (Table F-15). The probability of contact from spills of 100,000 barrels or greater is negligible (Tables F-23 and F-27). Cumulative effects on gray whales could be significant if oil and gas development takes place throughout Alaskan and Pacific coast waters, since gray whales are known to migrate through a number of proposed lease-sale areas (i.e., southern and central California, Gulf of Alaska/Cook Inlet, Kodiak, Shumagin, North Aleutian Basin, St. George Basin, St. Matthew Hall, Norton Basin, Hope Basin, Chukchi Sea, and Beaufort Sea). Effects of oil spills on individual gray whales would be as described in the proposal; however, cumulative effects on the gray whale population would be greater than for the proposal because more spills are expected and more individuals are likely to be contacted. The greatest effects would be expected as a result of spills within gray whale summer-feeding areas when whales are present. Long-term, ecosystem-wide cumulative effects of chronic pollution are of concern because changes in total ecosystem productivity, though remote, are at least a possibility. Effects to gray whales from oil spills in a cumulative scenario are expected to be MODERATE, as compared to MINOR for the proposal. The installation of drilling units and production platforms and the emplacement of oil and/or gas pipelines may disturb or degrade some areas of gray whale benthic or feeding habitat. Some whales may be excluded from feeding within a few hundred meters of drilling units and production platforms. However, areas disturbed would likely be a very small percentage of available habitat and are expected to result in a MINOR effect on the gray whale population. Discharges of fluids from drilling units and production platforms are not expected to significantly reduce gray whale-food resources. The overall effect of nonacoustic factors on gray whales is expected to be MODERATE, as compared with MINOR for the proposal.

Cumulative acoustical disturbance from proposed Federal lease sales would affect endangered gray whales, although habituation to some forms of acoustical disturbance is likely. It is believed that responses to the increased ambient-noise levels would be similar to those described in the proposal but may last many years for the cumulative case instead of the few years that are expected for the proposal. For the gray whale, offshore development associated with the proposal would constitute a minor portion of total acoustical stimuli. If several proposed sales yielded large discoveries of oil and gas, the cumulative effects of intensive production activities and resultant increases in human activity, increased localized or shipping-corridor disturbance, pollution, oil spills, or disturbance are expected to be MODERATE for the gray whale. Cumulative industrial disturbance to migration would appear to be greatest at locations where tanker traffic due to several sales may be focused (i.e., Unimak Pass) and may result in alterations of migration routes and/or timing.

CONCLUSION: The cumulative effects to gray whales are expected to be MODERATE, as compared to MINOR for the proposal.

d. Effects on the Arctic Peregrine Falcon:

(1) Effects of the Proposal: If oil is released and contacts 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 may 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. Appendix F, Table F-21, shows less than a 0.5-percent probability that one or more spills of 1,000 barrels or greater would contact the Colville Delta (Fig. IV-1, Land Segments 31 and 32) and a 2-percent probability that the Canning River Delta would be contacted within a 10-day period following a spill. Probabilities of spilled oil contacting the coast south of Barrow during the nesting season are less than 0.5 percent. Since these probabilities are greater than the risks to which peregrines actually would be exposed, due to their transient occurrence in the area (and since they do not typically occur in the water), it can be concluded that it is very unlikely that oil spills will come in contact with areas inhabited by peregrine falcons and thus very unlikely that they would be significantly affected by oil spills. If oil spills affected prey populations of this species, then short-term, localized reductions in food availability 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 25 miles inland, may be vulnerable to such occasional disturbance. Nesting sites along the coast south of Barrow could also be vulnerable to such 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 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 phases would be unlikely as well. Gravel mining for the proposed artificial island associated with Sale 97 is also unlikely to affect the peregrine because extraction is expected to occur near the coast in the vicinity of Oliktok Point.

(a) Summary: It is unlikely that noise and disturbance or oil spills would affect the peregrine falcon; any possible disturbance would be short term and localized.

(b) CONCLUSION (Effects on Peregrine Falcons): The degree of potential effect on peregrine falcons from oil spills and disturbance is expected to be NEGLIGIBLE.

(2) Cumulative Effects: Proposed Sale 97 and other Federal OCS lease sales are expected to contribute only slightly to cumulative factors that may affect the peregrine falcon. Onshore projects have greater potential for adverse effects, but noise and oil-spill effects (such as those described for the proposal) from Federal OCS lease sales should have only occasional, brief adverse effects on the peregrine falcon. The accumulation of all OCS lease sales throughout the range of the peregrine falcon would, however, have slightly greater effects than the proposal alone and is expected to result in a MINOR effect on the species.

CONCLUSION: Since peregrine falcons are unlikely to be affected substantially by noise and oil spills from Federal OCS sales, these activities are expected to result in MINOR effects under the cumulative case as compared with NEGLIGIBLE effects for the proposal.

6. Effects on Caribou:

a. Effects of the Proposal: Among the terrestrial mammal populations that could be affected by the proposal are the more than 352,000 caribou of the Western Arctic, Central Arctic, Teshekpuk Lake, 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. The primary potential effects of OCS activities on caribou would come from onshore support and development activities adjacent to the Sale 97 area and to a minor degree from oil spills. The primary concerns are human disturbance of caribou and habitat changes. Human activities can cause temporary and possibly permanent displacement of caribou, particularly cows and calves, from important habitats such as calving grounds, insect-relief areas, and preferred feeding habitats (see Graphic 5).

(1) Effects of Present North Slope Development: Recent studies (Cameron, Whitten, and Smith, 1981, 1983; Roby, 1978) indicate significant seasonal avoidance of the Prudhoe Bay area by cows and calves during calving and postcalving periods (May through August). Cameron, Whitten, and Smith (1983) also reported that caribou cow-calf groups avoid the northern portion of the Trans-Alaska Pipeline (TAP) corridor/haul road, particularly during the postcalving period. However, caribou cow-calf groups may be avoiding the pipeline/haul-road corridor because it runs primarily along the riparian habitat of the Sagavanirktok River valley, a habitat type cows and calves normally avoid using during that season (Carruthers, Jakimchuk, and Ferguson, 1984). Carruthers, Jakimchuk, and Ferguson (1984) reported no significant differences in cow-calf distribution between the TAP corridor and other riparian habitats on the summer range of the CAH. Also, caribou cow-calf groups did not avoid a portion of the pipeline corridor on the North Slope, which is separate (4 km away) from riparian habitat and the haul road (Carruthers, Jakimchuk, and Ferguson, 1984). The latter investiga-

tors concluded that the differences in the distribution of caribou cows with calves reported by Cameron, Whitten, and Smith, (1983) along TAP reflects the seasonal habitat preference of caribou cows with calves in avoiding riparian habitats on which most of the TAP corridor is located. However, the question of whether caribou cows with calves avoid the haul road (Dalton Highway) during periods of heavy truck traffic was not investigated by Carruthers, Jakimchuk, and Ferguson (1984). The mere physical presence of the pipeline and associated facilities probably has no effect on the behavior, movement, or distribution of caribou except perhaps when heavy snowfall may prevent some animals from crossing under or over the pipeline in local areas. On the other hand, human activities associated with transportation routes--particularly motor-vehicle traffic--can have short-term and perhaps long-term effects on the behavior, movements, and distribution of caribou.

(2) General Effects of Disturbance: Caribou can be briefly disturbed by very low-flying (altitudes less than 600 m) aircraft, fast-moving ground vehicles, and other human activities (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 (altitude of the aircraft); 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 most sensitive to motor-vehicle traffic, especially during the summer months, while bulls appear to be least sensitive during that season.

Habituation to aircraft and motor-vehicle traffic and other human activities has been reported in several studies of hoofed-mammal populations in North America, including caribou (Davis, Valkenberg, and Boertje, 1985; Valkenberg and Davis, 1985; Johnson and Todd, 1977). The variability and instability of Arctic ecosystems dictate that caribou have the ability to adapt behaviorally to environmental changes. Consequently, repeated exposure to human activities such as oil and gas development over several hundred square kilometers of the summer range of the CAH (see Graphics 5 and 6) has lead to some habituation. Bulls in the CAH have especially demonstrated this ability. However, there have been no long-term studies that have specifically addressed habituation of an entire caribou herd. The movement of many CAH caribou--including cows and calves--across the Prudhoe Bay area oil fields suggests that some level of habituation has occurred. The majority of the caribou herds on the North Slope that overwinter south of the Brooks Range may take longer to adapt to human activities, to which they are seasonally or intermittently exposed. However, caribou of the CAH successfully cross pipelines, roads, and the oil fields on the North Slope. Some displacement of the CAH from a small portion (perhaps 5%) of the calving and summer range has occurred (Cameron et al., 1981, 1983). This displacement of some but not all caribou cows and calves has occurred within about 4 kilometers (2.5 miles) of the Milne Point pipeline and road and near some oil facilities at Prudhoe Bay (Smith and Cameron, 1986). However, the use of specific calving sites within the broad calving area varies from year to year; and the amount of displacement is probably of MINOR importance to the distribution and abundance of the CAH--this herd continues to increase at an average of 13 percent/year. If this displacement were greater than a MINOR effect, the CAH would not continue to increase in size.

Alteration of less than 1 percent of the total caribou-grazing habitats would occur. Construction of additional gravel roads (over 200 km) and processing facilities and gravel mining for drilling platforms and onshore pipelines would alter or eliminate a small amount of additional caribou-grazing habitat on the North Slope.

(3) Effects of Site-Specific Onshore Development Associated With the Proposal: This analysis assumes that transportation activities associated with exploration would be centered out of the Prudhoe Bay area and that no permanent roads would accompany exploration (see Sec. II.A.2). Other exploration-support activities are assumed to occur at Camp Lonely and by offshore barges located near the drilling sites. Therefore, exploration alone in the proposed sale area would not substantially increase industrial development on the North Slope. Neither would it increase disturbance of caribou-calving activities.

If 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: gas will be uneconomical to export in the near future unless a gas pipeline is built (Alaska Natural Gas Transportation System [ANGTS]); TAP will have the capacity to handle production from the lease sale; and three main pipeline routes will be required to connect TAP with the acreage offered (see Sec. II.A.2). These routes would originate east of Prudhoe Bay, west of Prudhoe Bay, and west of Barrow.

(a) Oil Transportation East of Prudhoe Bay: Oil transportation from leases offshore of Camden Bay east to Demarcation Bay, in addition to the leases from Sale 87 in this area, probably would be by offshore pipeline connecting either into the Endicott Development route and TAP or to an onshore pipeline with a landfall at Bullen Point. This onshore 90-kilometer pipeline would connect to the Endicott pipeline. The pipeline for eastern Beaufort Sea development may be located offshore. Effects of oil development on the PCH could probably 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 Arctic National Wildlife Refuge. The 90 kilometers of onshore pipeline and road from Bullen Point to TAP would increase vehicle traffic by perhaps several hundred vehicles per day during construction, which could temporarily disturb some of the 12,000 caribou of the CAH within about 2 miles 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 MINOR 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 less than 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 proposal.

(b) Oil Transportation West of Prudhoe Bay to Barrow: Oil would be transported from leases west of Prudhoe Bay and Harrison Bay by an offshore pipeline route in the shorefast-ice zone. This pipeline would tie into the possible Sale 71 pipeline, with the landfall located at Oliktok Point, and from there it would be connected by a 20-kilometer onshore pipeline to TAP. Two or three support facilities covering perhaps 2.6 square kilometers would be located at Deadhorse and Camp Lonely with additional support facilities located near the production fields. Because the pipeline route is located offshore (as assumed in this analysis), construction and support activities would have little or no effect on the TLH and its calving habitat. However, the 20-kilometer onshore-pipeline segment from Oliktok Point to TAP--with accompanying road, vehicle-traffic (zero to several hundred vehicles/day), and construction activities--would temporarily disturb some caribou of the CAH, particularly when high levels (several hundred vehicles per day) of vehicle traffic are present during construction-gravel hauling. Disturbance levels would subside after construction is complete (because of the great reduction in vehicle traffic to less than 100 vehicles per day at most) and is expected to have MINOR effects on caribou because the animals would eventually cross the pipeline and road and their numbers and regional distribution are not expected to be affected.

(c) Oil Transportation West of Point Barrow: Oil transportation from leases offshore of Peard Bay and west of Point Barrow are assumed to be by pipeline coming onshore at Point Belcher on the Chukchi Sea coast. From there, a 140-kilometer pipeline would cross NPR-A south of the lake district (but probably north of the Colville River), connecting with the potential NPR-A pipeline, crossing the Colville near Umiat, and connecting with TAP at Pump Station 3. This approximately 480-kilometer-long cumulative pipeline (altering about 4,000 hectares of habitat) would transect all WAH movements to the Beaufort Sea coast from wintering habitat south of the Brooks Range and also would transect the southward spring migration of several thousand caribou that overwinter north of the caribou-calving range and along the Arctic coast. (An estimated 30,000 caribou overwintered on the North Slope of NPR-A in 1976-1977 [USDOI, NPR-A, 1978].) However, caribou that winter on the North Slope apparently do not use well-defined migration routes to the calving range. The pipeline would not cross the major well-defined migration routes through the Brooks Range mountain passes south of the calving area, where the majority of the WAH overwinters (see Graphic 5).

Construction of the pipeline could temporarily interfere with some caribou-migration movements--particularly of cows and calves during construction activities and during periods of heavy vehicle traffic (several hundred vehicles per day). In a severe situation, such motor-vehicle traffic associated with the pipeline and access road could affect the local distribution and movement of the WAH within about 4 kilometers along the pipeline corridor if it acts as a temporal barrier to cow-calf movements. However, caribou-migration movements would not be blocked. Some caribou would have temporary difficulty crossing the pipeline road during heavy traffic periods, but successful crossings would still occur. Caribou successfully cross the Dalton Highway-TAP pipeline, the Dempster Highway in Canada, and other highways in Alaska. The temporary disturbance of some caribou groups of the WAH and the short-term interference with movements during construction is expected to have a MINOR effect; the WAH would successfully cross the pipeline during migration as the CAH and the Nelchina caribou herd successfully cross the TAP-Dalton

Highway and TAP-Richardson Highway, respectively, during spring and fall migrations (Cameron, Whitten, and Smith, 1986, and Eide, Miller, and Chihuly, 1986). Development of this transportation corridor across NPR-A could increase hunter access to the WAH, increasing hunter pressure on the population. However, current regulation of harvest should prevent over-hunting. The 480-kilometer-long pipeline and road across NPR-A is not expected to affect the abundance and regional distribution of the PCH.

(4) Effects of Oil Spills:

(a) General Effects of Oil Spills: Caribou sometimes frequent barrier islands and shallow coastal waters during periods of heavy insect harassment and may possibly become oiled or ingest contaminated vegetation. 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. These effects could increase mortality rates of any caribou that interact with oil pollution.

(b) Site-Specific Effects of Oil Spills: Unless otherwise specified, oil-spill-contact probabilities referred to in this section assume the occurrence of development to the extent estimated in Section II.A and associated spill rates. Attention is devoted to one spill equal to or greater than 1,000 barrels and to spill contacts that occur within 10 days of meltout or summer spillage. Coastlines that may be frequented by caribou in the Prudhoe Bay and Cape Halkett areas have a 3- and 2-percent chance of oil-spill contact (Appendix F, Table F-21, Land Segments 34 and 28, respectively), while barrier islands that may be used by caribou in the Elson Lagoon and Flaxman Island areas have a 2-percent chance of spill contact (Appendix F, Table F-21, Land Segments 20 and 38). The chance of contacting any coastlines within 10 days is 20 percent (Appendix F, Table F-19). Thus, some caribou may come in contact with contaminated coastlines and oiled vegetation if a spill occurs. However, only a very narrow band of coastline probably would be oiled (see Sec. IV.A.2.b). The number of caribou that are likely to be affected is likely to be small in comparison to the number of caribou that die from natural causes on the Arctic slope.

If a spill occurs during the open-water season, caribou that frequent coastal habitats such as in the Cape Halkett or Prudhoe Bay areas could possibly be directly exposed to oil along the beaches and in shallow waters during periods of insect-pest-escape activities. Caribou may ingest oiled vegetation along contaminated shorelines in these areas. However, even in a severe situation, a comparatively small number of animals is likely to be exposed to the oil spill and die as a result. This effect is expected to be NEGLIGIBLE to any of the caribou herds.

(5) Summary: The primary source of disturbance of caribou is vehicle traffic (perhaps as much as several hundred vehicles/day) that would be associated with onshore transportation of oil and gas from offshore leases of the proposal. Possible oil spills, offshore construction, and marine transportation would probably have NEGLIGIBLE effects on caribou. The construction and presence of over 160 kilometers of onshore pipelines and roads, the development of other facilities and associated motor-vehicle

traffic (several hundred vehicles/day particularly during construction activities), and the increase in human presence (several thousand people) are disturbance factors to caribou, particularly cow/calf groups on their summer range. CAH-caribou surveys have shown some displacement of cow/calf groups from coastal habitats within 4 kilometers of some but not all industrial facilities on the calving range of the CAH. Therefore, disturbance from vehicle traffic and human presence associated with present levels of oil development in the Prudhoe Bay area have apparently affected caribou local distribution on a small percentage (an estimated 5%) of their summer range. However, caribou abundance and overall distribution have not been affected--the herd has greatly increased since oil development began although this increase in caribou numbers is not to be inferred as caused by oil development.

Onshore oil transportation by 160 kilometers of onshore pipelines, two or three support facilities (at Point Belcher, Camp Lonely, and Prudhoe Bay), and over 200 kilometers of maintenance roads that may be associated with development and production of leases in the Sale 97 area would increase motor-vehicle disturbance of caribou, particularly cows and calves of the CAH. Approximately 20 percent of the WAH (that portion of the herd that winters on the North Slope) may be temporarily disturbed by vehicle traffic (several hundred vehicles/day) associated with construction of an assumed 480-kilometer-long pipeline and maintenance road crossing the NPR-A north of the calving range. Disturbance of caribou along the pipeline crossing NPR-A 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 and no effect on caribou distribution and abundance, representing a MINOR effect. 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, the frequency of vehicle-traffic disturbance of caribou by nonindustrial activities would be limited. Access on the Dalton Highway north of the Brooks Range is restricted to oil-industry-support traffic only.

Because oil transportation for development of leases east of the Sale 71/BF area is expected to be located offshore, 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. Such a pipeline would cross a portion of the calving range of the PCH, and it might (1) cause disturbance and some displacement of caribou on a small portion (estimated to be less than 1%) of the calving and summer range and (2) slightly reduce caribou distribution on the calving and summer range. Even if an onshore pipeline did cross a portion of a concentrated calving area, motor-vehicle-traffic disturbance of caribou would subside after construction is complete. Additionally, PCH caribou are not likely to totally or permanently abandon the concentrated calving area but may reduce their use of calving habitat within 4 kilometers of the pipeline corridor. Also, because caribou cows and calves are likely to successfully cross the pipeline and road even during the high traffic-construction season, an onshore pipeline is likely to have no effect on caribou abundance or overall distribution. Thus, the effects of the proposal alone are expected to be MINOR. Caribou movements, distribution, or abundance are not likely to be significantly affected by the proposal.

(6) Conclusion: Effects of the proposal on caribou are expected to be MINOR.

b. Cumulative Effects: The additive effects of other ongoing and planned projects, as well as the proposal, on caribou are discussed in this section. Although the probability of any or all planned and ongoing projects reaching developmental stages is generally unknown, this analysis assumes that all the following projects do reach developmental stages. Motor-vehicle traffic along over 500 kilometers of existing and future pipeline roads associated with these projects could disturb caribou and alter or destroy some calving and summer range through facility construction (Appendix B, Table B-1).

Cumulative oil and gas activities of proposed Sale 97 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 Graphic 6). Potential oil spills from offshore as well as onshore oil activities associated with Federal, State, and Canadian leases are likely to have NEGLIGIBLE effects on the caribou herds in general, since few caribou are likely to be contaminated or ingest contaminated vegetation and die as a result of oil spills.

(1) Effects of 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 MINOR effects on some caribou (particularly cow/calf groups) with animals being briefly displaced from feeding and resting areas when aircraft pass nearby. The greatest concern during development from ground-vehicle/road-traffic disturbance of caribou is that associated with roads adjacent to pipelines. Caribou are most hesitant to cross (1) under an elevated pipeline adjacent to a road and (2) when motor-vehicle traffic is present on the road. The success of crossing 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. Cumulative disturbance of caribou from road traffic (several hundred vehicles/day) associated with pipelines (over 3,000 km in the cumulative case) are expected to cause MINOR, or short-term, disturbance of caribou. Road traffic temporarily delays the successful crossing of pipelines and roads by some animals but has no 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) and cause some displacement--local change in distribution of some cows and calves from within about 4 kilometers of some pipeline roads that cross concentrated calving areas (Dau and Cameron, 1986).

At present, cumulative oil development in the Prudhoe Bay-Kuparuk area (total of 1,797 km of pipelines, 553 km of roads, and 2,847 hectares of habitat covered by facilities [Appendix B, Table B-1]) 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-Kaparuk area (see Graphic 6), in the NPR-A (14% of the WAH calving range), and as a result of ANWR and Canadian oil development (about 30% of the PCH calving area), could represent a MODERATE displacement of caribou from available calving habitat and have a MODERATE effect on the overall distribution of these caribou herds.

(2) Effect on Displacement from Calving Areas: At present, oil development in the Prudhoe Bay-Kuparuk River area has caused displacement of some cow caribou from within an estimated 4 kilometers 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 4 kilometers of Milne Point facilities (the 11-km-long pipeline and road from Milne Point) in comparison to caribou numbers occurring on habitats beyond 4 kilometers (Smith and Cameron, 1986). This small amount of displacement has had no measurable effect on the abundance or growth of the CAH, which has been increasing annually by about 13 percent. 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 CAH range. If the U.S. Congress allows ANWR oil development another perhaps 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 TLH calving range to development (USDOI, BLM, 1983). Oil development on ANWR could expose 78 percent of the core-calving range of the PCH to oil development (Elison, Rappaport, and Reid, 1986). Assuming cow-calf displacement within 4 kilometers of potential ANWR oil-development facilities (several hundred km of roads, pipelines, drill platforms, etc.), an estimated partial displacement (some cows and calves) of over 37 percent of the core-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 core-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 4 kilometers of oil-development facilities.

Assuming this displacement (reduction in habitat use) persists beyond the construction period and lasts over the life of the oil fields, it is expected to represent a MODERATE 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 4 kilometers 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. However, such an effect is unlikely to occur because natural changes in the productivity of the caribou range and 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. Changes in caribou distribution on and near the above oil-development projects may persists over the life the oil fields in the Arctic and represent a MODERATE effect on caribou distribution.

(3) Effects of Habitat Alteration and Destruction: Cumulative oil development in the Prudhoe Bay-Kuparuk area encompasses over 800 square kilometers, and hundreds of miles of gravel roads cross a major portion of the calving range of the CAH. However, a small percentage of the tundra-grazing habitat has been destroyed where roads, gravel pads, gravel quarries, pipelines, pump stations, and other facilities are located. The cumulative loss of range habitat from facility construction in future oil development (such as in the NPR-A and ANWR) would also represent a small percentage of the available grazing habitat of the WAH and the PCH, respectively, and is likely to represent MINOR or NEGLIGIBLE habitat loss.

(4) Effect of Roads: The development of more transportation corridors in support of oil development on the North Slope--particularly several hundred kilometers of roads that eventually will 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 the herds. Caribou would continue to cross roads-highways, even when subject to heavy hunting pressure (Valkenberg and Davis, 1986).

Although existing hunting regulations should prevent overharvest of the caribou herds, political pressure to accommodate the needs and desires of a growing human population could force hunting pressure and harvest rates on particular caribou herds beyond the recruitment rate of the population, resulting in overharvest.

(5) Overall Cumulative Effects on Caribou: Combined onshore oil and gas activities proposed and ongoing in the Prudhoe Bay, NPR-A, ANWR, and Canadian Mackenzie River Delta are likely to have some MODERATE effects on the distribution of caribou herds if significant parts of the core-calving areas of either the WAH, CAH, TLH, or the PCH were avoided for the life of the oil fields or more than one generation and resulted in a reduction in caribou distribution. Motor-vehicle traffic associated with transportation facilities from Federal and State offshore oil activities are likely to have MINOR cumulative disturbance and habitat effects on caribou (see above discussions [1], [2], [3], and [4]).

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 or more vehicles/hour) and air traffic (of perhaps several hundred flights per day) is likely to have MODERATE effects on the distribution of one or more of the Arctic North Slope caribou herds by displacing some portion of a caribou herd from a part of its calving and summer range for more than one generation. In theory, a MAJOR effect on 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 lasted 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 or overall distribution of any caribou herds on the North Slope. 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 may lead to overharvest.

The United States and Canada initialled a draft agreement on the conservation of the Porcupine Caribou Herd in December 1986. The 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.

(6) Conclusion: Cumulative oil and gas exploration, development, and production from the above projects and the proposal are likely to have MODERATE effects on the distribution of one or more caribou herds.

7. Effects on Population:

a. Effects of the Proposal: To illustrate the potential effects of the proposed action, population forecasts for the North Slope Borough (NSB) were prepared for the MMS (University of Alaska, ISER, 1986). In this forecast model, the local population is divided between residents and nonresidents. This distinction between the primarily Native resident population and the worker nonresidents is critical to the forecast of population growth in the NSB. How the resident population is defined affects the way in which the Borough tax revenues are to be forecasted and, in turn, determines the level of local economic growth stimulated by the Capital Improvement Program (CIP). Changes in the level of nonresident population are not particularly important when illustrating the expected effects of Sale 97 on the NSB.

Table IV-B-2 shows--for the period 1980 through 2010--the projected population, resident and nonresident, Native and non-Native, expected should Sale 97 proceed. According to this projection, total population in the NSB rises dramatically through the 1980's and then shows a general decline throughout the projection period. This trend, and the occasional perturbations that can be seen here, are directly associated with the development of onshore oil

Table IV-B-2
North Slope Population Projection
Alternative I: Proposal

Year	Total Population	Average Nonresident Population	Resident Population	Resident Native Population	Resident Non-Native Population
1980	6,805	2,978	3,827	3,208	619
1985	9,397	4,245	5,152	3,665	1,487
1990	8,574	3,671	4,903	3,943	960
1995	9,495	4,137	5,358	4,347	1,010
2000	8,253	2,663	5,590	4,690	900
2005	7,534	1,849	5,685	4,846	839
2010	6,400	1,447	4,953	4,252	701

Source: University of Alaska, ISER, 1986.

resources and our assumptions about the exploration and development of previous OCS lease sales. Oil-industry employment is approximately 95 percent of the nonresident component of the population shown on this table.

Resident population reached a peak in 1985 due to the level of Borough CIP and operating employment. The brief decline that follows parallels the decline in the Borough's capacity to maintain the CIP. If it were not for the Borough's operating revenues, which are expected to begin to decline somewhat later, the drop in resident population would be more precipitous. From 1988 through 2003, resident population is forecasted to grow at a steady 1.2 percent per annum. Without Sale 97, the growth rate probably would be slightly less and would peak 2 years earlier.

The further decline in resident population that is expected to occur in the last years of the projection period would be caused by a decline in employment for both Native and non-Native residents. The Native population is less likely to respond to economic conditions in the Borough than the non-Native resident population. Nevertheless, the forecast of Native out-migration is very sensitive to assumptions made about the Native labor market. It is assumed for the projection in Table IV-B-2 that 20 percent of newly unemployed Native workers will leave the North Slope in any given year. This number may be greater should the total Native unemployment-rate rise above 50 percent. The effect of changing the migration assumption for newly unemployed Native workers from 20 to 30 percent and the maximum Native unemployment-rate assumption from 50 to 30 percent is a drop in the Native population of over 50 percent by the end of the forecast period. In either case, Native out-migration would be slightly moderated as a result of Sale 97 because we assume that 2 percent of all oil-industry jobs are available to Natives on the North Slope.

Sale 97 would affect the level of resident population in two ways: First, it would contribute to the capacity of the NSB to maintain a higher level of operating employment than would be possible without the property-tax revenues from the onshore-support base and pipelines constructed for the sale. At the conclusion of the construction phase in 1995, Sale 97 would add about 10 percent more operating revenues to the Borough. As property-tax revenues fall from other sources in the out years of the projection period, Sale 97 would contribute over 11 percent to NSB operating revenues. These revenues would maintain the number of Borough jobs available to Natives, without which out-migration would occur at a higher rate.

A second way in which Sale 97 would affect the level of the resident population is through the provision of direct employment opportunities in the oil industry. Though it is assumed in the model forecasts for the NSB that oil-industry employment is never a very significant source of jobs for the resident population, 25 percent of these jobs in 1996 and 44 percent of these jobs in 2007 through 2010 are attributable to Sale 97.

<u>CONCLUSION</u>: The effect on the level and the trend of population growth on the North Slope attributable to the proposal is expected to be NEGLIGIBLE.

b. <u>Cumulative Effects</u>: In the NSB, the growth of resident and nonresident populations would be dramatically affected by the sizable increase in employment opportunities on the North Slope. In the cumulative case, there should be sufficient jobs available, both directly as part of the onshore and offshore development projects themselves and indirectly through NSB jobs financed by the increased tax base, to stem Native out-migration and, to a point, stimulate in-migration. The resulting growth of the resident population in excess of the peak shown in Table IV-B-2 could contribute to some pressure on local housing and social infrastructure; and the cumulative population effects are, therefore, expected to be MINOR.

CONCLUSION: The cumulative effects on population are expected to be MINOR.

8. Effects on North Slope Sociocultural Systems: The causes of social and cultural change and the possible consequences of the development of offshore oil on NSB Native communities are complex and difficult to assess. The following analysis focuses on several aspects of Inupiat sociocultural systems that are currently undergoing change or may potentially be changed by oil development on the OCS.

- recent changes in the quality of community life.
- private-sector opportunities for Native enterprises.
- serious Native health problems of alcoholism and domestic violence.
- kinship and sharing.
- traditional values, including retention of the Native language.
- Native household income.
- changes in community services that affect traditional social behaviors.
- changing community attitudes towards administrative and governing institutions.

To assess the consequences of OCS development, the following interpretations make a number of analytical distinctions. One of the most important distinctions involves the effects that may be a result of oil revenues versus those consequences that may be a result of oil spills. Over $1 billion have been transferred to the NSB from bond sales guaranteed by the Borough's taxing ability of onshore oil facilities.

This flow of revenues has quadrupled the average Native-household income in less than a decade. At the household level, this increased income has the potential for changing Native patterns of sharing and cooperation. On a community level, this huge volume of revenues has required fundamental changes in the administrative and program content of NSB agencies. In addition, these increased revenues have had important consequences for the quality of life in NSB communities, private-sector opportunities for Native enterprises, and the social-service responsibilities of the NSB. Less clear is the strength of the relationship between increased revenues and the high rates of alcoholism and social pathology.

In direct contrast to onshore revenues, the potential for offshore revenues is modest. Technical Report 85, A Description of the Socioeconomics of the North Slope Borough (Kruse, Baring-Gould, and Schneider, 1983, 1985), clearly describes the Borough's limited taxing ability of offshore structures; and, despite the Borough's ability to tax onshore-support facilities, Section III.D.1 (Economy of the North Slope Borough) details the very limited revenues that the NSB can expect from Sale 97. In general, the total cumulative revenues from all offshore leases within the region are expected to be modest.

In contrast to the complicated and interrelated effects of oil revenues, oil spills present a significant and direct consequence to North Slope governing and administrative entities. In addition, oil spills present some potential disruption of traditional kinship and sharing behaviors.

It should also be noted that effects mentioned in this analysis can reverse themselves over time. That is, the consequences during the "boom" phase of oil development may be very much different from the "bust" phase when production has fallen off dramatically. For example, enhanced revenues during the production phase of oil development may increase the opportunity for private-sector Native entrepreneurs; but, as revenues decline and production drops, these same enterprises may find themselves without sufficient resources to continue in business.

During either the "boom" or the "bust" phase, it is possible that Sale 97 will have positive consequences for one aspect of Inupiat society and negative consequences for another. For example, increased NSB revenues may increase household income; be conducive to small-business development; and build an infrastructure of housing, plumbing, water, and sewers as well as police, fire, and educational services. At the same time, these revenues may fuel inflation, contribute to increased levels of alcoholism, and potentially affect traditional kinship and sharing networks.

Finally, important consideration must be given to the fact that sociocultural systems change independently of the effects of OCS or onshore-energy development. The intrusion of TV, radio, new technology and health-care systems, educational programs conducted in English, and formal State adoption agencies are just some examples of agents of change that are independent of energy development. These types of "ongoing" change may have important consequences for language retention and respect for traditional values and may be a decisive ingredient in the rise in social pathologies.

In summary, this analysis is cognizant of the following processes: (1) The effects of oil-based revenues versus the consequences of oil spills; (2) the dramatic differences in revenues produced from onshore facilities versus the modest revenue potential of offshore leases; (3) the "boom" versus "bust" phases of energy development, the potential for reversed effects over time, and the mixed (positive/negative) nature of effects; and (4) the contribution of "ongoing" social change, independent of the effects of energy development.

a. Effects of the Proposal:

(1) Effects of Revenues:

(a) Recent Changes in the Quality of Community Life: A survey of Inupiat adults 18 years and older conducted in 1977 by the Institute for Social and Economic Research revealed that a number of respondents felt that village life had become harder since 1970. The main reason cited for this increase in hardship was higher living expenses (Kruse, Kleinfeld, and Travis, 1981).

Section III of this EIS describes how cost-of-living differentials are calculated. In general, when one compares the NSB with Anchorage, it is much more expensive to live in the NSB. For example, housing (which includes utilities) is 40 percent higher, food is 53 percent higher, and transportation (which includes gasoline, spare parts, and non-local travel) is 27 percent higher. It should be noted that the actual effects of inflation on housing costs are difficult to determine because much of the Borough's rents and housing payments are subsidized. The Alaska Geographic Differential Study (1985) also indicates major differences in population, households, employment, and income between Barrow and Anchorage (see Sec. III of this EIS for further details).

Sale 97 is expected to have NEGLIGIBLE effects on North Slope cost of living, partially because of anticipated low employment projections for Natives in OCS development and partially because the anticipated enclave developments would be independent of local communities (i.e., enclave workers would not spend their wages in North Slope communities). However, the most important factor would be the inability of the NSB to tax offshore facilities for the revenues needed to fund capital-improvement projects.

(b) Private-Sector-Enterprise Opportunities: Wage income has become an integral part of Inupiat life. It provides cash for critical items such as heating oil and also purchases the technology now necessary to pursue subsistence activities. The economics section of this EIS has described the expected major declines in CIP spending with the consequent dramatic rise in unemployment. As onshore production and the revenues for CIP employment continue to decline, it is expected that Inupiat households on the North Slope will be turning to the private sector for employment.

Currently, public funds are used in Wainwright, Nuiqsut, and other North Slope communities to provide cash to households who have family members employed by local (Borough), State, and Federal institutions. The instability of economies based on public-sector funding has important consequences. As Jorgensen (n.d.) notes: "Because oil sales are the principal source of state and borough revenues, hence the principal source of state transfers to native villages, employment, construction and the availability of cash in villages are also especially sensitive to the price of oil and the demands for it."

As discussed in Section III.C.2.d, little is known about the current private-sector infrastructure in the larger NSB communities; the details of the decline in small businesses in Nuiqsut also are discussed in this section. It does not appear that small businesses will provide viable entrepreneurial or wage-employment opportunities to meet the needs of Inupiat households during the "bust" phase of energy development. In summary, with miniscule revenues predicted for the NSB from Sale 97 and with very little CIP employment projected in the smaller coastal communities, opportunities for Native entrepreneurs and for Native employment are expected to decline in Barrow and decrease dramatically in other NSB communities. Thus, Sale 97 is expected to have NEGLIGIBLE consequences for improving these aspects of the economic quality of life for North Slope Native households.

(c) The Effects of Community Services on Traditional Social Behavior: Section III.C.2.d details the enormous growth in responsibility accepted by the NSB in the social-service and health-care areas. For a number of reasons discussed in earlier sections--oil-company use of enclaves, the Borough's inability to tax offshore facilities, the role of the State legislature in determining the Borough's ability to tax, the small potential for local employment, and so forth--community social-service consequences caused by

Sale 97 are expected to be NEGLIGIBLE. Thus, ongoing social change and effects from revenues from onshore development are the most important factors in changes in traditional behavior such as adoption.

(d) Social Pathologies: In a discussion in Section III.C.2.a on kinship and sharing, it was noted that Inupiat perceived that the best aspect of village life that had remained unchanged was that villagers still helped and shared with each other.

On the other hand, Kruse, Kleinfeld, and Travis (1981) indicate that drinking and violence were the aspects of village life that had become worse since 1970. As Kruse notes:

> "The most important difference in conditions that residents of various villages rated as worst in 1970 and 1977 was that, while only residents of Barrow and Kaktovik recalled that fighting and drinking had been prevalent in their villages in 1970, by 1977 residents of all North Slope villages rated drinking and fighting as problems in their communities."

Thus, drinking and violence, already a problem in 1970, had become worse and more widespread by 1977. Whereas only 19 percent of residents recalled that these conditions were "bad" or "very bad" in 1970, 81 percent perceived them to be bad in 1977. There are some methodological problems with this study. Respondents were asked to remember conditions in 1970 and then compare them with conditions in 1977--a process that may entail the problem of "psychological leveling." However, whatever the problems with "psychological leveling," the behavior of minimizing traumatic events in the past, it is clear that, by 1977, 8 out of 10 North Slope residents felt alcoholism, drug abuse, and violence were serious community problems.

The etiology of alcoholism and violence is complex (see Kraus and Buffler, 1979; Jorgensen et al., 1982; Stillner and Stillner, 1974; Chance, 1965, 1966; Murphy, 1965; Kiev, 1964; and Klausner and Foulks, 1982, for divergent and often contradictory perceptions and explanations). It is difficult to assert which is the most important cause, given the large number of independent variables--e.g. social change caused by the introduction of large amounts of wage income, "acculturation" caused by the intrusion of outside "institutions" such as schools and social services, increased "social mobility" that isolates individuals from extended kinsmen, "psychic stress" caused by socialization for a lifestyle that no longer exists, and so forth. In fact, the whole relationship between rapid social change and substance abuse, homicide, suicide, and domestic violence has been challenged by Jorgensen et al. (1982), who after a careful analysis of time-series data concluded there was no convincing statistical evidence to support this view. As Luton (1986) suggests, the methods of collection and the quality of the data on substance abuse, homicide, suicide, etc., have varied over time, making meaningful time-series analysis difficult. In addition, other types of formal statistical analysis (e.g., path analysis) have yielded ambiguous results, and much of the variation remains unexplained. Measurement problems are endemic; concepts such as "psychological stress," "acculturation," "role," and so forth have been difficult to define, let alone measure.

Unfortunately, little solid evidence is available to link social pathologies with one or two discrete social causes. Prudent analysis would indicate that the massive changes (from a variety of causes) that have taken place in Inupiat society in the last century share a major part of the responsibility. Disease, widescale population relocations, the intrusion of dominant outside institutions such as schools and government bureaucracies, dependence on wage income, and the recent large-scale consequences of onshore revenues have dramatically altered the content and context of traditional Inupiat society. Many of the explanations described above assume that these changes have resulted in a number of stresses (perhaps most noticeable in their effects on self-esteem), some of which are expressed in violent and inappropriate behavior. From the standpoint of measuring the effects of energy development on these behaviors, it is important to point out that many Native communities in Alaska experience these problems despite having little or no involvement with onshore or offshore activities. Thus, it seems reasonable to conclude that changes caused by the intrusion of outside institutions, even without the massive effects of onshore development, are the locus for the complex interplay of forces that lead to social pathology. Given Sale 97's expected slight contribution of revenues to the NSB, the anticipated use of enclaves, and the potential short-term disruption of subsistence activities, the sale is expected to have only a MINOR influence on social pathologies.

(e) <u>Kinship and Sharing</u>: Davis (1978) concludes that: "Since family and kin are consistently reported as being key to Native life . . . if change occurs within these relationships, we may assume important change has occurred." Numerous ethnographies indicate that it is obvious, even to the most casual observer, the central role that extended families play in Native life.

Wage income has the potential, as evidenced in the larger society, of "separating" traditional households from the interdependencies that exist among extended families. However, Inupiat households, and their kinship unit, the family, do not function in isolation (see discussion of cultural values in Sec. III). In addition, given the current decline in wage employment, few households will wish to function as separate economic units. As wage income declines, Inupiat households will have to cope by sharing a combination of sporadic wage income, transfer and welfare payments, and subsistence products (which account for over half their diet) among several households.

During the last decade, the large increase in employment and wage income derived from North Slope energy revenues had the potential, in at least an economic sense, of isolating households from their traditional context of interhousehold support. And other forces have added to the strain: a need for privacy, the increased availability of housing, the stresses of balancing one's own family needs against the demands of extended kin, and the expectations of generosity. Before summarizing Sale 97's expected contribution to these changes in kinship behavior, recent changes in sharing and reciprocity need to be analyzed.

(f) <u>The Persistence of Sharing Bowhead Whale Meat</u>: Worl and a number of other authors (e.g., Luton, 1985; Burch, 1975; Alaska Consultants, Inc., and ACI-Braund, 1984; Nelson, 1982; Chance, 1966) have described the formal Inupiat distributional rules for several sea mammal species, e.g. bowhead whale. In addition, Worl has documented the distribution of the 1978 whale harvest among 11 communities. Her study found a significant reduction in intercommunity distribution; however, the customary initial (among the whaling crew and extended kin) and secondary (community-wide ceremonies) distribution patterns still persist.

(g) Changing Attitudes Towards Sharing Bowhead Whale: ACI-Braund (1984) found that over 95 percent of their Inupiat respondents felt that people in their villages were as interested in bowhead whaling today as they were 10 years ago (61% stated they were more interested). It is noteworthy that the only community with a significant drop in interest (Wales) had a limited number of families involved in whaling; and, because of a lack of wage income, few families could afford the prohibitively high startup costs required to outfit a whaling crew.

It is also interesting to note that respondents who asserted increased interest in whaling stated that the rulings of the International Whaling Commission (IWC) 1978 quota and cultural revitalization were the major reasons for their increased interest. Over 98 percent of the respondents in the subsistence study of Eskimo whaling villages said they usually share meat with other people. Nearly two-thirds said they share meat primarily because it was their tradition and custom.

(h) Changes in the Sharing of Meat: Paradoxically, while it was nearly universal to share Native subsistence products (whale, seal, caribou, fish), a large proportion of ACI-Braund's (1984) respondents (over 50%) did not distribute store-bought meats such as beef, pork, chicken, or lamb. The most common rationale for this (44%) was that it is not a custom to share this type of meat. Moreover, 28 percent of the nonsharing respondents failed to share because "store-bought meat is too expensive" (ACI-Braund, 1984). A sizeable percentage (40%) of those who did share store-bought meat did so only at meals and did not necessarily distribute it as they would have subsistence products. Store-bought-meat prices at the time of the interviews were two to three times higher than those in Anchorage.

Recent evidence indicates a sustaining interest in the sharing of subsistence resources, especially whale meat. Communities continue to share whale meat with one another, although at apparently reduced levels. Sharing and reciprocity within the community seem to be sustained, despite the huge influx of household income, and will probably be reinforced as wage income fueled by oil revenues continues to decline. Foods introduced from the outside are not regarded as traditional foods, and different rules are applied in their sharing and distribution.

Despite the Inupiat perception that there has been a relative decrease in sharing during the last decade (see Sec. III.C.2.c), the available information suggests that Sale 97 will have NEGLIGIBLE consequences for Inupiat kinship and sharing behavior. Sale 97 would provide minimal employment for Inupiat households. Only 18 jobs directly related to petroleum employment are anticipated, and less than 10 percent of the current jobs available in the NSB (which are supported from onshore taxes) would be supplemented by Sale 97 revenues (see Sec. IV.B.10 of this EIS for further details). In addition, because of the Borough's limited taxing ability on offshore facilities, only a small amount of revenues would accrue to the Borough; thus, additional employment through NSB CIP projects would be modest. With little potential for employment and with decreasing revenues from onshore development, Inupiat kinship and sharing will probably be reinforced in the trying days ahead.

(i) Traditional Values--Native-Language Retention: As Galginaitis (1984) clearly demonstrates in his analysis of traditional Inupiaq values and the changes that new social and economic situations are bringing to them, the preservation of Inupiaq values requires knowledge of the Inupiaq language. In fact, several sources quoted by Galginaitis (including Christensen, n.d., Inupiaq Ilitquisiat Yesterday, Today and Tomorrow) list knowledge of the Inupiaq language as the first priority for sustaining Inupiaq culture. Section III.C.2.c describes the rapid process of language loss now going on in North Slope communities. The major influence in this process is "ongoing" social change, especially the use of English in the school curriculum. Revenues from Sale 97 would have a small indirect influence on the NSB school system, which has only the most tenuous of links with other outside institutions (such as communications, or State and Federal bureaucracies), and should have minimal consequences for the migration of Native families. Given these considerations, Sale 97 is expected to have NEGLIGIBLE consequences for Native-language retention.

(j) Effects of Energy Development on Community Attitudes Toward Government: McBeath (1981), Smythe and Worl (1985), and Klausner and Foulks (1982) detail the growth in political institutions on the North Slope. Using the NSB as an example, one notes that 2 years after its incorporation in 1972, the NSB assumed responsibility for health services, light power, heat, water, transportation systems, libraries, airport, solid-waste collection and disposal, and housing and urban renewal. Police powers were assumed by the Borough in 1976. In the NSB government, an elected mayor and assembly are vested with legislative and administrative power. The recent strain on political and administrative entities is forcefully revealed in the growth of the Borough budget (see Klausner and Foulks, 1982; McBeath, 1981; and Knapp, 1986) and the addition of new administrative and service personnel. For example, administrative personnel in the mayor's office grew from 2 in 1978 to a peak of 10 in 1983. In this same period, recreational department personnel grew from 0 to 6 (Smythe and Worl, 1985; McBeath, 1981). However, the real increase is revealed in overall employment. The NSB government grew from a handful of individuals in the mid-1970's to 823 individuals (including 356 CIP employees) as of July 12, 1980. These effects are almost entirely a product of onshore revenues; and, given its miniscule revenue potential, Sale 97 is expected have a NEGLIGIBLE effect on these ongoing changes.

(2) Effects of Offshore Oil Spills: It must be emphasized that the preceding discussions have been limited to the direct and indirect effects of revenue flows. The consequences of a large oil spill--for example, a spill of 100,000 barrels or greater--may be very different. Historically, local communities such as Wainwright and Kaktovik have opposed any OCS development, while the NSB has been conflicted by its need for revenues and has been more likely to compromise (e.g., agree to OCS development within the barrier islands but oppose development outside of them). A large spill may initiate sharp reactions against any forces of compromise. Within the NSB analysis of North Slope public testimony, Kruse, Baring-Gould, and Schneider (1983) show that a considerable proportion of the testimony focuses

on issues of local control. The testimony is directed at external government and industry activities that conflict with local policies. Associated with this testimony is the key Inupiat perception that there has been a lack of consideration of Inupiat public involvement in decisionmaking. Community attitudes as reflected in repeated public testimony indicate that Inupiat believe that regardless of the source of the oil spill--blowouts, tanker and pipeline spills, or ice damage to drilling rigs and wells--that oil would be swept under the ice and that cleanup would be impossible, particularly in the fall and spring when the ice movement is greatest or where pressure areas or ridges are involved. It is commonly believed that oil-spill technology is inadequate for cleanup in all but minor spills occurring under optimal conditions. Testimony on the threats from sea ice and the inadequacy of cleanup procedures is found in roughly equivalent proportions in the coastal villages, although they are mentioned less frequently in the interior villages of Atqasuk and Anaktuvuk (Kruse, Baring-Gould, and Schneider, 1983). Thus, an offshore oil spill associated with Sale 97 is expected to have MODERATE effects on community attitudes towards their governing and administrative institutions.

The Sale 97 scenario and the subsistence analysis in this EIS call for no long-term disruptions of subsistence species. Short-term disruptions of bowhead whale harvests would have MINOR consequences for Inupiat systems of sharing and reciprocity. These systems are based on a number of behaviors and would be flexible enough to absorb the temporary loss of a subsistence product.

(3) Summary: Sale 97 would provide limited revenues to the NSB. As a result, this sale is expected to have NEGLIGIBLE effects on the cost-of-living aspect of the community's quality of life. With miniscule revenues predicted for the NSB and with very little CIP employment projected in the smaller coastal communities, opportunities for Native entrepreneurs would decline in Barrow and decrease dramatically in the other NSB communities. Community social services are more a product of onshore revenues and ongoing social change, and their effects on traditional social behaviors (including language retention), as mediated through the influence of Sale 97, should be NEGLIGIBLE. The presence of enclaves and the considerable influence of other forces should limit the sale's effects on social pathologies to MINOR levels. Available information indicates that Sale 97 is expected to have MINOR consequences for Inupiat sharing and reciprocal behaviors. Although an oil spill (or spills) is expected to have MODERATE consequences for community governing and administrative institutions, the overall effect should not cause long-term chronic disruption of the entire sociocultural system nor lead to the displacement of the broad range of social and cultural institutions discussed in this analysis.

(4) Conclusion: The overall consequence of Sale 97 on Inupiat sociocultural systems is expected to be MINOR.

b. Cumulative Effects:

(1) Cumulative Effects of Onshore and Offshore Revenues:

(a) Quality of Community Life: Cost of Living: Up until this point, there has been no production of North Slope offshore oil. Because of this fact, overall cumulative consequences from offshore developments have been MINOR. The cumulative consequences of future offshore production are difficult to estimate; however, given transportation costs, the lack of diversified markets, and the effects of onshore development, it seems reasonable to assume that future inflationary pressures that are a strict result of offshore production would be no worse than MODERATE.

Cumulative effects from onshore-development projects and the indirect effects of tax revenues fueling CIP-project expenditures are MAJOR. Ongoing social change in the form of outside institutions probably adds a significant amount to inflationary pressures independent of energy development. Naturally, the national rates of inflation affect the people of the NSB in many ways--when they attempt to sell bonds, when they try to borrow money, what rate of return they receive on their investment portfolio, and so forth. The international monetary situation and especially the price of oil also have profound consequences. However, the economic and fiscal complexity of these relationships preclude their inclusion in this analysis.

Of real concern is the complex issue of the consequences of a rapid drop in wage-income flows to the community, an increased dependence on less remunerative transfer and welfare payments, and a cost of living inflated by earlier pressures. The "bust" phase of energy development may leave many households with too little cash to purchase expensive necessities such as fuel, housing, and food. These consequences may be somewhat ameliorated in Barrow, where a substantial administrative infrastructure is expected to continue to bring a steady (although much decreased) flow of wage income. Without these public-sector infrastructures, smaller communities such as Wainwright, Nuiqsut, and Kaktovik may be especially hard-hit. The downside of energy revenues may thus bring MODERATE consequences to the quality of life in Barrow but may have MAJOR consequences on the smaller communities.

(b) Private-Sector-Enterprise Opportunities: The cumulative effects of offshore leasing are difficult to predict but are expected to be MODERATE and positive. The cumulative effects of onshore-energy development have been MAJOR, positive, and short-lived. The ongoing effects of public-sector spending for small businesses are expected to be MODERATE, positive, and unstable.

(c) The Effects of Community Services on Traditional Social Behavior: To this point, the ability of local communities to control land use within the community, the use of the "blue ticket" whereby individuals judged to be detrimental to the community welfare are given one-way tickets out of town, and the compliance of the oil companies in regulating their workers' behavior have all minimized the consequences of outsiders creating an overwhelming demand on local social-service infrastructures. The use of enclaves has minimized friction between workers and local residents, and the decision by oil companies to comply with and enforce local ordinances has provided local communities with some measure of self-determination.

On the other hand, the rapid political and infrastructural changes occasioned by ANSCA and the rapid infusion of tax revenues have caused major changes in the Borough's social services. The situation has an ungainly balance. Because of cost reasons, both the State and the Federal Governments would like to relinquish their fiduciary responsibilities of delivering health and social services to the NSB. For its part, the Borough would like to have local control over services provided to local community members. Initially, revenues from onshore development allowed the NSB to assume some of these responsibilities, although it prudently declined to assume control of the local Public Health Service Hospital in Barrow. However, the difficulties of training and developing skilled administrators and professionals in a short period of time from within the local area have proved impossible. In addition, administrative and other difficulties have caused the Inupiat Corporation of the Arctic Slope (ICAS) to relinquish to the BIA some of the programs they had formerly administered. These administrative difficulties are now compounded by the rapid decrease in tax revenues. And while future onshore production presents the possibility of future NSB revenues, the social-service system for the NSB has been changed irreversibly.

The cumulative effects of offshore leases have been MINOR both in their consequences for creating demand for social services and in their indirect influence of generating income that has allowed the NSB to assume responsibility for the provision of social services. The consequences of future offshore leases are difficult to intuit. Proposed Chukchi Sea Sale 109 has the potential for a MODERATE effect on Wainwright, but this consequence will be dependent upon the construction of a pipeline during the production phase.

Whatever the mesh of NSB, Federal, and State-funded and -administered services that eventually develops, many aspects of Inupiat society--such as adoption--have been profoundly changed. Onshore-energy development and the revenues it has provided have been important participants in the MAJOR consequences experienced by NSB social services.

(d) Social Pathologies: The cumulative effects of offshore leases are almost impossible to predict. A series of large offshore finds that result in large amounts of increased cash flow to local communities or that result in serious disruption of subsistence activities have the potential for at least MODERATE effects. Anecdotal information reveals that drinking and violence plummet when individuals engage in subsistence pursuits away from the villages. More cash also opens the possibility for increased purchases of expensive controlled substances.

Historically, it is suggestive that abuse of alcohol and increased violence seem to be loosely connected to the increased flow of income into North Slope communities. During the peak of whaling and then again during the height of the fur trade, secondary sources seem to indicate the onset of socially dysfunctional behavior. During the "busts" that followed these economies, 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 seems rational to assume that the significant social changes encouraged and abetted by the huge cash flows from onshore oil development have played at least a MODERATE role in the expression of these problems.

(2) Offshore Development: Cumulative Effects of Oil Spills: As Kruse, Baring-Gould, and Schneider (1983) note about community attitudes towards oil spills: "Our review of the public hearing transcripts from the North Slope produced the primary conclusion that there is almost universal Inupiat opposition to OCS oil and gas development."

North Slope governing and administrative entities may find themselves in a no-win situation. Despite the opposition of local community leaders, OCS development continues, thus weakening local constituents' confidence in the ability of their institutions to control change. Yet despite their opposition and clear lack of influence in the process, local community leaders are likely to bear the brunt of the community's anger should a spill significantly disrupt subsistence pursuits, even for a short period of time. However, the effects of offshore spills on political institutions may be somewhat mitigated by recent changes in political attitudes towards onshore development. A recent monitoring study (that is, a followup investigation of original research) for the community of Nuiqsut concluded: "One of the largest attitudinal changes to have taken place in Nuiqsut is this realization that oil development must be accommodated rather than fought tooth and nail" (Galginaitis, 1985).

(3) Summary of Cumulative Effects of Offshore Oil Spills: In summary, the effects of one or two oil spills as a result of Sale 97 are expected to have a MODERATE consequence. However, while the consequences of a number of oil spills under the cumulative scenario would certainly contain additional stress, they should not lead to the replacement of existing governing and administrative institutions. Thus, one spill--or a number of spills--effectively has the same potential consequences for governing and administrative institutions.

However, the combined consequences to the entire sociocultural system from the cumulative effects of a series of oil spills from OCS development are expected to be MAJOR as institutions and individuals face their inability to control the decisions of outside political and economic forces. Offshore development also may exacerbate the already difficult situation with respect to substance abuse and personal violence. On the positive side, small businesses should benefit from any substantial offshore production.

(4) Summary of Cumulative Effects of Onshore Development: The cumulative consequences of onshore development have been MAJOR. Should production be augmented by other substantial finds, new technological innovations, the rise in the price of energy on the world markets, and/or the development of the North Slope's gas reserves, then these consequences would continue to be MAJOR for at least a decade. Overall, even given the perspective of hindsight, few would roll back the large wage incomes once available or return the large infrastructural improvements that have been a consequence of onshore activities. Thus, despite the severe stresses--to kinship and sharing, to inflation, to political institutions, and to the socialization of the young--precipitated by these huge cash flows, on balance, onshore development has had a net positive consequence. A caveat that might be applied to this judgment is the uncertain consequences of energy development on social pathologies. Alcoholism, domestic and personal violence, drug abuse, homicide, and suicide have manifold etiologies. And while social, cultural, and economic changes occasioned by energy development have some influence on these behaviors, it is difficult to partial out their contribution from those produced by other institutions--schools, social services, television, transportation--and the history of these problems during the last century.

MAJOR consequences for governing and administrative institutions, inflation, and social services have been on the debit side. On the plus side have been the MAJOR increases in NSB revenues and the increased viability of the small business economy. Both these major pluses may eventually have more serious negative consequences, as revenues have dropped precipitously. And while the cumulative effects of onshore development for kinship and sharing and social pathologies have been assigned MODERATE consequences, these are extremely difficult topics to analyze. In addition, these topics represent the polar antithesis of Inupiat perceptions of social change. Inupiat want their kinship and sharing values to remain constant, but they are concerned about the increases in the amount of drinking and violence. Yet energy development has the potential for drastically altering or accelerating these behaviors--with decreases in sharing and further increases in drinking and violence.

(5) Conclusion: Cumulative Effects of Onshore and Offshore Development: The cumulative effects to North Slope sociocultural systems from both onshore and offshore development are expected to be MAJOR.

9. Effects on Subsistence-Harvest Patterns: Section III.C.3 (1) describes the subsistence-harvest patterns characteristic of communities within the Beaufort Sea study area, (2) outlines the important seasonal subsistence-harvest patterns by community and resource, (3) provides figures depicting the areal extent of each community's general subsistence-harvest area and the timing of harvests, and (4) presents the estimated quantities of subsistence resources harvested. Sections III.C.2 and III.C.3 demonstrate that significant aspects of the area's economy, culture, social organization, political structure, normative behavior, and moral beliefs interact with, and depend on, the area's patterns of subsistence use. The sociocultural aspects of this problem are addressed as part of Section IV.B.8.

a. Effects of the Proposal: This section analyzes the effects of the proposal on the subsistence areas of Barrow-Atqasuk, Nuiqsut, and Kaktovik as well as a substantial portion of Wainwright's area. If commercially recoverable amounts of oil were discovered, pipelines and other onshore facilities associated with its development could affect terrestrial-subsistence species harvested by these five communities as well as marine-subsistence species. While the subsistence systems of communities outside of the study area are considered, for reasons stated in the analysis that follows, these subsistence systems are extremely unlikely to be affected by the proposed sale.

As noted in the description (Secs. III.C.2 and 3), onshore oil developments at Prudhoe Bay already have affected community subsistence systems of the North Slope. Many of these effects have been indirect--the result of increased wage work made available through NSB-funded projects and services. Wage work has led to an upgrading of hunting technology as well as a constriction of the total time available for hunting. However, over the life of this proposal, household incomes and available jobs are expected to decrease (see Secs. III.C.2 and IV.B.8). If this decrease occurs, hunting technology will remain constant while the time available for hunting will increase. Currently, constricting household incomes are encouraging increased harvest levels for many species; this trend also will continue.

(1) Effects on Subsistence Harvests by Resource:

(a) Effects on Marine Mammal Harvests: Limited evidence from the Canadian Beaufort suggests that bowhead whales may avoid areas of high industrial activity (Johnston, 1985). Beluga whales also may avoid such activities in the Arctic, while the distributions of other marine mammal species, including ringed and bearded seals and walrus, may be less sensitive to such developments (Sec. IV.B.4.d; see also Nelson, 1969). The scenario indicates that two production platforms, one located in the Beaufort Sea and the other in the Chukchi Sea, may result from the proposal. Because this level of industrial activity is not comparable to the high-activity levels found in the Canadian Beaufort Sea, it is not expected to result in distributional changes to bowhead and beluga whale populations. Thus, the proposal is not expected to affect subsistence-harvest patterns by affecting long-term distributional changes in marine mammal populations. Marine mammals might avoid the immediate vicinity of a production platform, but this would affect a total area of less than 20 square kilometers for both platforms, a tiny portion of the marine mammal-harvesting area of a North Slope community. Noise from supply boats and helicopters traveling between shore bases and the two platforms might occasionally disturb the hunting effort of a boat crew, causing an animal to flee before it could be harvested. However, supply traffic during production is not expected to be intense--an average of less than one helicopter trip per day and seven boats trips every 2 weeks may occur for each platform. Thus, effects would be intermittent and transitory and should normally produce no apparent effect on a community's subsistence-harvest levels or add measurably to the time and effort necessary to accomplish these harvests.

Because activities are more intense during exploration and development than during production, the effects of noise and traffic disturbance on marine mammal hunting is of most concern during the exploration and development stages. Under the proposal, two exploratory rigs would drill an annual average of three wells, mostly in the Beaufort Sea, for a period of 3 years.

Distributional effects to marine mammals might occur in the immediate vicinity of exploration-drilling units not only because of drilling activities and boat- and helicopter-supply traffic but also because of the operations of the associated icebreakers. In the case of walrus, ringed seal, and bearded seal, these activities might increase, slightly, the area around platforms that the animals would avoid. Even if the area triples, however, 60 square kilometers represent a small fraction of the marine mammal harvesting area of a North Slope community. Depending on the placement of a platform during a drilling season, a boat crew from Barrow, Nuiqsut, or Kaktovik might have to travel several extra miles to successfully harvest seals or walruses. During the exploratory phase, the operations of the associated icebreakers could affect the distribution of beluga whales sufficiently to limit their harvests for one or more seasons for one community (see Sec. IV.B.4.d). (Both Barrow and Kaktovik harvest an annual average of five beluga; Wainwright's annual average is 11.) If, during a drilling season, a drilling rig is operating off Point Barrow and the Barrow airport is used as a staging area, the intermittent effects of helicopter traffic might add slightly to the time and effort Barrow boat crews would expend to harvest walruses and seals. However, these effects should not be intense enough to change the harvest levels of these species. All such noise disturbances are localized and could not affect communities outside of the sale area.

Under certain conditions, exploratory-drilling units and their associated support activities could affect bowhead whaling for a community within the sale area. Such whaling usually occurs in the open-water area between the pack ice and the fast ice or 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 might become unavailable to whalers. Recent evidence indicates that a whale may react to vessel-engine noise 12 kilometers distant. For this reason, if an exploration platform were located near an open-water area that was being used for whaling and if the platform and icebreakers continued to operate, a community's whaling could be disrupted for the entire season in which the disruption occurs. A second effect could occur if heavy ice conditions during the fall caused support vessels to move within the same open-water areas used by whalers, which might cause user conflicts between vessels and whalers.

While the probability of a drilling rig being located in an area critical to whaling during the whaling season cannot be determined from the scenario, if this condition were to occur, it could be mitigated by ceasing drilling operations during the whale migration. Since fall ice conditions are unplanned events, the second effect--user conflicts between vessels and whalers due to bad ice conditions-- might be more difficult to mitigate. This problem has been reported once for the Alaskan Arctic; in the fall of 1985, extreme ice conditions curtailed the length of Kaktovik's whaling season and, at the same time, caused vessels traveling to their overwintering sites to operate near whaling locations.

As a result of this conflict, in 1986 a cooperative program was formed between the NSB, AEWC, the Nuiqsut and Kaktovik whaling captains, and those petroleum companies who were 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 AEWC pursuant to the 1983 Cooperative Agreement, as amended, between NOAA and the AEWC. A group called 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 conditions for the oil industry to provide certain kinds of assistance to the whalers. The program was successful. Kaktovik harvested three whales and Nuiqsut harvested one. This cooperative program is a good example of how interference with a subsistence harvest can be effectively mitigated.

Vessel traffic associated with preliminary activities such as seismic surveys and with exploratory activities such as the excavation of glory holes could produce similar user conflicts if they occur in the immediate vicinity of whaling activities during a year in which heavy ice conditions severely limit the length of the whaling season. Because of the limited geographical area and duration of preliminary activities (see App. G, Table G-12), such user conflicts are not expected to occur. However, should they occur, they are expected to have MODERATE effects on subsistence harvests of bowhead whales, the same level of effect that is expected from noise and traffic disturbances during the later phases of the proposal.

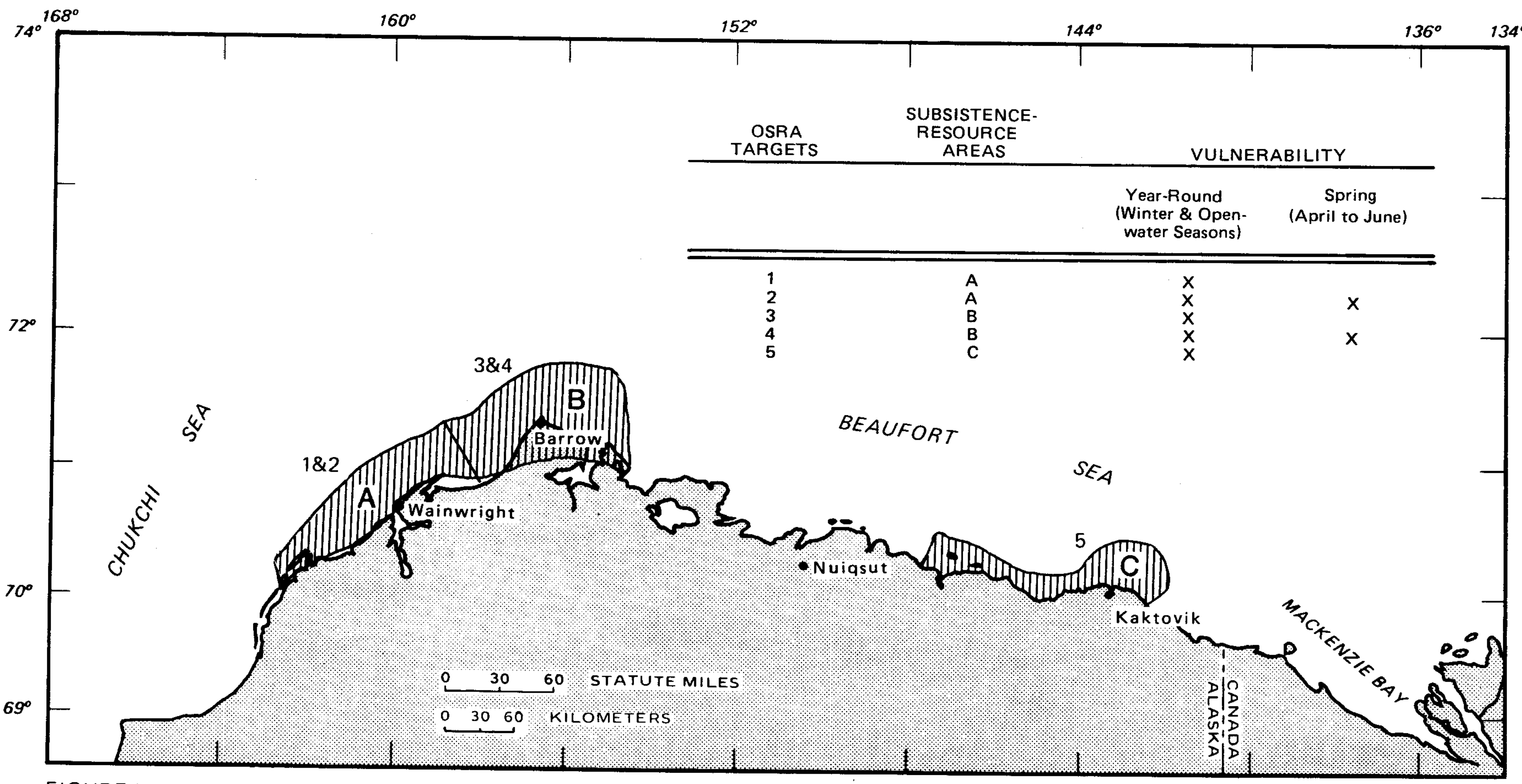
Since Oliktok Point lies outside of major marine mammal-hunting areas of North Slope communities, a pipeline landfall at this point is unlikely to have long-term effects on marine mammal-harvest levels. During its construction phase, an offshore pipeline from Oliktok Point to Harrison Bay might disturb the hunting of bearded and ringed seals or beluga whales by Nuiqsut and Barrow harvesters. Construction disturbances should not last longer than the construction season and, since the area involved lies outside of intensely harvested zones, construction activities should not make any species unavailable. Point Belcher lies in the center of an important bowhead whaling area for Wainwright and several miles from Peard Bay, an important area for harvesting bearded seals, ringed seals, walruses, and beluga whales. A landfall at Point Belcher would concentrate noise and traffic disturbance in this harvest zone. The harvests of bearded and ringed seals and walruses could be reduced during the construction period. Since bowhead and beluga whaling may be particularly sensitive to noise and traffic disturbance, the harvests of these mammals could be eliminated for 1 year or more. Thus, a landfall at Point Belcher is expected to have MAJOR effects on Wainwright's marine mammal harvests. No landfalls, due to the proposal, are expected to occur outside of the sale area (i.e., on the Alaska Peninsula).

Resource Areas A, B, and C (see Fig. IV-17) are used to indicate important marine mammal subsistence-harvest areas. There is a 4-percent chance of an oil spill of 1,000 barrels or greater occurring and contacting Resource Area A during the winter. There is a 1-percent chance of such an oil spill occurring and contacting this area within 10 days during the open-water season. Since Resource Area A includes most of the ocean area used by Wainwright's hunters, these figures indicate little likelihood that this community's harvests would be affected by contact from a spill.

Resource Area B includes much of the area used by Barrow hunters to harvest marine mammals. There is a 32-percent chance of an oil spill of 1,000 barrels or greater occurring and contacting this area during the winter and a 21-percent chance of contact from such a spill during the open-water season. During the winter, such contact could affect sealing and polar bear hunting; during the open-water season, it could affect sealing, walrus hunting, and bird hunting; during the fall, it could affect whaling and ocean-fish netting.

Resource Area C is used to indicate Kaktovik's and a portion of Nuiqsut's marine mammal-harvest areas. There is a 12-percent chance that an oil spill of 1,000 barrels or greater could occur and contact Resource Area C during Barrow's spring whaling season. There is a 24-percent chance of an oil spill of 1,000 barrels or greater contacting this area during the winter; and, during the open-water season, there is a 12-percent chance of a spill of this size occurring and contacting Resource Area C within 10 days. In the winter, such contact could affect Kaktovik's harvests of seals and polar bears; during the open-water season, it could affect this community's sealing, bird hunting, fall whaling, and ocean-fish netting, as well as Nuiqsut's fall whaling. Finally, there is a 50-percent chance of one or more spills of 1,000 barrels or greater occurring and contacting one of these resource areas during the winter and a 34-percent chance of such contact within 10 days during the open-water season.

These figures indicate that Barrow's, Nuiqsut's, or Kaktovik's bowhead whaling may be affected by an oil spill. If a whale recently has been oiled or has ingested oil, it will likely be rendered inedible or, at least, be perceived as such (Luton, 1985; USDOI, MMS, 1985d). Also, whales might avoid areas where oil is present. Since whaling activities are localized and occur within a short time period, an ill-timed oil spill could disrupt a community's subsistence effort for an entire season. However, it is more likely that a



OSRA TARGETS	SUBSISTENCE-RESOURCE AREAS	VULNERABILITY Year-Round (Winter & Open-water Seasons)	VULNERABILITY Spring (April to June)
1	A	X	
2	A	X	X
3	B	X	
4	B	X	X
5	C	X	

FIGURE IV-17. SUBSISTENCE-RESOURCE AREAS USED IN THE OIL-SPILL-RISK ANALYSIS spill would force hunters to move to a new location. This would shorten the whaling season and might decrease the number of whales harvested. If bowhead whales were oiled, it is possible the IWC could suspend subsistence hunting of the bowhead whale until research could be conducted to establish the effects of the oil spill on the bowhead population. However, should an oil spill occur when bowhead whales are in the Sale 97 area, it is not likely that sufficient numbers of bowheads would be affected to lead to an IWC suspension of bowhead whaling. Thus, while the effects of an oil spill on bowhead whaling could be MAJOR, they are expected to be MODERATE. Even a MODERATE effect on the harvest of bowhead whales could have a more intensive sociocultural effect on the Inupiat communities than such an effect on other subsistence harvests. This is because of the strong cultural importance of the bowhead whale, which is central to the major celebration, Nalukataq, and strengthens social and kinship ties (see Secs. III.C.2 and III.C.3).

While the effects of an oil spill of 100,000 barrels or more would be greater than the effects of a spill of 1,000 barrels, an oil spill of 100,000 barrels is unlikely. Under the proposal, there is a 6-percent chance of one or more oil spills of 100,000 barrels or greater occurring and only a 1-percent chance of such a spill contacting land anywhere during the open-water or winter season. If an oil spill of 100,000 barrels or greater occurred and contacted Barrow's, Nuiqsut's, or Kaktovik's marine mammal-hunting areas, the harvests of seals, walruses, and beluga whales could be reduced for more than 1 year and bowhead whaling could be curtailed for more than a year. These would be MAJOR effects. However, the low probability (less than 1%) of an oil spill of 100,000 barrels or greater contacting subsistence-use areas and affecting harvests indicates the effects from an oil spill are not expected to be greater than MODERATE.

Section IV.B.4 concludes that oil spills could cause some contamination of seals, loss of subsistence economic values of seal hides, and loss of 1 year's young in affected areas. Such contamination also could cause some mortality in the polar bear population. Such effects are most likely to occur in the Point Barrow area and between Harrison Bay and Prudhoe Bay where Barrow's subsistence area overlaps Nuiqsut's. The harvests of these marine mammals occur over a longer period of time than do the harvests of bowheads and are not as constrained by the lead system. For this reason, although the biological effects that may occur to seals and polar bears from an oil spill due to Sale 97 might cause harvesters to hunt longer or take extra trips, these effects should not reduce harvests for an entire season. Similarly, most beluga whales migrate north later than the bowheads and are not constricted by the lead system. For this reason, the subsistence pursuit of belugas is less likely to suffer from the direct effects of oil spills than is the case with bowheads.

Under the scenario, oil spills are expected to make bowheads locally unavailable for a period of time not exceeding 1 year and may reduce the availability of seals for less than 1 year. Although the numbers harvested may be reduced, bowhead whales and seals would remain available to any community that may harvest them. Since the scenario indicates that oil will be transported by pipelines, subsistence-harvest areas of other Alaskan (or Canadian) communities will not be affected by spills from Sale 97 oil carried in tankers. Under the scenario, noise and traffic disturbance associated with exploratory drilling are expected to reduce the availability of beluga whales for a period of less than 1 year for Kaktovik and Barrow, but this species is expected to remain available to these communities.

Noise and disturbance associated with the construction of a pipeline landfall at Point Belcher is expected to (1) make bowhead and beluga whales unavailable to Wainwright for more than 1 year and (2) reduce the availability of seals. However, seals would remain available for harvesting.

Thus, under the scenario, MODERATE effects on subsistence-harvest patterns are expected for Kaktovik, Nuiqsut, and Barrow and MAJOR effects are expected for Wainwright. Wainwright's harvest pattern would be affected in the following ways: (1) hunters would have to focus more heavily on caribou, a species of unreliable availability, and harvest greater amounts of resources such as seals and fish, resources that are considered less desirable; and (2) the total harvest levels may be reduced.

(b) Effects on Caribou Harvests: While caribou harvests vary greatly from year to year, on average caribou contributes over 50 percent of the subsistence diets at Wainwright, Barrow/Atqasuk, and Nuiqsut and more than 16 percent of the subsistence diet at Kaktovik (see Sec. III.C.3).

The effects of the proposal on caribou varies according to the location of onshore facilities; see Section III.B.6. Likewise, the proposal's subsistence effects would vary depending on the siting of onshore facilities--pipelines, roads, etc. Under the scenario, a landfall at Oliktok Point is likely. A pipeline and its associated road and traffic running from this point to TAP would disturb caribou of the Central Arctic herd that are harvested by people in Nuiqsut and Kaktovik. However, since such a pipeline is adjacent to present areas of oil development, its effects on caribou harvest patterns would be limited. Construction of the Oliktok landfall and pipeline and traffic from a maintenance road is expected to have few effects on the harvest patterns of Barrow and Nuiqsut hunters since this landfall is adjacent to Prudhoe Bay and Kuparuk oil fields, an area already closed to subsistence hunting. Thus, any disruption would occur on the periphery of areas in which caribou are harvested by people in Nuiqsut and Kaktovik.

In the event of a large western discovery, a pipeline running from Point Belcher through NPR-A to TAP would not cross major calving areas of the Western Arctic herd. However, traffic associated with a maintenance road might serve as an intermittant barrier to cow-calf movements and thereby delay some caribou movement during heavy traffic periods. However, since these delays would be intermittent, they are not expected to make caribou unavailable to subsistence hunters. During construction, noise and disturbance could cause caribou harvests to be locally unavailable at Atqasuk or Wainwright for a season, causing a MODERATE effect. Onshore pipelines create physical or legal barriers to access that make pursuit of wildlife more difficult (Kruse, Baring-Gould, and Schneider, 1983). However, since pipelines are constructed to allow for the passage of caribou, this should not become a major problem. Under all the scenarios, the proposal's effects on caribou harvests due to construction activities would occur only near onshore facilities--about 2 miles at most.

As offshore oil activities associated with the development of Sale 97 oil move east and west from the Prudhoe Bay-Kuparuk industrial area, industrial activities will overlap with the more-traditional subsistence areas (see Table IV-A-7 and Appendix B for a listing of major projects). New regulations may be imposed that prohibit hunting near pipelines or other facilities in order to safeguard pipelines, construction camps, and support facilities (Kruse et al., 1983). Recent evidence from Kaktovik and Nuiqsut indicates that even perceived restrictions to access have affected Inupiat-hunting patterns (USDOI, BLM, 1982; Pedersen and Coffing, 1985; King, 1986, personal communication). However, a landfall at Oliktok Point or at Point Belcher is not likely to substantially reduce hunter access to caribou at these sites since they are not located near important caribou hunting sites (see also Sec. IV.B.6 for a discussion of effects of the landfall on caribou).

Several thousand caribou frequent the barrier islands and shallow coastal waters during the summer insect season. If an oil spill contacts these areas, some caribou may become oiled, but effects on the caribou herd would not be significant (see Sec. IV.B.6). However, Barrow and Kaktovik take a high percentage of their caribou during the summer, along the ocean coast, by boat (see Sec. III.C.3). If an oil spill contacted the coast during the summer in an area that is intensely hunted, annual caribou harvests could be affected for 1 year because increased activities associated with oil-spill cleanup could temporarily disturb caribou from the harvest area due to greater contact risk; however, while the harvest would be affected, caribou would not become unavailable (a MINOR effect). This possibility is more likely in Barrow's subsistence area than in Kaktovik's. The coast between Point Barrow and Cape Simpson (Land Segments 19 through 23), an area from which Barrow hunters harvest caribou during the summer, has a combined probability of 21 percent of being contacted by an oil spill of 1,000 barrels or greater, within 10 days, during the open-water season. None of the coastal segments harvested by Kaktovik hunters have greater than a 1-percent chance of contact from such a spill. Probabilities of such contact of coastal segments harvested by Wainwright hunters is less, and no probability of such contact exists for Alaskan (or Canadian) communities outside of the sale area.

Because of onshore pipeline construction, effects to caribou harvest are expected to be MODERATE for Wainwright and MINOR for Kaktovik, Nuiqsut, and Barrow-Atqasuk. Should an oil spill occur and affect caribou harvests, these levels of effects are not expected to change. The MODERATE effects expected for Wainwright are particularly important to the community's hunting patterns. Because of expected effects to their marine mammal harvests, they may have to rely more than usual on caribou harvests.

(c) Effects on Fish Harvests: The reliability of fish and their year-round availability make them a very important subsistence staple (see Tables III-C-12 and III-C-13). The nearshore zone of the Beaufort Sea area, particularly the fish-overwintering areas in and near the major river deltas of the Canning, Meade, and Colville Rivers, would be the most sensitive to the effects of the proposal (Sec IV.B.2.a). Here, and upriver, people fish for the anadromous species--salmon, arctic char, and arctic and least cisco--and for broad and humpback whitefish (see Tables III-C-12 and III-C-13).

This nearshore migration and feeding area is not a significant spawning or rearing area for these species. Therefore, the low number of oil spills expected during the life of the field is unlikely to change the size of regional fish populations enough to affect subsistence fishing. If a large oil spill (1,000 barrels or greater) contacted one of the major river deltas (Canning, Meade, or Colville), effects on subsistence-fish harvests could be higher not only because of the biological consequences (see Sec. IV.B.2), but also because of tainting or perceived tainting (Ellanna, 1980; JMI, 1985). However, none of the river deltas that are important to subsistence fishing have greater than a 2-percent chance of contact by an oil spill of 1,000 barrels or greater within 10 days during the open-water months. Section IV.B.2 of this EIS indicates that very substantial declines in subsistence-fish resources could result from causeway construction; however, no such construction occurs under the scenario for this proposal. Boat noise and seismic activity are not expected to have large effects on subsistence-fish stocks (see Sec. IV.B.2). Seismic activity from Sale 97 would be greater than 3 miles from subsistence-fishing areas, and boat noise would have only transitory effects on fish. While some access problems may arise due to the placement of onshore facilities, harvest pressures are not expected to increase significantly. The proposal's effects on subsistence fishing are expected to be NEGLIGIBLE for all communities adjacent to the planning area.

(d) Effects on Marine and Coastal Bird Harvests: Marine and coastal birds are considered a primary subsistence species, not because of the quantity of meat harvested or the time spent hunting them, but because of their dietary importance during spring and summer and because they are a preferred food. According to Section IV.B.3, if an oil spill occurs during breakup or during the open-water period--the seasons when bird hunting takes place--it would likely have immediate effects on birds. Oldsquaws and eiders (both subsistence species) would be most likely to suffer direct mortality; brant and other waterfowl could be harmed indirectly through damage to food supplies. Resource Areas A, B, and C (Fig. IV-17) are used to indicate subsistence-harvest areas of coastal North Slope communities. There is a 1-percent chance of an oil spill of 1,000 barrels or greater occurring and contacting Resource Area A within 10 days during the open-water season. This means that Wainwright's bird hunting is unlikely to be affected by an oil spill. There is a 23-percent chance of contact from such a spill for Resource Area B and a 13-percent chance of such a spill occurring and contacting Resource Area C within 10 days during the open-water period. Since most eider hunting occurs on the ocean and along the coasts in 2 months during the spring and most brant hunting occurs along the coasts in 2 months during the fall, the probability that oil would affect subsistence-bird hunting is lower than the probability of contact for a resource area. However, if an oil spill were to occur, contact, and affect the birds during the bird hunting season in either the spring or fall, the harvest would become unavailable during that time. Such contact is expected to have a MODERATE effect. Such localized reductions are extremely unlikely to affect the subsistence harvests of more than one or two communities in the study area, however.

The noise caused by construction of oil facilities both offshore and onshore may alter waterfowl migrations and nesting patterns. Existing aircraft traffic in the Prudhoe Bay area already has affected common eider nesting success on some of the barrier islands. Construction also may disrupt waterfowl-food sources, but this is likely to be local and temporary. However, such low-level biological effects should be too widely dispersed to have significant effects on the bird harvests of any community.

(2) Summary of Effects on Subsistence Harvests by Community: The following discussion summarizes the preceding section by community; see Sections IV.B.9.a(3)(a) through (d) for the complete analyses.

(a) Wainwright: Only a limited portion of Wainwright's subsistence-use area lies within the Sale 97 proposal area. However, as indicated in Section II.A.3, a large western oil find could lead to the construction of a pipeline landfall at Point Belcher under the scenario.

Noise and disturbance due to the proposal are likely to occur well outside most of Wainwright's subsistence-use area. For this reason, while caribou and seal harvests may experience intermittent effects, such disturbances should not make them unavailable for an entire year. However, if a pipeline landfall is constructed at Point Belcher, bowhead and beluga whales may be unavailable to the community for more than 1 year during the life of the proposal. Since bowhead whaling occurs in narrow leads and whales can easily escape into the ice pack, this activity may be particularly sensitive to such disturbance. Because of the area's importance to Wainwright's harvests of other marine mammals as well, the construction of a pipeline landfall at Point Belcher may make seals unavailable for less than 1 year.

Oil spills are not expected to have large biological effects on bowhead whales, nonendangered marine mammals, caribou, or fishes; see Sections IV.B.9.a(3)(a) through (d). The low probability (1%) of an oil spill occurring and contacting the Wainwright subsistence-harvest area indicates little likelihood that the community's subsistence harvests would be affected; see Section IV.B.9.a(3)(a).

Except for construction associated with a Point Belcher pipeline landfall, such activities due to the proposal are likely to occur well outside of Wainwright's subsistence-use area, see Figure III-14. If a pipeline landfall were constructed at Point Belcher, construction activities may cause bowhead whales, beluga whales, bearded seals, and/or caribou to become unavailable for a season, a MAJOR effect (see Secs. IV.B.9.a[3][a] through [d] for the analyses). Under this scenario, the overall amount of subsistence foods harvested by Wainwright is expected to be reduced and this community is expected to experience a greater dependency on fish and ringed seals than it does normally.

Conclusion (Effects on Wainwright): Effects on subsistence harvests due to the proposal are expected to be MAJOR.

(b) Barrow-Atqasuk: Localized, short-term effects from noise and traffic disturbance are not expected to have long-term biological consequences on bowhead whales. However, since whaling occurs in narrow leads and whales can easily escape into the pack ice, this activity may be particularly sensitive to noise disturbance. During exploration and development, noise from support vessels may disrupt whaling at Barrow during one season, particularly if ice conditions were severe. Although exploration would last 5 years, disturbance of such activities is not likely to occur to such an extent that no whales are harvested for more than one season. Beluga whales may be more sensitive to noise and traffic disturbance than are bowheads. However, like the harvests of seals and polar bears, the harvests of belugas occur over a longer time period and in a larger geographical range. For this reason, beluga whales and other nonendangered marine mammals are not likely to be made unavailable for more than one season.

Oil spills are unlikely to have long-term biological effects on bowhead whales, nonendangered marine mammals, caribou, or fishes; see Sections IV.B.9.a(3)(a) through (d). However, an oil spill could affect Barrow's spring or fall whaling for 1 year. This would affect the availability of bowheads for no more than 1 year. An oil spill could also make waterfowl locally unavailable for less than 1 year.

Construction activities are not likely to greatly affect subsistence harvests. The construction of a pipeline from the TAP to Point Belcher may locally reduce the availability of caribou for less than 1 year for some areas harvested by Barrow-Atqasuk; see Section IV.B.9.a(3)(b) for the analysis. A pipeline from Oliktok Point to the TAP is likely to have only MINOR effects on the caribou harvests of Barrow. During its construction, such a pipeline may similarly locally reduce the availability of bearded seals for Barrow hunters.

Conclusion (Effects on Barrow-Atqasuk): The effects of the proposal on subsistence-harvest patterns are expected to be MODERATE.

(c) Nuiqsut: Localized, short-term effects from noise and traffic disturbance are not expected to have long-term biological consequences on bowhead whales. However--as in the case of Barrow--during exploration and development, noise from support vessels may disrupt whaling during one season. The availability of other marine mammals may be affected for less than one season; see Section IV.B.9.a(3)(a) for the analysis. Oil spills are unlikely to have long-term biological effects on bowhead whales, nonendangered marine mammals, caribou, or fishes. However, an oil spill could make bowhead whales (fall whaling) and/or waterfowl locally unavailable for 1 year or less; a MODERATE effect (see Secs. IV.B.9.a(3)(a) through (d) for the analyses).

The discharge of drilling muds and cuttings would not affect Nuiqsut's subsistence harvests.

Construction activities are not likely to greatly affect subsistence harvests. The only pipeline landfall that may, under the scenario, affect Nuiqsut would occur at Oliktok Point. A landfall in this area is likely to have only MINOR effects on the caribou harvests of Nuiqsut; see Section IV.B.9.a(3)(b) for the analysis.

Conclusion (Effects on Nuiqsut): The effects of the proposal on subsistence-harvest patterns are expected to be MODERATE.

(d) Kaktovik: During exploration and development, noise from support vessels may disrupt whaling at Kaktovik during one season, particularly if ice conditions are severe. Such a disruption would not make bowheads locally unavailable for more than 1 year. Because of noise and traffic disturbance, beluga whales may be locally unavailable for more than 1 year, but effects on other marine mammal harvests are expected to be MINOR.

Oil spills are unlikely to have long-term biological effects on bowhead whales, nonendangered marine mammals, caribou, or fishes. However, the localized effects of an oil spill during the fall hunt could cause bowheads to be locally unavailable to Kaktovik for 1 year or less, a MODERATE effect; see Section IV.B.9.a(3)(a) for the analysis. Oil spills could have a similar effect on the availability of waterfowl.

The discharge of drilling muds and cuttings is not expected to affect Kaktovik's subsistence harvests.

Effects on caribou harvests are most likely to occur from the placement of onshore-support facilities and pipelines. A pipeline landfall at Oliktok Point is too distant to affect Kaktovik's caribou harvests.

Conclusion (Effects on Kaktovik): The effects of the proposal on subsistence-harvest patterns are expected to be MODERATE.

(e) Other Communities: Possible effects on subsistence of noise and disturbance are very localized and would not affect the subsistence harvests of Alaskan (or Canadian) communities other than Wainwright, Barrow-Atqasuk, Nuiqsut, or Kaktovik.

Oil spills due to the proposal are extremely unlikely to contact subsistence-harvest areas of Alaskan (or Canadian) communities other than Barrow-Atqasuk, Kaktovik, Nuiqsut, or Wainwright. Hence, oil spills would not affect their subsistence harvests.

Onshore-support facilities and pipelines due to the proposal would be constructed only in the study area. Since effects from construction would be localized; they would not affect communities other than Barrow-Atqasuk, Kaktovik, Nuiqsut, or Wainwright.

Conclusions (Effects on Other Communities): The effects of the proposal on subsistence-harvest patterns are expected to be NEGLIGIBLE.

Summary of Effects (Affected North Slope Communities): The effect of Sale 97 on subsistence-harvest patterns is expected to be MAJOR in Wainwright; MODERATE in Barrow-Atqasuk, Nuiqsut, and Kaktovik; and NEGLIGIBLE in other communities.

(3) Conclusion (Effect on Subsistence-Harvest Patterns): Overall effects due to the proposal are expected to be MAJOR.

b. Cumulative Effects: Cumulative effects include effects from this Sale 97 proposal and other ongoing or planned projects on the North Slope and in the western Canadian Arctic. (For a complete list of these ongoing and planned projects, their scenarios and timetables, and the resource estimates involved, see Sec. IV.A.4.) The probability of any or all of the ongoing and planned offshore and onshore projects reaching the development stage is unknown. However, the following discussion assumes that all these projects will reach the development and production stage.

Subsistence effects of these projects may occur because of oil spills, noise and traffic disturbance, or facility sitings. Noise and traffic disturbance might come from seismic activities, the building and operation of drilling facilities, supply efforts, or the tankering of oil from the Canadian Arctic.

(1) Oil Spills: The effect of a single oil spill under the cumulative case would be the same as that under the proposal. However, 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 proposal. In the cumulative case, there is a 90-percent chance of an oil spill of 1,000 barrels or greater occurring. The most likely number of oil spills of 1,000 barrels or greater increases from 1 for the proposal to 24 for the cumulative case. The probability of an oil spill of this size occurring and contacting land within 10 days during the open-water season increases from 20 percent in the proposal to 76 percent in the cumulative case. For the proposal, there is a 6-percent probability that 1 or more oil spills of 100,000 barrels or greater would occur; for the cumulative case, the probability is 65 percent. Since oil spills associated with the Chukchi Sea Planning Area (proposed OCS Sale 109) tend to move westward away from the coast, most of the increased probabilities of contact occur within the Beaufort Sea Planning Area. For this reason, Subsistence-Resource-Area A (Fig. IV-17)--used to indicate Wainwright's marine mammal and waterfowl harvesting area for the oil-spill-risk analysis--has approximately the same chance of being contacted by oil in the cumulative case as it does in the proposal. It has a 1-percent chance of being contacted by an oil spill of 1,000 barrels or greater during the winter and the same chance of being contacted by such a spill within 10 days during the open-water season. As noted for the proposal, these figures indicate that Wainwright's subsistence hunting is not expected to experience any effects from an oil spill.

Subsistence-Resource-Areas B and C (Fig. IV-17) are used in the oil-spill-risk analysis to indicate marine mammal and waterfowl harvest areas in the Beaufort Sea Planning Area. Area B--which includes most of the area intensively harvested by Barrow hunters--has a 53-percent chance of being contacted by an oil spill of 1,000 barrels or greater during the winter, a 25-percent chance of such contact during the spring, and a 48-percent chance within 10 days during the open-water season. During the winter, an oil spill 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 seals, walruses, and shorebirds could be affected; and the fall harvests of bowhead whales could be affected. For the reasons explained above for the proposal, due to their short harvest period, an oil spill is expected to have MAJOR effects on the bowhead harvests of a single village. However, effects are expected to be MODERATE for all marine mammals (including bowheads) as well as for waterfowl. Since, in the cumulative case, a harvestable species is more likely to experience the effects of several oil spills than it is in the proposal, the likelihood of higher effects levels is also greater. Oil spills also could affect the harvests of fish. As in the proposal, spills are not likely to affect the population size of harvestable fish species that migrate up rivers. However, in the cumulative case, the ocean netting of anadromous fish, particularly salmon and capelin, between Barrow and Cape Halkett could be affected. There is an approximate 20-percent chance of an oil spill of 1,000 barrels or greater contacting this area within 10 days during the open-water season. Such contact could eliminate the subsistence harvests of salmon and/or capelin for 1 year or more for many Barrow residents. However, these are harvests of secondary subsistence resources; and, for this reason, such effects are expected to be MODERATE.

In the cumulative case, Subsistence-Resource-Area C (Fig. IV-17) has a 55-percent chance of being contacted by an oil spill of 1,000 barrels or greater in the winter and a 32-percent chance of being contacted by such a spill within 10 days during the summer. During the winter, the harvests of seals and polar bears may be affected; during the open-water season, the harvests of bowhead (fall) and beluga whales, seals, waterfowl, and anadromous fishes may be affected. For the reasons explained above for the proposal, the effects to bowhead harvests from an oil spill are expected to be MAJOR, the effects to the harvests of all marine mammal species and seabirds are expected to be MODERATE, and effects to the harvests of fishes in Resource-Area C from an oil spill are expected to be NEGLIGIBLE. However, since a harvestable species is more likely to experience the effects of several oil spills in the cumulative case than it is in the proposal, the likelihood of higher effects levels is also greater.

(2) Noise and Disturbance: Short-term effects from the construction of onshore-support facilities 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 and MINOR effects on caribou harvests. Wainwright may experience such effects from the construction of a pipeline from TAP to Point Belcher; Barrow and Nuiqsut may experience such effects from the construction of an onshore pipeline from TAP to Oliktok Point and an offshore pipeline from this point to Harrison Bay; Kaktovik may experience such effects from the construction of a pipeline to Bullen Point. (However, see the discussion below on the effects of siting a facility at Bullen Point.)

Certain birds, such as white-fronted geese during their spring migration, are reported to avoid areas where they see movement on the ground. Thus, construction activities could cause them to avoid one or more locations that would otherwise serve as productive hunting sites. However, this effect should be limited to the immediate location of construction activities.

Noise and traffic disturbance from onshore facilities also may affect maritime-subsistence 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. Since most marine-hunting activities occur within a wide area of ice in open water, normally such interruptions may cause boat crews to hunt longer or take extra trips but may not reduce the overall harvests of marine mammals or waterfowl. However, as explained for the proposal, beluga whales appear to be sensitive to noise and traffic disturbances and may avoid areas of heavy industrial activities such as are presently found in the Canadian Arctic. In the cumulative case, the harvests of beluga could be curtailed for more than 1 year at Wainwright (due to a landfall at Point Belcher, which would tend to concentrate noise and traffic disturbance near Peard Bay), Barrow (due to increased air traffic and increased exploratory activities east of Point Barrow and near Peard Bay), and Kaktovik (due to increased air traffic and exploratory activities). There may be MAJOR effects on the harvests of beluga whales. Also, as explained for the proposal, because of their short and ice-condition-dependent seasons, bowhead whale harvests are more likely to be affected by noise and traffic disturbance than are other forms of marine mammal hunting (other than beluga whaling). Already, such activities may have occasionally affected subsistence hunting. For example, Kaktovik whalers have contended that their 1985 fall-whaling season was adversely affected by vessels related to oil development operating in open-water areas. Because of its greater intensity, vessel and helicopter traffic is more likely to affect bowhead whaling in the cumulative case than in the proposal. However, effects are expected to remain MODERATE.

The amount of seismic surveying increases substantially in the cumulative case--from 1,892.4 kilometers in the proposal to 4,747.8 kilometers in the cumulative case. However, even with this increase seismic testing is not expected to greatly affect the size of regional biological populations of species used for subsistence purposes. For example, effects on fishes would remain MINOR, while effects on nonendangered marine mammals are expected to range from NEGLIGIBLE to MINOR.

(3) Facility Sitings: Pipelines and their associated roadways may affect caribou harvests over the long term. The biological effects from onshore sites on herd size, composition, productivity, or distribution would likely be concentrated in particular areas and in particular herds. For example, a pipeline involving the Arctic National Wildlife Refuge may affect the Porcupine caribou herd, harvested by Kaktovik, while a pipeline running from the TAP to Point Belcher may affect the distribution of the Western Arctic caribou herd, a herd depended on by hunters from Barrow, Wainwright, and Atqasuk. A landfall at Bullen Point may occur due to Sale 87 and would be located in an area intensively harvested by Kaktovik hunters. This siting of an onshore facility is expected to have MODERATE effects on Kaktovik's caribou harvests, while a landfall in conjunction with the development of the Arctic National Wildlife Refuge is expected to have MAJOR effects on these harvests.

Two causeways have been constructed thus far as a result of North Slope oil development, and another is proposed at Lisburne. According to the biological analysis, these causeways may greatly decrease the availability of various species of fish on the North Slope--particularly arctic cisco, which may comprise more than 50 percent of all fish harvested at Kaktovik, Nuiqsut, and Barrow. In these three villages, as well as Wainwright to the west, 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. Thus, the alteration in availability of fishes that may occur with causeway construction could adversely affect the long-term viability of North Slope subsistence systems. In the cumulative case, effects on harvest levels of arctic cisco at Nuiqsut, Barrow, Wainwright, and (possibly) Kaktovik are expected to be MAJOR.

(4) Summary: At Wainwright, cumulative-case effects to subsistence-harvest levels of bowhead whales, beluga whales, and bearded seals are expected to be MAJOR due to a landfall and onshore-support facility at Point Belcher. Effects to other marine mammals, caribou, and waterfowl are expected to be MODERATE. Due to causeway construction at Prudhoe Bay, effects to the harvests of anadromous fishes, particularly arctic cisco, are expected to be MAJOR. At Barrow, due to noise and traffic disturbance, the effects on

harvests of beluga whales are expected to be MAJOR. The combined effects of noise and traffic and oil spills on bowhead whale harvests may be MAJOR but are, as in the case of the proposal, expected to be MODERATE. Effects to other marine mammal, caribou, and waterfowl harvests are expected to be MODERATE, while--because of causeway construction--effects on the harvests of anadromous fishes are expected to be MAJOR. In the cumulative case at Nuiqsut, the effects are most likely to be similar to Barrow's. At Kaktovik, effects levels may also be the same except for caribou: because of a landfall at Bullen Point and possible oil development in the Arctic National Wildlife Refuge, effects on caribou harvests at Kaktovik are expected to be MAJOR.

(5) Conclusion: In the cumulative case, effects to North Slope subsistence harvests are expected to be MAJOR.

10. Effects on the Economy of the North Slope Borough:

a. Effects of the Proposal: Most of the information that follows on the economic effects of proposed Sale 97 in the NSB is summarized and incorporated by reference from the Economic and Demographic Systems and Base Case Projections on the North Slope Borough (University of Alaska, ISER, 1986). This report was prepared using the employment projections for Sale 97 prepared by MMS (see Appendix I, Table I-2).

(1) NSB Revenues and Expenditures: As discussed in Section III.D.1.a, total-property-tax value in the NSB and NSB revenues are projected to steadily decline under existing conditions. However, as also discussed in Section III.D.1.a, these revenues will be determined by several different factors. Therefore, the revenue projections should be used with the understanding that many uncertainties exist about these factors. The proposed sale is projected to increase property-tax value starting in the year 1989. This value is expected to reach a maximum of 3 percent above the declining existing-condition level between the years 1998 and 2010. The two expenditure categories that affect employment--operations and Capital Improvements Program (CIP)--are projected to steadily decline under existing conditions. Of these two categories, only expenditures on operations would be affected by the proposed sale's effects on taxable property value. CIP expenditures that have generated many high-paying jobs for residents would not be affected.

Sale 97 is projected to increase operating revenues less than 5 percent above the declining existing-condition levels up to the year 2005, except for the years 1998 and 1999. Revenues are expected to be 10 percent and 8 percent above the existing-condition levels in the years 1998 and 1999, respectively, as a result of the construction activity concentrated in this 2-year period that would affect both employment and population. The population effect of sale-induced employment would affect NSB revenues by allowing collection of additional intergovernmental and property-tax-operations revenues that are proportional to NSB population. The percentage effect on operating revenues would begin to rise again after 2005 because of the expected declining existing-condition level and the induced-population effect on revenues.

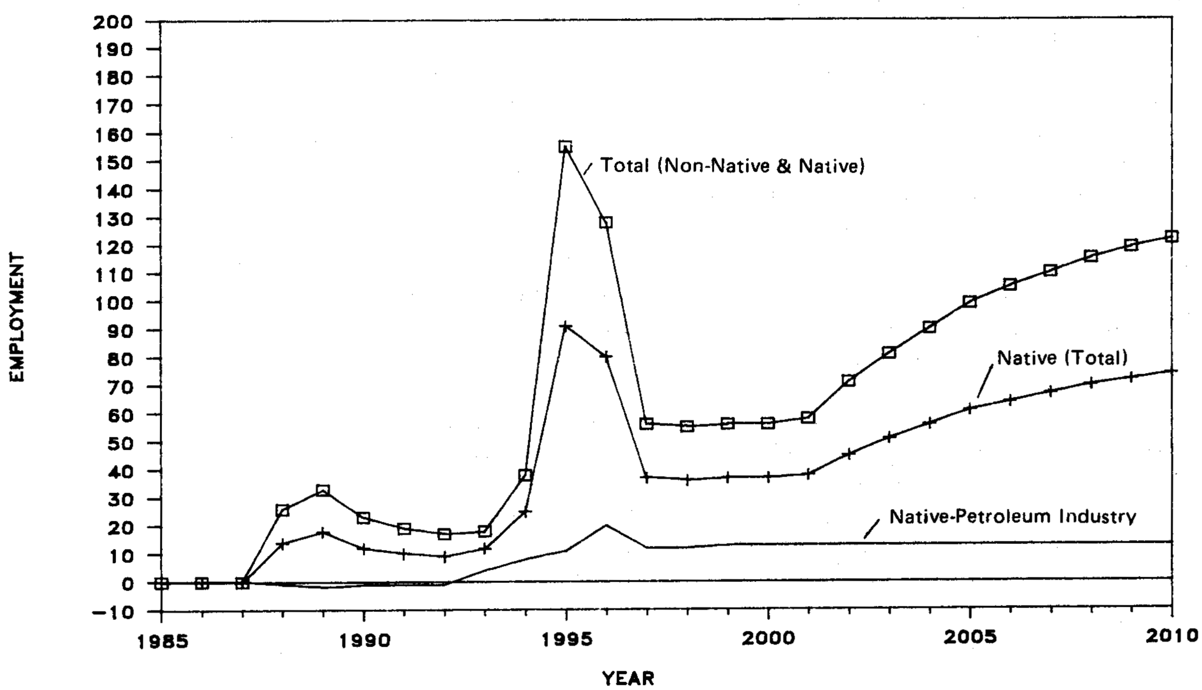
(2) Employment: The gains from Sale 97 in direct employment would include jobs in petroleum exploration and development and production and jobs in related activities. The estimated peak employment, including petroleum-industry-headquarters jobs in Anchorage, would be 2,190

jobs in the year 1998 (see Appendix I, Table I-2), of which 1,383 would be offshore and 807 would be onshore. Additional projections are as follows: throughout the production phase, total employment would average about 700 jobs, of which approximately 300 would be onshore. All of these jobs, except for the small percentage of headquarters jobs, would be filled by commuters who would be present at the work sites approximately half of the days in any year. Most workers would commute to permanent residences in the following three regions of Alaska--Southcentral; Fairbanks; and, to a much smaller extent, the North Slope. Some workers would commute to permanent residences outside of Alaska, especially during the exploration phase. 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 97 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.

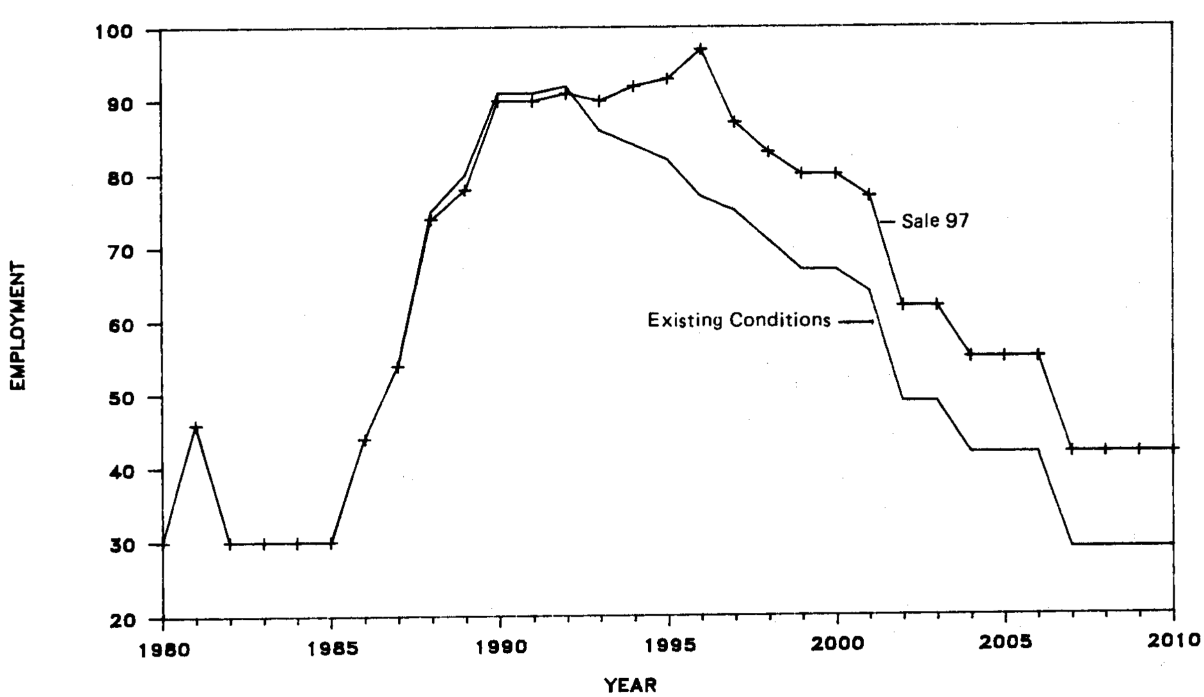
While the proposed sale is projected to generate a large number of industry jobs in the region, the number of jobs filled by permanent residents of the region is not projected to be large. The predominant factor in the decline of employment in both cases is declining NSB expenditures. Total sale-case resident employment is expected to be less than 10 percent greater than existing-condition employment until 2010, when increases in sale-related employment and decreases in total existing-condition employment should combine to produce a sale effect greater than 10 percent. In the years 1998 and 1999, the sale is projected to increase employment by 9.8 and 8.3 percent, respectively, because of concentrated sale-related construction in those years. Total sale-case employment should decline at a slightly slower rate, and therefore employment should not decline as far by the end of the projection period as it would under existing conditions. Even so, the increase in employment opportunities may partially offset declines in other job opportunities and, therefore, delay expected out-migration.

Figure IV-18 presents expected sale-induced resident employment divided into three categories: (1) residents working for petroleum-related industry (assumed to be all Natives), (2) Natives not working for petroleum-related industry, and (3) non-Natives. As can be observed, most of the sale-induced employment is not with the petroleum industry, and the number of sale-induced petroleum-industry jobs would drop as a percentage of sale-induced employment. The population effect on NSB revenues can be observed during 1989 to 1993, when petroleum-industry employment would decline in response to the expanded employment opportunities for Natives with the NSB. In addition to the constraints on industry employment of Native residents discussed in Section III.D.1.b, the projected small sale-induced effect can be attributed to a combination of an already historically high level of industry employment assumed under existing conditions and declining petroleum-related employment in the region (see Fig. IV-19). As industry employment declines in the region, there probably would be less effort made to recruit and retain Native workers.



Source: University of Alaska, ISER, 1986.

FIGURE IV-18. PROJECTED EMPLOYMENT EFFECT OF PROPOSED SALE 97 ON NATIVE AND NON-NATIVE RESIDENTS OF THE NSB, 1987 TO 2010



Source: University of Alaska, ISER, 1986.

FIGURE IV-19. PETROLEUM-INDUSTRY EMPLOYMENT (ACTUAL AND PROJECTED) OF NATIVE RESIDENTS OF THE NSB AS A RESULT OF PROPOSED SALE 97, 1980 TO 2010

As for the case under existing conditions, the unemployment rate for Natives is projected to rise from 0 percent in the year 1985 to 50 percent by the year 2002 and to remain at that level until the end of the projection period in the year 2010. While the unemployment rates are about the same for both cases, the sale case is projected to have a larger number of unemployed and a larger labor force, which results in similar rates. As under existing conditions, non-Native residents who lose their jobs are assumed to leave the region.

(3) Summary: Economic effects in the North Slope region are expected to be NEGLIGIBLE because the projected economic declines, with or without the sale, would not have any adverse consequences on the NSB government or residents. While most of the jobs in sale-related activities would be filled by commuters from outside the region, fiscal and employment conditions in the region would be improved. The effect of the proposed sale on resident employment would be less than 10 percent above employment without the sale in all years except 2010. Sale effects on Native and non-Native resident employment would be slightly higher and slightly lower, respectively. However, the unemployment rate for Native residents should still reach 50 percent by 2002, with or without the sale.

Economic benefits from new jobs, income, taxes, etc., that could result from the proposed sale are expected to occur after the level of petroleum activities on the North Slope (e.g., Prudhoe Bay) has begun to decline. This decline would not be reversed by the projected effects of proposed Sale 97.

(4) Conclusion: The economic effects on the NSB region are expected to be NEGLIGIBLE.

b. Cumulative Effects:

(1) NSB Revenues and Employment: 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 probably 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. The expected economic effects of the cumulative-case projects are considered by category--existing developments, exploration and potential development, and future lease sales. Most of the existing developments were considered as part of the existing-conditions case. The remainder of the existing developments that were not considered are expected to have NEGLIGIBLE economic effects and only marginally increase the economic benefits. Projects under exploration and potential development are expected to have MINOR economic effects and moderately increase the economic benefits. Future-lease-sale projects would have MINOR economic effects. The economic benefits would be greater but would still be considered a MODERATE increase.

The overall revenue and employment effects of these projects would be beneficial, but the magnitude and timing of these effects are extremely difficult to estimate. Major uncertainties exist about future world-energy prices; Arctic-development technology; scale, timing, and location of developments;

and hiring practices. If and when these factors result in a downturn of development activity, households (especially in the smaller communities) may have trouble maintaining standards of living attained during boom periods.

(2) Conclusion: Cumulative effects are expected to be MINOR in the North Slope region.

11. Effects on Land Use Plans and Coastal Management Programs:

a. Effects of the Proposal:

(1) Land Use Plans: Land requirements for activities associated with Sale 97 include onshore-support facilities, hydrocarbon pipeline rights-of-way, transportation corridors, docking facilities, and airfields (including helicopter pads).

On the Beaufort Sea coast, the development scenario places all onshore activities at locations previously developed--Camp Lonely, Oliktok Point, Deadhorse, and Bullen Point (Roberts, 1987). As a result, overall patterns of land use on the Beaufort coast should not change. Changes in land use would occur, however, if roads were built to connect these support bases with Deadhorse and the Dalton Highway. Land use also would be altered if pipelines were constructed and located onshore rather than offshore as hypothesized. As portrayed in the scenario, however, the onshore-pipeline segment should be short.

Activity on the portion of the Sale 97 west of Barrow could generate major changes in land use. The shift would be if open areas used for subsistence purposes were used as a landfall for the offshore pipeline, a support base, and a road/pipeline corridor from Point Belcher to TAP Pump Station 3. Production from this area is unlikely, however, unless it is combined with production from the Chukchi Sea and NPR-A.

Associated with any of the possible changes in land use are potential effects on biological resources and potential effects on subsistence and traditional uses of the areas. The potential biological effects identified in Sections IV.B.1 through 6 and potential social effects identified in Sections IV.B.7 through 14 are related in this section to the plans or programs in place that modify or control land use in the NSB--the Capital Improvements Program (CIP), the Comprehensive Plan and Land Management Regulations, and the Alaska Coastal Management Program.

(a) Capital Improvements Program: Activities generated by Sale 97 are assumed to occur within the boundaries of Service Area 10. Additional CIP projects may be needed to accommodate industrial growth in the support bases and to construct a road if the NSB would want a road along the pipeline to be public. Since revenue from oil and gas activities on the North Slope provides most of the backing for the bonds sold by the Borough to finance CIP projects, there is a potential economic link between this lease sale and the CIP. This link is examined in Sections IV.B.8 and 10.

(b) NSB Comprehensive Plan and Land Management Regulations: The zoning districts of the Comprehensive Plan would apply to developments hypothesized in the scenario. In Resource Development (RD) Districts, operators may prepare a master plan complete with all the necessary public and private facilities which, once approved by the Borough, permits all development included in the plan to become a use-by-right under NSB Code of Ordinances (NSBC) Title 19, the Borough's Land Management Regulations. A use-by-right is subject only to a 3-day permit review to determine if the development is consistent with the Master Plan and to identify any Master Plan conditions that apply. The Endicott Field, the only offshore development to date, was developed following NSB approval of its master plan.

Although a comparable process is likely for development from Sale 97, developers could elect to pursue individual permits (Lisburne developers chose this option). Permits issued individually could each require lengthy reviews. Because developments associated with this lease sale are assumed to be extensions of previous development, either process is feasible. Regardless of the process pursued, however, the review probably will emphasize the cumulative effects.

Some portions of the onshore pipeline from the Chukchi Sea would cross lands subject to the NSB Land Management Regulations. Conflicts associated with this development would be of a different nature than those experienced with the Endicott project. For Endicott, an extensive causeway system led directly onshore only 12 miles east of the road system in the Prudhoe Bay Unit. Effects of the causeway were primary concerns. For this development, no causeway is likely, but the development would occur in an area used extensively for subsistence purposes and in proximity to Wainwright. Although an analysis of the offshore and nearshore environment would remain important, policies concerning a variety of habitats and environmental factors, subsistence, and cultural resources would become central.

TAP Pump Station 3, the terminus of the hypothetical pipeline, has been identified as a permissible site for development under NSBC 19.80.021 (k), a Mandatory Policy detailing areas where development is allowed within the Haul Road Corridor Special Area. The pipeline to TAP could be prohibited if it significantly obstructs wildlife migration (NSBC 19.80.031 [i]). If permitted, the pipeline would be required to conform with design criteria that were enacted to facilitate migration. The pipeline probably would not conflict with Mandatory Policies that prohibit (1) depleting a subsistence resource below the needs of local residents or (2) precluding subsistence-user access to a subsistence resource (NSBC 19.80.021 [a] and [e]). As a result, the activities would not be prohibited automatically if the developer has complied with an applicable policy as best as possible and there is no feasible and prudent alternative to the proposed compliance (NSBC 19.80.030). Again, mitigating measures probably would be required to ensure conformance. Other policies cited by the NSB during permit reviews include: Mandatory Policies, Best Efforts Policies, and Minimization of Negative Impacts policies related to hazardous wastes, road crossings, and ice-road construction (NSBC 19.80.021 [d]; 19.80.025 [c]; 19.80.031 [a], [e], (o], [q], [r]; 19.80.032 [c]; and 19.80.040 [b]). These policies also would apply to development activity associated with Sale 97. Since the pipeline between Point Belcher and TAP would be developed only in conjunction with production from the Chukchi Sea (Sale 109), potential effects from this area will be examined further for that lease sale. Should this development occur, however, the effect on land use would be major, and conflicts with Land Management Regulations for subsistence and habitats would need to be resolved.

The Geographic Information System should enable the NSB to analyze development permits more quickly. As a result, the Borough should be able to adhere to its permit-review schedule without overburdening Borough resources.

(2) Coastal Management Programs: Coastal management policies apply to all activities occurring within the coastal boundaries of the NSB. This area encompasses all the shore bases hypothesized for proposed Sale 97 and most of the hypothetical transportation system. Offshore activities beyond the 3-mile State limit and onshore activities, such as pipelines located on Federal lands or inland of the 200-foot contour (except along several river systems where the boundary extends upstream [Fig. III-19]), are excluded from this policy analysis unless the activities could have a direct effect upon the coastal zone.

Standards of the Alaska Coastal Management Program (ACMP) are related to the scenario and to potential effects identified in other sections of this EIS. Policies of the NSB district program adopted by the Coastal Policy Council are not included because the U.S. Department of Commerce denied the State's request to include the NSB CMP in the ACMP.

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.

(a) 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 that can be placed inland do not displace activities dependent upon locations along limited shoreline areas. The only OCS development hypothesized in the scenario that requires a shoreline location is the landfall site for the pipeline. Most other developments could be located either inland or offshore. It is unlikely that this policy would create conflict with the hypothetical development.

State standards also require that the placement of structures and discharge of dredged material into coastal waters comply with the regulations of the U.S. Army Corps of Engineers (COE) (6 AAC 80.040 [b]). All offshore and much of the onshore development hypothesized in the scenario would be subject to the COE regulations. Hypothetical developments along the Beaufort Sea coast that would require COE permits include constructing a gravel island and berm; dredging and possibly burying pipelines; and placing pipelines and associated roads onshore. Along the Chukchi Sea coast, relevant development would include dredging and possibly burying pipelines; emplacing a bottom-founded structure offshore; constructing, in conjunction with a find in the Chukchi Sea, a shore base in the vicinity of Point Belcher; and building a pipeline with a road parallel to it to the TAP at Pump Station 3. 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. Analyses of potential effects noted elsewhere in Section IV.B would be honed for the particular development.

(b) Geophysical Hazard Areas (6 AAC 80.050): State policies require coastal districts and State agencies to identify areas in which geophysical hazards are known and in which there is a substantial probability that geophysical hazards may occur. Development in these areas is prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life have been provided.

A variety of hazards are evident in the lease area. Sea ice is the most dominant physical hazard to 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, especially within the 30-meter isobath (Sec. IV.A.3). Natural gas hydrates are found in Arctic environments. Problems arise if the release of hydrate gas is too fast; a blowout may occur and escaping gas may be ignited. Shallow gas deposits may also be a hazard if they underlie manmade structures or are penetrated during drilling because they reduce the ability of the sediments to support structures. In addition, erosion could cause stresses in pipelines or create vortex shedding and structural resonance (Sec. IV.A.3).

These hazards were related specifically to offshore activities in the EIS. The conclusion reached in Section IV.A.3 indicates industry currently has the ability to safely explore for and develop offshore oil in the Arctic, particularly to a depth of 30 meters. Conformance with MMS Operating Orders should ensure that such hazards are addressed adequately.

Onshore development associated with the Chukchi Sea portion of this sale will cover extensive areas of permafrost. Although only portions of the pipeline from the platform to the TAP would cross offshore areas and streams included within the coastal boundary, development along the entire route could be subject to problems with offshore hazards, permafrost, and aufeis. These hazards will constrain pipeline routes and be a source of constant concern to both those developing the field and those reviewing the development. Current and emerging technologies are considered adequate to meet the demands (Sec. IV.A.3). Conformance should be achievable by applying appropriate planning and engineering concepts.

(c) 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 following assessment focuses on those standards considered most applicable for this lease sale.

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 facilities along the Beaufort Sea coast are expected to tie into existing production lines and, therefore, would be compatible with existing uses. However, adverse environmental and social effects could be possible if pipelines along the Beaufort Sea coast are not placed offshore in the area of landfast ice as hypothesized. MODERATE effects on caribou could arise and access to subsistence resources could be curtailed by pipelines placed onshore, especially across the Arctic National Wildlife Refuge. Along the Chukchi Sea coast, the shore base at Point Belcher and pipeline to TAP may not be compatible with existing uses. In fact, the base at Point Belcher would be a major shift in land use that could affect both subsistence resources and access to subsistence resources. Therefore, prior to construction, these adverse social effects must be minimized.

Other ACMP standards require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability (6 AAC 80.070 [3] and [13]). Onshore activities hypothesized for the Beaufort Sea coast are consolidated. To the greatest extent possible these activities are placed in Deadhorse, the center for oil and gas activities on the North Slope. Less-extensive support bases are located at three additional sites along the coast--all of which are or have been subject to development. Although other sites may be preferred if the field developed for Sale 97 is a great distance from the sites used for Sale 87 development, potential conflict with these policies could be determined only when the sites are identified. Development along the Chukchi coast, however, could create severe conflicts with these policies. No other facilities are near, and the area is used extensively for subsistence hunting.

Facilities must be designed to permit free passage and movement of fish and wildlife with due consideration for historic migratory patterns (6 AAC 80.070 [12]). As is evidenced by the Endicott 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. No causeway is hypothesized for this development; however, berms may be used to bring pipelines ashore. Although a berm would be less extensive than a causeway, a berm would raise similar issues. Studies undertaken in conjunction with the Endicott project and for the proposed Lisburne causeway should provide important information for future decisions on causeways and berms. Offshore pipelines should pose no barriers to migrating fish and wildlife.

Construction associated with energy-related facilities resulting from Sale 97 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.

(d) Transportation and Utilities (6 AAC 80.080): The State standard requires that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Assuming that after an offshore pipeline crossed the beach it would continue inland of the beaches, conformance with this policy is possible.

(e) Mining and Mineral Processing (6 AAC 80.110): ACMP standards require that mining and mineral processing be compatible with the other standards, adjacent uses and activities, State and national needs, and district programs (6 AAC 80.110 [a]). Sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits when no feasible and prudent noncoastal alternative is available to meet the public need (6 AAC 80.110 [b]).

Extraction of sand and gravel is a major concern on the North Slope, and gravel requirements associated with development from blocks leased in Sale 97 would be extensive. Gravel resources are needed for construction pads for all onshore development to protect the tundra, and for roadbeds, berms or causeways, docks, and island construction. Assumptions for development along the

Beaufort Sea coast include one gravel island, possibly one berm where the pipeline would come onshore, and an addition to shore-base facilities. Development of a field north and west of Barrow would occur in conjunction with development from Sale 109 and would require a major commitment of gravel. Gravel would be needed for the berm to bring the pipeline onshore, to develop the shore base and airfield at Point Belcher, and to construct the pipeline and associated road and heliopads to the TAP at Pump Station 3.

The ACMP standard for gravel extraction sited earlier would apply to the pipeline from the Chukchi Sea coast because the nearshore area as well as several river crossings are either within the coastal boundary or could have a direct effect on uses in the coastal zone. Given the national importance of developing oil reserves within the U.S., these developments would conform to the first criterion for exemptions--that there be a significant public need for the development. Although industry's preferences for gravel sources and the CMP policy may diverge on occasion from those that are deemed consistent with the CMP policy, conflict is not inherent in the scenario.

(f) Subsistence (6 AAC 80.120): State standards guarantee opportunities for subsistence use of coastal areas and resources. Subsistence is a primary concern of the residents and occurs throughout the NSB. The prevalence of subsistence use of land in the NSB is evident in the NSB Land Management Regulations, in which all lands outside the Village, Barrow, and Resource Development Districts are designated as a Conservation District. The intent of that designation is to conserve the natural ecosystem needed to support subsistence (NSBC 19.40.041).

Potential conflicts with the subsistence standard are assessed with respect to the effects of the proposal in Section IV.B.9. Along the Beaufort Sea coast, this proposal offers for lease the entire marine-subsistence areas of Barrow, Kaktovik, and Nuiqsut. If an oil spill occurred in the limited area used for whaling during the brief period in which whaling takes place, a community's subsistence effort could be disrupted for an entire season. An offshore spill also could affect resources in nearshore areas used for subsistence purposes (Secs. IV.B.2, 3, and 6). Onshore development could affect caribou, especially during construction. These effects along the Beaufort Sea coast would possibly conflict with the subsistence policy.

Development along the Chukchi Sea coast could affect a substantial portion of Wainwright's marine-subsistence area. As on the Beaufort Sea coast, subsistence could be affected by oiling or shifts in migration patterns of subsistence resources. These effects would be accentuated, however, because of the proximity of the hypothetical shore base at Point Belcher to Wainwright. Moreover, siting a shore base at Point Belcher could obscure three archaeological-resource landmarks currently used by whalers (Luton, H., personal comm.). The support facility could have a MAJOR effect on Wainwright's subsistence and could conflict with the subsistence policy.

(g) Habitats (6 AAC 80.130): The ACMP 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]). Habitats of particular relevance for this analysis include the offshore; barrier islands and lagoons; wetlands; and rivers, lakes, and streams.

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. Some effects in the offshore habitat could be MODERATE in the unlikely event that an oil spill occurred in a sensitive area, such as Stefansson Sound or the lead system off Barrow, at a time when resources are present. However, most offshore effects are not expected to exceed MINOR. This level of effects would not preclude offshore development, assuming the developer has undertaken all feasible and prudent steps to maximize conformance.

Barrier islands and lagoons characterize the Beaufort Sea coast where 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]). No causeways are proposed; therefore, alterations to these habitats should not result from the proposal. Disruptive activities, however, could occur. During the construction of Mukluk Island, Thetis Island was used a transshipment point for gravel. Gravel was stockpiled during the winter months in the least sensitive area of the island and was barged to the construction site during the open-water season. Similar arrangements could occur for the construction of the gravel island associated with Sale 97. This activity could increase the level of disruption of local populations of nesting, feeding, and molting birds on the barrier islands and lagoons noted in Section IV.B.3. Oil spills are assumed to occur as a result of this lease sale. Elson Lagoon and Simpson Lagoon are those at greatest risk from an oil spill. However, there is less than a 10-percent risk to any lagoon habitat as a result of this proposal. As a result, no substantial conflict with this habitat policy should occur.

Much of the uplands in the NSB are considered wetlands. Therefore, onshore development would need to be designed and constructed to avoid adverse effects on the natural drainage patterns, destruction of important habitat, and the discharge of toxic substances (6 AAC 80.130 [c][3]). In Section IV.B.3, the amount of tundra habitat in the North Slope used by development for this lease sale is estimated to be less than 1 percent; an amount considered insignificant to the bird populations of the North Slope. Pipelines and roadways would transect this habitat both along the shore and farther inland, affecting caribou habitat and creating the potential for an oil spill. Effects on caribou are expected to be minimal. Scarring of the landscape and ecosystem could result from an oil spill due to removal of contaminated soil and vegetation or even heavy foot traffic. However, newer cleanup techniques, such as low-pressure hosing combined with clipping of oiled vegetation, provide both ecologically and technologically sound means of cleaning some of these areas (Sec. IV.A.2). Restrictions on storing toxic substances are covered more completely by policies related to the following topic--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]). These habitats could be affected by construction activities and gravel extraction. Gravel extraction is regulated under specific policies described earlier in the section on mining. Gravel-extraction activities also would need to be conducted consistent with this policy to ensure that the riverine habitat and fish resources are protected. Pipelines, especially the pipeline from Point Belcher, would cross several streams and rivers within the coastal area of the NSB. Special care would need to be taken both to protect the stream or river habitat and to prevent the streams from affecting the pipeline and roadway. This attention should ensure that all feasible and prudent steps are taken to protect the river, lake, and stream habitats.

(h) 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.

Water quality can be affected by oil spills, deliberate discharges (e.g., muds and cuttings, formation waters, and sanitary waste), and dredging and gravel operations. An accidental oil spill is very likely to occur. One spill of at least 1,000 barrels has 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 below State and Federal standards (Sec. IV.B.14). Only a spill of 100,000 barrels or more could cause a moderate effect on water quality. Chronic minor spills might have a MINOR effect on water quality (Sec. IV.B.14).

Effects of dredging on water quality are expected to be short term and local and fall within State and Federal standards (Sec. IV.B.14). Even construction of the gravel island that would create turbidity over a total area of 7 kilometers would have only NEGLIGIBLE effects.

Water quality also could be affected by deliberate discharges. Discharges of muds, cuttings, and drilling fluids are regulated closely; NEGLIGIBLE effects are expected (Sec. IV.B.14). During production, the discharge of formation waters into the sea could have local, long-term effects. However, it is likely that formation waters would be reinjected rather than released, and effects again would be NEGLIGIBLE (Sec. IV.B.14).

Air quality also must conform with Federal and State standards (6 AAC 80.140). The analysis in Section IV.B.15 indicates that conformance is anticipated and no conflict between air quality and coastal policies should occur.

(i) Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): The ACMP standard requires that coastal districts and appropriate State agencies identify areas of the coast that are important to the study, understanding, or illustration of national, State, or local history or prehistory. Many areas along the coast have been identified as archaeologically important sites (Wickersham and Flavin, 1983).

Development along the Chukchi Sea coast likely would affect archaeological sites. Three such sites are located in the vicinity of Point Belcher, the hypothetical site for the pipeline landfall and shore base.

Numerous sites also are along the Beaufort Sea coast. However, onshore facilities along that coast are assumed to be built at Bullen Point, where development has occurred already. Therefore, no conflict is expected there.

(3) Summary: The potential level of conflict between CMP and NSB Land Management policies and the proposal differs for the two potentially affected coasts. Along the Beaufort Sea coast, where development would be comparatively limited and an extension of industrial growth, some conflict with Best Efforts Policies of the NSB Land Management Regulations is expected. This would be especially true for the subsistence policy because the proposal could lead to alterations in subsistence patterns for four communities. Most other policy areas where conflict could occur (e.g., transportation or habitat policies) cannot be identified by generic types of activities. Rather, site-specific analyses would be needed. Along the Chukchi Sea coast, however, onshore development would occur in an area that has three important cultural sites used during subsistence whaling. Depending upon the provisions made for continued use of this area for subsistence purposes, the activities could conflict with the mandatory subsistence policy that would preclude the development. Surface-transportation systems and additional airfields would be placed in an area served at the present time only by a local airstrip. The transportation facilities and shore base would be major shifts in land use. Changes of this magnitude could lead to a conflict with the NSB Land Management Regulations and the Alaska Coastal Management Program.

(4) Conclusion: Changes along the Beaufort Sea coast are expected to cause MINOR conflicts with the NSB Land Management Regulations and ACMP policies. Along the Chukchi Sea coast, MAJOR conflicts are expected.

b. Cumulative Effects:

(1) Land Use Plans: The NSB has approved a Master Plan for the Endicott project and development permits for activities in the NSB contingent upon conditions to mitigate potential adverse effects and to foster beneficial effects. If future developments lead to greater levels of adverse effects on onshore resources (see Sec. IV.B.6.b), more stringent conditions may be imposed to mitigate conflicts with Best Efforts Policies and Mandatory Policies. Ultimately, the NSB may prohibit development.

For example, if the potential effects of a development would lead to a decline in subsistence resources below the level needed by residents or would preclude user access to the subsistence resources, Mandatory Policies are not met (NSBC 19.80.021 [a] and [e]). Variances can be granted by the NSB Planning Commission if (1) the development implements the spirit, but not the letter, of the mandatory policy and (2) enforcement would either work undue hardship without a concomitant public purpose or would require designs out of character with the surroundings that are not justified by a concomitant public purpose (NSBC 19.60.060).

Effects on the Porcupine caribou herd could lead from the outset to imposing stringent conditions for development to conform to Mandatory Policies. This could occur because this herd is subject to effects of developments outside the jurisdiction of the NSB as well as within the Borough, and negative effects on the herd could reach higher levels in spite of the land management policies.

Many of the projects included in the cumulative case could occur on Federal lands, including the OCS, where policies of the Alaska Coastal Management Program could be applied. Because of the broader application of the ACMP, policies dealing with offshore development are discussed under the section on Coastal Management.

In most instances, conflict with the land management policies is expected to be MODERATE. However, MAJOR conflicts are expected if development outside the jurisdiction of the NSB combined adversely with that inside the Borough.

(2) Coastal Zone Management: Cumulative effects may lead to changes in the level of effects or may involve policies that were not relevant to the proposal. These differences are the focus of this analysis.

(a) Energy Facilities (6 AAC 80.070) and Transportation and Utilities (6 AAC 80.080): Along the Chukchi Sea coast, development assumed in the proposal occurs in conjunction with activities associated with Sale 109. Negative effects on land use identified in the proposal are accentuated in the cumulative case both because the likelihood of development increases and the magnitude of potential developments is greater. As a result, development is more likely to affect environmentally sensitive areas and conflict with ACMP policies 6 AAC 80.070(b) (1), (2), and (13).

Along the Beaufort Sea coast, free passage of fish becomes a major concern in the cumulative case because additional causeways may be constructed. ACMP standard 6 AAC 80.070 (12) requires that causeways be sited and designed to allow free passage of fish and wildlife with due consideration for migration patterns. In the past, industry has insisted that causeways were critical elements in their development plans and the breaches initially requested by government agencies were too extensive. Studies now underway should help the NSB and Federal and State agencies to make informed decisions on causeways. However, given this past experience, conflicts with ACMP 6 AAC 80.070(b) (12) are likely.

The effects of pipelines and roads are also magnified in the cumulative case. An extensive network of pipelines and associated roads would extend east from Pump Station 1 to the Canadian border, west from Pump Station 1 along the Beaufort Sea, west from Pump Station 3 to the Chukchi Sea, and south from Pump Station 1 to Valdez. If these networks were to bisect important calving areas, effects would be greater (MAJOR effects are possible, though not likely), thereby increasing the potential for conflict with 6 AAC 80.070 (b)(1)(2), and (10).

(b) Subsistence (6 AAC 80.120): In the proposal, MAJOR effects on subsistence are expected to occur along the Chukchi Sea coast. In the cumulative case, MAJOR effects also could occur along the Beaufort Sea coast. First, there is an increased probability that tidal areas and shorelines would be oiled during the open-water season during the time that subsistence hunters are using the area. Loss of both subsistence access and resources could persist for an entire season. It is likely that the effects of an oil spill could result in increased conflicts with the subsistence policy.

In addition, onshore construction and facilities and offshore vessel traffic could affect hunter access--either precluding access or making hunters travel farther and hunt longer. Last, siting causeways may alter the availability of subsistence fishes, the most reliable and one of the larger sources of subsistence foods. These effects are more likely to be long-term; therefore, these activities are more likely to conflict with the subsistence standard of the ACMP.

(c) Habitats (6 AAC 80.130): All habitats noted as at risk for the proposal (offshore; barrier islands and lagoons; wetlands; and rivers, lakes, and streams) and for upland habitat are more likely to be affected adversely in the cumulative case and, therefore, lead to conflict with ACMP standards 6 AAC 80.130(a), (b), and (c) (1), (3), (5), and (7).

Offshore, increased risks of oil spills and more traffic raise potential levels of effects for some marine mammals. Causeways extending offshore could increase risks to anadromous fishes to major.

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.

The proposal depicts development from Sale 97 as merely an add-on to extensive development that precedes it. However, in the cumulative case, tundra wetlands would be subject to significantly greater infilling. Adverse effects on tundra and wetland nesting, feeding, and staging areas could lead to MODERATE or MAJOR adverse effects on marine and coastal birds. Increased levels of air traffic could lead to MAJOR effects on snow geese and brant if traffic routes were not selected carefully. These effects could conflict with the standard for wetland habitat.

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.

On uplands, if all the potential development occurred and the associated pipelines and roads were constructed, caribou would be more likely to be adversely affected. As a result, proper routing and buffers would be required to maintain habitat characteristics necessary for supporting a living resource. Conflict may arise if a preferred route for industry purposes is not permitted.

(d) Air, Land, and Water Quality (6 AAC 80.140): Adverse effects for water quality increase to MODERATE in the cumulative case as a result of the high potential for an oil spill. This increases the potential for conflict with the ACMP water-quality standard. Because it is unknown in advance which development would create the spill, it is unlikely that the potential conflict would be apparent at the time an activity is reviewed for conformance.

(e) Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): Numerous sites along the NSB coast have been identified as culturally important sites. Because of the vast areal extent susceptible to development in the cumulative case, opportunities for culturally important areas to be violated are increased significantly.

(3) Summary: Potential policy conflicts that would lead to major effects along the Chukchi Sea coast for the proposal become evident along the Beaufort Sea coast in the cumulative case. Moreover, along the Beaufort Sea coast, there is greater potential than there is along the Chukchi Sea coast for oil spills to affect coastal areas and for causeways to be constructed. Therefore, conflict with additional policy areas could become evident.

Policies that are most likely to conflict with potential development along the Beaufort Sea coast 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 and the associated roads and causeways. These and other onshore facilities also could infringe upon cultural sites, thereby causing a conflict with the policy for protecting culturally important areas.

Effects of oil spills would create a conflict with several habitat policies and the water-quality standard. However, these conflicts could only be determined with hindsight.

(4) Conclusion: Potential conflicts of developments included in the cumulative case with land use and land and coastal management regulations are expected to be MAJOR for the entire planning area, as opposed to MINOR for the proposal along the Beaufort Sea and MAJOR for the proposal along the Chukchi Sea.

12. Effects on Archaeological Resources:

a. Effects of the Proposal: Effects of the proposal on archaeological resources could result from lease exploration, onshore-facility construction, construction of pipelines to shore from the production platforms, employees (directly and indirectly employed) in sale-related activities who visit archaeological-resource sites, and other oil-related activities. Section II describes the Sale 97 scenarios. For the proposal, 15 exploratory wells are expected to be drilled, and 39 production and service wells are expected to be drilled from 2 installed production platforms. Approximately 160 kilometers of offshore pipelines are expected to be installed, which could affect shipwrecks closer to shore.

The existence of offshore prehistoric resources has been estimated by MMS. (MMS Archaeological Analysis, Appendix H). An analysis of various data sources, including fathograms, subbottom seismic profiles, and side-scan sonar records, indicates that there is very little likelihood that prehistoric sites in the proposed sale area could have survived the extensive ice gouging experienced in this part of the OCS. However, offshore shipwrecks may have escaped destruction if the wrecks took place beyond ice-gouging depths or were recent enough that chance has not allowed gouging in the wreck area. Finding such wrecks while doing surveys for exploratory drilling is unlikely, but it is more likely while conducting activities associated with other petroleum activities in the Sale 97 area. Such a cause of disturbance makes the anticipated effect higher than negligible; therefore, the effects of oil exploration are expected to be MINOR.

The offshore pipeline could place at risk the following land segments along the shores of the Beaufort and the Chukchi Seas:

There are three land segments (see Appendix H, Table H-3) on the west coast that are the most sensitive of the 45 Alaskan segments of the oil-spill-risk analysis (OSRA). The three segments (13, 15, and 19) are Type-I segments; that is, they have the highest number of known shipwrecks and known archaeological sites. However, oil-spill-contact probability for these segments for the proposal is quite low: 1 percent on Segment 19 and less than 0.5 percent on Segments 13 and 15 (Appendix H, Table H-3). The OCS off Point Belcher (Seg. 15) is an historic whaling area with remnants of 38 ships nearshore (Tornfelt, 1986). There are six known prehistoric and historic sites onshore. Some personnel from the petroleum-industry facilities or their relatives would recreate on and/or tour the land segments. It is possible that some archaeological material could be adversely affected from such visits, although it is unlikely, since industry guidelines and regulations prohibit their personnel from disturbing archaeological sites. Therefore, the effect of this combined OCS activity is expected to be MINOR for these three segments.

There are 16 Type-II segments (Appendix H, Table H-3) along the coast near the Sale 97 area that are above the mean number of archaeological sites but have no known shipwrecks offshore or on beaches. Although the remains of the archaeological sites may not be contacted directly by oil-industry personnel in normal activities, cleanup efforts in the vicinity of known archaeological sites could bring in cleanup equipment and workers that may have some effect on the sites or remains. Of these, Nuiqsut (Seg. 32) and Kaktovik are expected to incur the most effect because they will receive industry and oil-related managers as visitors and possibly be visited by petroleum-industry personnel and/or their relatives. Segments 12, 22, 33, and 36 have the most known archaeological sites. Segment 20, east of Barrow, has approximately 24 shipwrecks in the waters offshore. (The definition for MINOR is that few archaeological resources are expected to be present and disturbed.) The segments have many sites, but the disturbance is likely to be small. It is expected that tourist and OCS-population visits related to oil-exploration activity could have an effect on any cultural remains on the beaches of Segment 20; and, if there is cleanup of oil spills, cultural sites are expected to be adversely affected only to a MINOR degree.

CONCLUSION: The overall effect of the proposal on archaeological resources is expected to be MINOR.

b. Cumulative Effects: The cumulative effect of other private, State, and Federal projects (see Table IV-A-7), together with the effects of the proposal, are expected to result in a MINOR cumulative effect on archaeological resources. Some of these projects were covered in the Sale 87 FEIS (USDOI, MMS, 1984a). The effect on land segments with many important archaeological resources (shown in Table H-3, Appendix H) is summarized as follows: The overall cumulative effects on archaeological resources are expected to remain MINOR because the additional causes of adverse effects--such as increased activity on existing projects and new projects--have taken a downturn related to world oil prices. The Milne Point Unit contributes some activity but not enough to cause more than an overall MINOR cumulative effect on archaeological resources.

CONCLUSION: The overall cumulative effects on archaeological resources are expected to be MINOR.

13. Effects on Recreation and Tourism Resources:

a. Effects of the Proposal: Recreation and tourism effects are assessed in terms of recreation-tourism noneconomic qualities and recreation-tourism economic values. The effects definitions are given in Table S-1, and the baseline qualities are described in Section III. Additional details on the effects of previous sales are assessed on pages 264 through 267 of the Sale BF FEIS (USDOI, BLM, 1979), Section IV of the Sale 71 FEIS (USDOI, BLM, 1982), and Section IV of the Sale 87 FEIS (USDOI, MMS, 1984a). This information is incorporated by reference and summarized in the discussions below. The changes due to the proposal are shown. There is a general downturn of new activities that would cause changes in noneconomic qualities from those qualities at the outset of Sale 97 activities. Such changes are expected to be as follows: (1) The quality of seasonal changeability of natural land/seascape would be reduced by the constant presence of facilities onshore and offshore--a minor reduction in changeability from the quality of the resources at the outset of Sale 97 activities can be expected; (2) a minor reduction in solitude would be effected by the presence of industrial activity; (3) the challenge of the immense Arctic environment with its dangers and stresses on human survivability would be diminished greatly by the presence of facilities, offshore-gravel islands, and accompanying structures; (4) the specialness of the area would be moderately reduced by the industrial presence; (5) the visual qualities of the area would be moderately reduced due to shore facilities, tankers, tugs, offshore structures, and traces of ice roads; and (6) the unity of offshore and onshore would be slightly lowered in quality. Offshore structures at known locations would indicate the locations about shorelines. Changes in economic values would be as follows: More industrial activity in the area would attract those who want to know more about the pursuits of oil companies and their exploitation activities. Some tourists would view the contrast between nature and industry with interest and would communicate their interest. As a result, more recreationists and tourists would arrive, thus slightly increasing recreation and tourism. Such a positive effect would push the slight reductions in effects toward a MINOR category.

CONCLUSION: The overall effect of the proposal on wilderness and recreation resources as a whole is expected to be MINOR.

b. Cumulative Effects: The overall cumulative effect on recreation and tourism resources would remain MINOR (the same effect expected for the proposal) because the additional causes of adverse effects--such as increased activity on existing and new projects--have taken a downturn related to world oil prices. Milne Point contributes some activity but not enough to cause more than an overall MINOR cumulative effect on the recreation and tourism qualities.

CONCLUSION: The overall cumulative effect on recreation and tourism resources is expected to be MINOR.

14. Effects on Water Quality: Agents that are most likely to affect water quality in the Beaufort Sea Planning Area are oil spills, dredging, gravel-island construction or removal, and deliberate discharges from platforms.

a. Effects of the Proposal:

(1) Oil Spills: Generic effects of oil spills on water quality are described in Sections IV.A.2.a and IV.J.5 of the Sale 100 FEIS (USDOI, MMS, 1985d) and are incorporated by reference; a summary of this description, as augmented by additional material, as cited, follows. In the context of this analysis, regional effects refer to effects encompassing many hundreds of square kilometers; local effects encompass smaller areas, most frequently a few or less square kilometers. Long term is on the order of decade(s); short term is on the order of hours to a few years.

The more volatile compounds in an oil slick, particularly aromatic volatiles, are usually the most toxic components of the slick and are, therefore, of more concern. In situ, cold-water measurements by Payne (1981, 1982, and 1984) and Payne et al. (1984a,b) demonstrate that for individual compounds in a slick, significant decreases in concentrations take from hours to tens of days. However, the bulk of these volatile compounds are lost in less than 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).

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, 1981). 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 meters in the water column, it would have spread horizontally and been diluted over a distance of perhaps 10,000 meters. The slick itself would become patchy, with the total area containing the widely separated patches of oil being orders of magnitude larger than the actual amount of surface area covered by oil (see Appendix C, Table C-1). Thus, at sea, the water under the slick changes continuously; and aromatics do not continue to accumulate in the same water.

Water-column concentrations of hydrocarbons following spills are difficult to compare to existing State and Federal water-quality standards because of ambiguity in the standards. Applicable ambient-water-quality standards for marine waters of the State of Alaska are the lower of 0.015 ppm (15 micrograms per liter) total hydrocarbons and 0.010 ppm (10 micrograms per liter) aromatic hydrocarbons or 0.01 of applicable continuous-flow, 96-hour LC_{50} for critical lifestages of important local species (State of Alaska, DEC, 1979). Federal standards are set at 0.01 of the applicable LC_{50}: no absolute Federal concentration standard exists for hydrocarbons (USEPA, 1986). The State of Alaska criteria of a maximum of 0.015 ppm of total hydrocarbons in marine waters--about 15-fold background concentrations--provide the readiest comparison and are used in this discussion of water quality (see Sec. IV.A.2.f for further discussion of LC_{50}'s).

Major spills generally result in peak dissolved hydrocarbon concentrations that are only locally and marginally at toxic levels (see Sec. IV.A.2.f). The highest concentration observed following the Argo Merchant spill was 0.25 ppm, despite the presence of 20 percent by volume of more-soluble cutting stock (Howarth, 1985; NRC, 1985). Volatile liquid hydrocarbons in the Ixtoc spill decreased from 0.4 ppm near the blowout to 0.06 ppm at a 10-kilometer distance and to 0.004 ppm at a 19-kilometer distance from the blowout (NRC, 1985). Similarly relative and rapid decreases were also found for specific toxic compounds such as benzene and toluene. Concentrations of volatile liquid hydrocarbons--present mostly as oil-in-water emulsion--within 19 kilometers of the Ekofisk Bravo blowout in the North Sea ranged up to 0.35 ppm (Grahl-Nielsen, 1978). Lesser amounts of oil [probably less than 0.02 ppm] were detectable in some samples, at a 56-kilometer distance, but not at an 89-kilometer distance.

In more restricted waters during flat calm, a test spill during the Baffin Island Oil Spill Project (BIOS) resulted in maximum hydrocarbon concentrations in the water column of 1 to 3 ppm (Green, Humphrey, and Fowler, 1982). These concentrations were reached within 2 hours of the spill and persisted through 24 hours. No oil was detected deeper than 3 meters, and the most oil and highest concentrations were in the top meter.

These concentrations of oil in the water column are relatively low because even if a slick were completely mixed into the same water mass through use of chemical dispersants, vertical--and especially horizontal--dispersion and consequent dilution would rapidly decrease hydrocarbon concentrations for all but the largest spills in several hours to a few days after spillage ceases (see Mackay and Wells, 1983). The volume of water contaminated would increase in direct proportion to the decrease in concentration, however, because the oil is diluted, not decomposed.

Because of unavoidable chronic and accidental discharges of oil, measurable degradation of existing pristine water quality is likely to occur in the sale area. Plumes of dissolved hydrocarbons from a 100,000-barrel spill could be above ambient standards and detectable over the low background levels for perhaps 100 kilometers or possibly 500 kilometers, if under ice (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 a slick--over a 1-to-26-square-kilometer area for a 10,000-barrel spill (see Appendix C), and over a smaller area for a smaller spill.

Only a small portion of the oil from a spill would be deposited in the sediments in the immediate vicinity of the spill or along the pathway of the slick. The observed range in deposition of oil in bottom sediments following offshore spills is 0.1 to 8 percent of slick mass (Jarvela, Thorsteinson, and Pelto, 1984). Generally, the higher percentages of deposition occur in spills near shore, where surf, tidal cycles, and other inshore processes can mix oil into the bottom. Farther offshore, suspended sediment loads are low and only about 0.1 percent of a crude would be incorporated into sediments within the first 10 days of a spill under such conditions (see Manen and Pelto, 1984).

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 after the slick disappeared, dispersed into individual tar balls. Slow photo-oxidation and biological degradation would continue to slowly decrease the residual amount of oil. Through 1,000 days, about 15 percent of the tar balls would sink, with an additional 20 percent of slick mass persisting in the remaining tar balls (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980). Because of drift of the oil over distances of hundreds or thousands of kilometers during the slow process of sinking, individual, sunken tar balls would be extremely widely dispersed in the sediments. The "average" levels of local or regional contamination in sediments would be insignificant. Only if oil were mixed into the shoreline and then dispersed offshore could elevated concentrations of hydrocarbons locally occur. Suspended loads of sediment in nearshore waters--150 milligrams per liter or less--are not high enough to significantly enhance oil removal from the slick or water column. Oil would either be locally present in the sediment as a tar ball or, more likely, absent. For a spill of 10,000 barrels, the 15 percent of the oil that sinks within 1,000 days would be equivalent to three small (10-gram) tar balls per hectare within the proposed sale area.

Decomposition and weathering processes for oil are much slower in the Alaskan OCS 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. 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 97 area, no isolated embayments exist--the lead system off of Barrow would be the most susceptible exception because Barrow Canyon could funnel pollutants downslope (Payne, 1984). 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-meter water depth. Stability of the stratified water mass would limit dispersion of the dissolved hydrocarbons and high concentrations (a few ppm) could be hypothesized to persist for several years. However, oil released under such conditions (rapid ice formation) would freeze into the ice in at most 5 to 10 days, stopping dissolution and limiting the effect of this freezeup scenario (Thomas, 1981).

It is likely that accidental oil spills will occur: one spill of at least 1,000 barrels has been assumed to occur as a result of proposed Sale 97; and, in addition to this large spill, more chronic spillage of smaller volumes is also expected (see Sec. IV.A.1.b). During drilling of 15 exploration and delineation wells over 6 years, on the order of 23 such chronic spills could occur, but the total spilled would amount to only about 6 barrels. For production, an additional 172 small spills of less than 1,000 barrels each, totaling 758 barrels, 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 below State and Federal standards because of hydrocarbon contamination is very unlikely. A spill of 100,000 barrels or more could temporarily contaminate water over long distances--a MODERATE effect on water quality--but a spill of such magnitude is not expected. 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. Thus, effects on water quality from oil spills are expected to be MINOR.

(2) Dredging: Dredging would be used primarily for trenching and burial of subsea pipelines. Dredging might also be used to prepare foundations for the two projected production platforms, but this latter use would be comparatively slight. Pipeline installation would involve greater volumes of dredged materials and greater areal disturbance.

If oil is found, 160 kilometers of offshore pipeline, 40 kilometers from one platform in the Beaufort Sea and 120 kilometers from one platform in the Chukchi Sea, could be emplaced over a 3-year period in the planning area and inshore waters (Sec. II.A). Pipeline would be placed in a dredged trench at a rate of slightly over 1 kilometer per day during summer. Trenching would disturb 135 hectares of ocean bottom in the Beaufort Sea and 655 hectares in the Chukchi Sea. Dumping of dredged spoils would disturb an additional 270 hectares in the Beaufort Sea and 1,310 hectares in the Chukchi Sea, or somewhat less if the spoils were used to backfill the trench (see Table G-12).

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) 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 (Pessah, 1982).

The size, duration, and amount of turbidity depends on the grain-size composition of the discharge, the rate and duration of the discharge, the turbulence in the water column, and the current regime. However, turbidity would not be expected to extend farther than 3 kilometers from the trenching and dumping operations.

Because dredging occurs at a rate of 1 kilometer per day, the extent of the turbidity plumes would be about 3 square kilometers (300 hectares) at any one time (a 1-km by 3-km 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 contaminates. Beaufort Sea Planning Area sediments are pristine, without evidence of industrial contamination (Sec. III.D.6).

Prior to any discharge, site-specific discharges of dredge or fill material into U.S. waters will be evaluated in followup environmental documents as required. This EIS, as a lease-sale environmental evaluation, does not contain sufficient specification with regard to locations of disposal or fill sites to meet the required permit evaluations of the U.S. Army Corps of Engineers.

However, based on the analysis in this EIS, the increased turbidity from dredging (and dumping) would be local and short-term. No long-term, regional effects on water quality from dredging would be expected. Thus, the effect on water quality of turbidity from dredging is expected to be NEGLIGIBLE.

(3) Gravel-Island Construction: In this EIS, it is assumed that one exploration platform, but neither of the production platforms, would be a gravel island east of Cape Halkett, in about 15 meters of water. Such a gravel island would require a mined gravel volume of 645,000 cubic meters (Roberts, 1987). If the construction site were in landfast ice, the artificial island could be constructed with gravel hauled by truck from onshore gravel pits. If the location were farther offshore, gravel would be carried to the construction site in summer by barge--perhaps from gravel trucked to a barrier island and stockpiled the previous winter. About 20 barge loads a day, each of 1,200 cubic meters of gravel, would be required over a 25- to 30-day period to construct the island.

(No causeways are anticipated as a result of the proposed action, although a short gravel berm may be used to protect the pipeline where it crosses the shore [Roberts, 1987].)

The only aspect of water quality expected to be affected by construction of an artificial island or pipeline shore crossing is turbidity (Sale 87 FEIS, USDOI, MMS, 1984a). Dumping of shore-mined gravel introduces particulate matter into the marine environment by disturbing the bottom sediments and by intermittently dumping large volumes of material. Most of the discharged material descends rapidly to the seafloor. The remainder, about 7 percent, composed of fine-grained silt and clay particles, would enter the suspended-transport system. Movement by waves and currents would then be the same as for naturally-suspended sediment particles. The increase in the concentration of sediment particles in the water column is expected to affect a relatively small area for a short period of time. Dispersion and settling would reduce the concentration of particulate matter downstream from any discharge- and sediment-disturbance sites.

Dumping from barges or trucks, or offloading and dumping with dragline buckets, intermittently introduces a large volume (up to 1,200 m^3 in this case) of sediment into the water column in a very short period of time. This action also creates a density current that is generated with a larger initial mass but is shorter-lived when compared to density currents associated with continuous discharge. Dumping of shore-barged fill would result in local high turbidity, similar in areal extent to that around the dredging sites, about 1 to 3 kilometers downcurrent. Over the 25 to 30 days of construction, current shifts could result in the plume extending in any direction from the construction site; a total area of 7 kilometers could be affected by increased turbidity for some part of this time. The effect of this turbidity on water quality is expected to be NEGLIGIBLE. No long-term or regional effects are expected.

(4) Artificial-Island Destruction: During its useful exploration life, the assumed artificial island would be protected from erosion by sandbagging (Roberts, 1987). If exploration from the artificial island were unsuccessful, the sandbags would be removed and the island itself would be either removed or left to naturally erode. The choice would depend upon several considerations, including applicable stipulations, island value as wildlife habitat, whether the island is a hazard to navigation, etc.

Removal of the gravel would result in a temporary increase in turbidity similar to that discussed above for dredging. If the island were left to erode, storms, ice override, and ice gouging would rework the sediments of the island over a period of several years. During this time, however, ocean currents would winnow finer sediments from the island into a plume detectable for about 1 to 3 kilometers downcurrent. The area affected would be similar to that of the construction area. Turbidity levels would be much lower than during construction, but increased turbidity could persist over several years. Effects on water quality of turbidity from gravel-island abandonment are therefore expected to be MINOR (long term but local).

(5) Deliberate Discharges During Exploration: Exploratory vessels would discharge drilling fluids in bulk quantities (Table IV-B-3), along with sanitary wastes from wastewater-discharge sources. Discharges of drilling muds and drill cuttings for exploration are projected from the development scenario in Section II.A; they would occur over a 6-year period. Discharges during exploration would peak between 1990 and 1993 at 2,640 metric tons of drilling mud per year and 4,230 metric 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 in permits for their discharge granted by the Environmental Protection Agency (EPA). During exploration, barium, lead, and mercury concentrations in discharged muds are expected to be more than 100-fold greater than background sediment concentrations (Table IV-B-4).

Based on the above and additional information presented in Appendix L, the EPA has determined that exploratory discharges are not likely to exceed applicable water-quality criteria outside of a 100-meter radius, or 0.03 square kilometers around each discharge site. With only two exploratory platforms present, water quality of no more than 0.03 square kilometers around each platform, for a total of 0.06 square kilometers, could be temporarily degraded during active discharge of drilling muds and cuttings. Therefore, the effect of exploration discharges on water quality would persist for a few hours over a fraction of a square kilometer--a NEGLIGIBLE effect.

(6) Deliberate Discharges During Production: The description of deliberate discharges from oil and gas platforms in Jones and Stokes Associates, Inc. (1983), is incorporated by reference; a summary of this description, as augmented by additional material, as cited, follows. Platforms on the OCS would discharge drilling fluids in bulk quantities, along

Table IV-B-3
Estimated Drilling Discharges of Muds and Cuttings for
Proposed Sale 97 and Previous Lease Sales (Federal)

	Previous Lease Sales		Sale 97	
	Short Tons	Metric Tons	Short Tons	Metric Tons
Exploration and Delineation Wells				
Average Depth (Meters)	4,050		4,050	
Drilling-Mud Requirements				
Average for all Wells (Dry Weight)	970	800	970	880
Total for all Wells (Dry Weight)	33,950 2/	30,800 2/	14,550 4/	13,200 4/
Drill Cuttings				
Average for all Wells (Dry Weight)	1,800	1,630	1,550	1,410
Total for all Wells (Dry Weight)	63,000 2/	57,150 2/	23,250 4/	21,100 4/
Production and Service Wells				
Average Depth (Meters)	4,480		4,480	
Drilling Mud Requirements				
Net Average for all Wells (Dry Weight) 1/	164	149	164	149
Net Average Disposal, each Well (Dry Weight) 1/	77	70	77	70
Total Net Disposal (Dry Weight)	2,772 3/	2,515 3/	3,003 5/	2,724 5/
Drill Cuttings				
Average for all Wells (Dry Weight)	1,850	1,680	1,600	1,450
Total for all Wells (Dry Weight)	66,600 3/	60,420 3/	62,400 5/	56,620 5/

Source: Roberts, 1987.

1/ Mud used in drilling production and service wells is assumed to be recycled through each subsequent well drilled on a particular platform.
2/ 35 wells.
3/ 36 wells.
4/ 15 wells.
5/ 39 wells.

Table IV-B-4
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	17.2	---1/	---	---
Barium	398,800	---	985 2/	985
Cadmium	4.2	---	21	42
Chromium	1,300	9 - 62	15	25
Copper	88	1 - 18	1.5	4.6
Lead	1,270	---	420	160
Mercury	3.7	---	53	190
Nickel	88	0.9- 62	1.9	2.7
Vanadium	235	0.8-120	1.7	3.0
Zinc	3,420	15 -430	35	55

Source: Table III-D-2 and Appendix I of the Sale 109 DEIS (USDOI, MMS, 1987).

1/ --- Denotes no data.
2/ Calculated using nearshore-sediment concentrations from Table III-13.

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.

Discharges of drilling muds and drill cuttings (Table IV-B-3) are projected from the development scenario in Section II.A and would occur over a 2-year period. Almost all discharges from the 2 production platforms would occur in 1996--when 27 of 39 wells would be drilled--with 39,150 metric tons of drill cuttings and somewhat less than 2,724 metric tons of drilling mud. (Most of the drilling-mud disposal would occur after the last production well is drilled on each platform.)

These quantities projected to be discharged are small compared to the natural sediment load of the Beaufort Sea Planning Area (Sec. III.D.6 in the Sale 87 FEIS, USDOI, MMS, 1984a). Inshore waters of the Chukchi Sea (Sharma, 1979) and the Beaufort Sea are naturally turbid. The Colville River alone carries 9 million metric tons of sediment into the Alaskan Beaufort Sea. High rates of erosion occur all along the coast (Sec. IV.A.2.b). Coastal erosion adds 300,000 metric tons annually to Simpson Lagoon. The seafloor itself is considered an erosional environment out to a 20-meter water depth (Sec. III.A.1.b). High turbidity from runoff following breakup on land extends to the 13-meter water-depth contour and limits primary production.

With only two drilling rigs per platform and assuming that maximum discharge rates are limited by EPA to the same extent during production as during exploration (see Appendix J), instantaneous discharges would be of the same order of magnitude in production as in exploration. The total quantity of drilling mud discharged in production is estimated to be fivefold less than during exploration (Table IV-B-3). Total discharge of drill cuttings during production drilling would be only thrice that discharged during exploration. Therefore, effects on water quality from discharges of muds and cuttings during production drilling should also only be local and short term--on the order of square kilometers or less--and would persist over a 2-year period of drilling; an effect that is expected to be NEGLIGIBLE.

Formation waters are produced from wells along with the oil (see Roberts, 1987). These waters contain dissolved minerals and soluble fractions of the crude oil. Process equipment installed on the production platform separates the formation water from the oil and treats it for disposal. The salinity usually ranges from 1 to 250 parts per thousand. (Seawater has a salinity of 35 parts per thousand.) Oil and grease concentrations in such waters are limited by EPA to a maximum of 72 milligrams per liter (72 ppm), with a maximum monthly average of 48 milligrams per liter (48 ppm). The EPA-approved analytical procedures used to measure oil and grease exclude lower-molecular-weight hydrocarbons (less than C14), which pose most of the risk to the biota (NRC, 1985). The National Research Council has estimated that formation waters average 20 to 50 ppm of lower-molecular-weight hydrocarbons and 30 ppm higher-molecular-weight hydrocarbons. In Alaska, treatment facilities for State fields in Cook Inlet discharge 6.6 to 21 ppm total aromatic hydrocarbons into Cook Inlet (Federal Register, 1986). (Lower-molecular-weight and total aromatic categories overlap but are not identical.)

Over the life of a field, the volume of formation water produced is equal to 20 to 150 percent of the oil-output volume (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 2.3 barrels of water for every barrel of oil produced, while the newer Kuparuk and Prudhoe Bay fields are producing 0.1 to 0.2 barrels of water per barrel of oil (Alaska Oil and Gas Conservation Commission [OGCC], 1985). Toward the very end of the productive life of a field, 10 barrels of water may be produced for every barrel of oil. On the basis of these considerations, the production of formation waters over the life of the field can be estimated at 130 to 975 million barrels, with up to 120 million barrels of this amount produced in the last year of field production. Over the life of the field, the mass equivalent of 10,000 to 70,000 barrels 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 an EPA 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, the EPA has prohibited discharge of formation waters in waters less than 10 meters deep. Reinjection and injection projects to maintain field pressure have become almost standard operating procedure. Of the eight active oil fields in Alaska as of October 1985, six had water-injection projects (Alaska OGCC, 1985). However, treatment facilities for State Cook Inlet fields still discharge formation waters into Cook Inlet (Federal Register, 1986). On the other hand, formation waters from the Endicott Reservoir, soon to be the first offshore producing field in the Beaufort Sea, will be reinjected into the oil formation as part of a waterflood project (USDOD, U.S. Army COE, and Environmental Research and Technology, Inc., 1984).

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 (Roberts, 1987). 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, an expected MINOR effect.

(7) Summary: An oil spill of 1,000 barrels or greater would temporarily and locally increase water-column hydrocarbon concentrations. A spill of 100,000 barrels or more could temporarily degrade water quality over several hundred kilometers for a MODERATE effect on water quality, but a spill of such magnitude is extremely unlikely. The large number of very small spills anticipated over the production life of the field ould result in local, chronic contamination within the margins of the oil field for a MINOR effect on water quality.

Construction activities, including artificial-island removal, would at most increase turbidity over a few square kilometers in the immediate vicinity of the construction, and only while the activity persisted. An artificial island left to erode could locally increase turbidity over the erosion years, producing an expected MINOR effect on water quality.

Deliberate discharges are regulated by EPA 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 EPA-issued discharge permit. Discharge of formation waters--rather than their reinjection into the seafloor--would result in local pollution, with whatever the formation waters contain, over the life of the field, an expected MINOR effect on water quality.

(8) Conclusion: Local degradation of water quality over the life of the field is likely, an expected MINOR effect.

b. Cumulative Effects: Agents that are most likely to affect water quality in the Beaufort Sea Planning Area are oil spills, causeways, dredging, gravel-construction and -removal projects, and deliberate discharges from platforms.

(1) Oil Spills: Only spills of 1,000 barrels or greater that occur in the Canadian Beaufort Sea plus spills of any size within the Beaufort Sea Planning Area or inshore water would affect the water quality of the Beaufort Sea Planning Area. The oil-spill-trajectory analysis indicates that trajectories in the most westward portion of the Beaufort Sea Planning Area generally move westward or northwestward. Spills resulting from proposed Chukchi Sea Sale 109 are unlikely to affect water quality in the Beaufort Sea Planning Area. Spills would have to be in the category of 1,000 barrels or greater to persist and reach U.S. waters from the locations of Canadian development.

On this basis, about 17 spills of 1,000 barrels or greater and about 600 smaller spills could occur in or reach the Beaufort Sea Planning Area over the life of the field. The smaller spills would total about 2,300 barrels. However, there is a significant chance that one of the 1,000-barrel spills could also be greater than 100,000 barrels (Table IV-3). In this analysis, one such spill of 100,000 barrels or greater has been assumed to contact the planning area. The relatively high frequency of spills of less than 100,000 barrels in the planning area would result in long-term (frequent) but dispersed and localized effects on water quality. A spill of 100,000 barrels or greater could temporarily contaminate waters with hydrocarbons over great distances and be expected to have a MODERATE effect on water quality.

(2) Causeways: Causeways locally affect turbidity through enhanced sedimentation of suspended loads and through redirection of the flow of water masses carrying the suspended loads. The redirection of flow also changes local temperature and salinity regimes. Causeways currently exist at both sides of Prudhoe Bay, at Oliktok Point, and the Endicott Development; and one has been proposed for the Lisburne Field. These causeways do

not extend into Federal waters, and their effect on the water quality of the Beaufort Sea is limited to the relatively immediate vicinity of the causeway. Any effect on water quality of the Beaufort Sea Planning Area would be long-term but local; that is, MINOR.

(3) 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 are already naturally turbid over much of the summer. Dredging to trench and/or bury pipelines from Federal leases, including those from proposed Sale 97, is projected at slightly more than twice that for proposed Sale 97 alone (Roberts, 1987). Still, only a few square kilometers of water on any single day would have increased turbidity as a result of dredging, and the turbidity at any location would rapidly disappear as the dredge moved onwards. Thus, the effect of dredging in the cumulative case is expected to be NEGLIGIBLE.

(4) Gravel-Construction Projects: The proposed Lisburne causeway and drilling island plus the two projected gravel islands on existing Federal leases constitute the largest gravel-construction projects anticipated. Seal Island is likely to be developed without causeway construction. Any gravel islands constructed on inshore State leases would require relatively little gravel compared to the above projects as long as causeways 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. Cumulative effects are expected to be NEGLIGIBLE.

(5) Gravel-Island Removal: At least three additional gravel islands are anticipated to be constructed in the cumulative case, including one resulting from proposed Sale 97 (Roberts, 1987). Twelve other gravel islands already exist as a result of past exploration in Federal and State waters. Artificial islands left to erode could result in local but persistent turbidity plumes as the sediments of the islands are reworked by waves and currents. The effect on water quality of leaving the islands to naturally erode is expected to be MINOR. (Causeways would not similarly erode, but would more likely enhance deposition of waterborne materials, decreasing turbidity.)

(6) Deliberate Discharges: Discharges of muds and cuttings resulting from continued exploration and development of past plus proposed Federal leases would be 2.6 times that for proposed Sale 97 alone (Table IV-B-3). Additional muds and cuttings would be discharged in State waters from leases in past or proposed State sales. Discharges from both State and Federal leases during both exploration and development are regulated by EPA. Discharges of muds and cuttings would continue for at most only a few years as production wells are drilled. Cumulative effects are expected to be local and short term; i.e., NEGLIGIBLE.

(7) Overall Cumulative Effects on Water Quality: One spill of 100,000 barrels or greater is assumed to occur and contact the Beaufort Sea Planning Area. Such a spill would temporarily contaminate waters over long distances, which would be a MODERATE effect. Other agents--smaller

spills, dredging, causeways, and construction or removal projects--and deliberate discharges would locally degrade water quality and would have no more than a MINOR effect on water quality. The overall cumulative effect on water quality is expected to be MODERATE.

(8) Conclusion: Cumulative development in the vicinity of the Beaufort Sea Planning Area could result in a MODERATE effect on water quality.

15. Effects on Air Quality:

a. Effects of the Proposal: The effects on Arctic air quality resulting from emissions during normal offshore operations and from accidental emissions are discussed in detail in Section IV.J.6 of the Sale 100 FEIS (USDOI, MMS, 1985d). This information is incorporated by reference. A summary pertinent to proposed Sale 97, augmented by additional material, follows.

(1) Normal Offshore Operations: For the proposal, the exploration scenario estimates two drilling rigs would drill a maximum of three wells in any 1 year. Although unlikely, the two rigs could simultaneously operate as close to shore as the Federal/State offshore boundary located 5 kilometers offshore. They could emit approximately 57.9 metric tons per year of nitrogen oxides. This does not exceed the DOI exemption criterion (90.8 metric tons per year) for nitrogen oxides at 5 kilometers (also see Table IV-B-5). If the exemption level were exeeded, further analysis of potential air-quality effects would be required in industry-exploration plans.

The major source of nitrogen-oxide emissions during exploration is the exhaust of diesel engines on a drilling unit. These engines typically emit between 11.8 and 49 metric tons of nitrogen oxides per exploratory well, depending upon depth of well, engine model, and site-specific drilling factors (Radian, 1982). The emissions projected in this analysis are based principally upon previous operating experience and evaluations for the California and Gulf of Mexico OCS. If a problem, emissions of nitrogen oxides could be reduced by either of two available strategies: emissions could be reduced below exemption levels through available pollutant-control technologies (Table IV-B-6) or, alternatively, the leaseholders could drill directionally from slightly farther offshore or make agreements to sequentially rather than simultaneously drill inshore blocks at the Federal/State inshore boundary. However, because exemption criteria would not be exceeded in this case, the air-quality effects of exploration are expected to be NEGLIGIBLE.

The assumed production scenario for the proposal calls for two platforms. During peak development and production 5 kilometers offshore, uncontrolled emissions of nitrogen oxides (953 metric tons per year) and of volatile organic compounds (VOC's) (1,880 metric tons per year) would exceed the exemption criteria. Uncontrolled emissions anywhere inshore of 55 kilometers for nitrogen oxides and anywhere in the proposed sale area for VOC's would exceed exemption levels. VOC's are a component of photochemical air pollution, which forms in conditions of bright sunlight, and may be trapped by topography and atmospheric inversions. However, the winter months are completely dark in the Beaufort Sea; and intense inversions are less common during the summer months than during the winter. There is little topographic relief. In any event, industry will have to either perform additional air-quality analyses prior to any development and/or incorporate emission controls to reduce nitrogen oxide and VOC emissions. Such control technologies are available and in use (Table IV-B-6). For example, the major source of VOC's--vapor losses from platform-storage tanks--can be reduced by 95 percent with vapor-recovery techniques currently in use offshore of California.

Storage is not planned because oil will be pumped to the TAP; onshore treatment and transportation facilities that already attain air-quality standards (for example, Radian, 1983) will be used. However, because DOI exemption criteria could be exceeded prior to application of emission controls, the effect on air quality must be considered MINOR.

(2) Secondary Effects: The possibility of environmental damage to coastal tundra from emissions of air pollutants from OCS and other sources is discussed in Sections III-D-7 and IV-G-7 of the Sale 87 FEIS (USDOI, MMS, 1984b) and in Olsen (1982). This information is incorporated by reference, and a summary pertinent to proposed Sale 97 follows. This section addresses only secondary effects of air emissions that are not included in air-quality-standards limitations.

In terms of potential damage to vegetation, emissions of acid pollutants, particularly sulfur oxides, are the most threatening. Lichens are the most vulnerable vegetation, with photosynthesis being depressed at concentrations of sulfur dioxide as low as 12 micrograms per cubic meter and damage occurring at 60 micrograms per cubic meter. Background concentrations of sulfur dioxide at Prudhoe Bay peak at 13 micrograms per cubic meter, and concentrations downwind of Prudhoe Bay peak at 25 micrograms per cubic meter for short periods (3-hour maximum). This concentration is above the amount affecting lichen photosynthetic rates but below the amount at which damage occurs to the lichen. Concentrations over time periods greater than 3-hour, 24-hour, and annual periods are lower both upwind and downwind of Prudhoe Bay and would not be expected to depress photosynthetic rates. Similarly, emissions of sulfur dioxide from Sale 97 should result in, at most, a local and infrequent depression of photosynthesis of lichens or other sensitive vegetation for a few hours at a time for a few day a year, a NEGLIGIBLE effect.

The possibility of acidification of coastal tundra on the North Slope was considered in detail in the Sale 87 FEIS. The Sale 87 analysis concluded that exploration, development, and production of 3 billion barrels of crude oil would emit sufficient air pollutants to acidify no more than 29 square kilometers of tundra, ignoring any dispersion, wind-direction variation, and distance from shore. For the 650 million barrels of oil estimated for Sale 97, no more than a proportionate 6.28 square kilometers could be acidified. Because winds will vary and will disperse emissions and distances of operations from shore will likely exceed 5 kilometers, long-term effects, even locally, are unlikely. Consequently, the effects of air emissions on tundra vegetation due to acidification are deemed NEGLIGIBLE.

Accidental emissions result from gas blowouts, evaporation of spilled oil, and burning of spilled oil. Large emissions, however, are historically rare. Because the technology used in OCS petroleum-related operations will be at least as good as in the past, large accidental emissions are unlikely to occur as a result of the proposal.

Table IV-B-5
Estimated Uncontrolled Emissions from All Offshore Platforms
for the Proposal and the Deferral Alternatives
(metric tons per year)

	Pollutant[1/]				
	CO	NO_x	TSP	SO_2	VOC
Peak Exploratory Drilling[2/]	36	57.9	2	11	4
Peak Development plus Development/Production					
Drilling[3/]	168	953	45	66	33
Mean Production Years[4/]	75	282	11	12	1,162
Peak Production Years[4/]	121	457	18	20	1,880
Exemption Levels					
Proposal and Alternatives IV, V and VI[5/]	6,430	90.8	90.8	90.8	90.8
Alternatives V and VI[6/]	10,400	188	188	188	188

1/ NO_x = Nitrogen Oxides as NO_2
TSP= Total Suspended Particulates
SO_2= Sulfur Dioxide
CO = Carbon Monoxide
VOC= Volatile Organic Compounds (excluding nonreactive compounds such as methane and ethane)

2/ Two wells per year, 2,835 meters average depth, 90 days of drilling per well with emissions based on estimates for Exxon Sale 71 exploratory well (Continental Shelf Associates, Inc., 1983). Calculation assumes that natural gas flared in well tests.

3/ In 1998, for construction of 2 platforms and drilling of 6 wells; based on information in Table V.D.3-1 of Final Supplement to the Final Environmental Statement, Proposed 5-Year OCS Oil and Gas Lease Sale Schedule (USDOI, BLM, 1982c).

4/ Based on Stephens et al. (1977); data from Gulf of Mexico offshore.

5/ Exemption levels 5 kilometers from shore, based on formulas in 30 CFR 250.57.

6/ Exemption levels 10 kilometers from shore.

Table IV-B-6
Control Measures for Major Offshore Oil and Gas Emission Sources

Emission Source	Location[1/]	Major Pollutant	Control Measure	Possible Emission Reductions	Measure In Use	Other Controls
Diesel Engines	Drilling vessel Marine tanker	NO_x	Injection timing retard	10-20%	No	Exhaust gas recirculation
			Intake air cooling	30%	Some engines	
		SO_x	Low sulfur fuel	Variable		
Gas Turbines	Platform OS&T	NO_x	Water injection	70-80%	Yes [2/]	Fuel-injection retard SCR on exhaust gas
		ALL	Waste heat recovery [3/]	26%	Yes [4/]	
Flares	Drilling vessel Platform OS&T	VOC	Vapor recovery	95%	No	
Valves, Flanges, Compressor Seals, Pumps	Platform OS&T	VOC	Inspection & maintenance	50-75%	No	Double mechanical seals on compressors and pumps; connect compressor pumps to vapor-recovery system
Storage Tanks	Platform	VOC	Use of floating roofs or vapor recovery on fixed roofs	75-95%	Yes [5/]	
Tanker Loading	Platform OS&T	VOC	Vapor recovery	95%	Yes [4/]	
Gas Processing	Platform OS&T	SO_x	Tail-gas treatment (e.g., Stretford) Sulfur recovery unit (e.g., Claus)	95-99%	Yes [6/]	

Source: Form and Substance, Inc., 1983.

1/ OS&T = Offshore separation and treatment.
2/ Used on Exxon Platform Hondo, Texaco Platform Habitat. Some problems noted.
3/ Can eliminate need for external combustion process heaters.
4/ Exxon Platform Hondo.
5/ Onshore facilities.
6/ Exxon Platform Hondo, Chevron Platform Grace, Union Platform Gilda (if H_2S is encountered).

The number of OCS blowouts--almost entirely gas and/or water--has averaged 3.3 per 1,000 wells drilled since 1956 (Fleury, 1983). The data do not show a statistical trend of decreasing rate of occurrence such as noted for platform oil spills in Section IV.A.1.b. The blowout rate has actually averaged somewhat higher since 1974, at 4.3 per 1,000 wells drilled; but the difference between the post-1974 period and the longer 1956 to 1982 record is statistically insignificant.

A gas blowout could release 20 metric tons per day of gaseous hydrocarbons, of which about 2 metric tons per day would be nonmethane hydrocarbons and, therefore, classified as VOC's (Stephens et al., 1977). Since 1974, 60 percent of the blowouts have lasted 1 day or less; only 10 percent have lasted more than 7 days. Based on the assumption of Poisson distribution (as for oil spills in Sec. IV.A.1.b), the probability of experiencing one or more blowouts in drilling the 54 wells projected for the proposal would be 18 to 22 percent. In the very unlikely event that a gas blowout occurred, it would also be unlikely to persist more than 1 day, and it would therefore release less than 2 metric tons of VOC's.

Oil spills are a second accidental source of gaseous emissions. The logarithmic mean size of 1,000-barrel-or-greater spills is 8,000 barrels for platform spills, 7,500 barrels for pipeline spills, and 20,000 barrels for tanker spills (Lanfear and Amstutz, 1983). Over the life of an oil slick, evaporation accounts for from one-sixth to two-thirds of the slick mass (Appendix C). If a 20,000-barrel spill occurred in the proposed sale area, 3,333 to 13,333 barrels of oil, 448 to 1,800 metric tons of gaseous hydrocarbons, or 45 to 180 metric tons of VOC's could be lost to the atmosphere, mostly within the first few days of the spill. For a 100,000-barrel spill, 16,666 to 66,666 barrels of oil, 2,237 to 8,947 metric tons of gaseous hydrocarbons, or 224 to 895 metric tons of VOC's could be lost to the atmosphere. The movement of the slick during this time would result in lower concentrations and dispersal of emissions over an area several-fold larger than the slick itself. The oil-spill-risk analysis for the proposal (Sec. IV.A.1.b) projects an 82-percent chance of one or more spills of 1,000 barrels within the Beaufort Sea.

Smaller spills of less than 1,000 barrels occur more frequently than larger spills. The number of small spills projected for the proposal is 203, totaling 770 barrels, over the life of the field (Sec. IV.A.1.b). Evaporation from these spills could release an additional 5 to 7 metric tons of VOC's over the projected 26 years of oil exploration and production for the proposed action.

Gas or oil blowouts may catch fire. In situ burning is a preferred technique for cleanup and disposal of any spilled oil. For catastrophic oil blowouts, in situ burning may be the only effective technique for spill control.

Burning affects air quality in two major ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98 percent and very slightly increase emission--relative to quantities in other oil and gas industry emissions--of other pollutants (Table IV-B-7).

A description of the generic effects of blowouts on air quality as contained in Section IV.A of the Sale 100 FEIS (USDOI, MMS, 1985d) is incorporated by reference. Blowouts omit hydrocarbons into the air, of which approximately 10 percent of the emissions are VOC's. Because blowouts are generally short-term phenomena (1 or 2 days), about 2 metric tons of VOC's would be released. A burning blowout could emit only soot also for an average of 1 or 2 days. The soot has been found mutagenic, but not highly so (Sheppard and Georghiou, 1981). National Ambient-Air-Quality Standards for total-suspended-particulate matter allow one exceedance each year, which could accommodate soot in the unlikely event of an offshore blowout and fire. Because air-quality standards are unlikely to be exceeded by accidental emissions and such emissions are not expected to have long-term effects, the effect on air quality must be considered NEGLIGIBLE.

(3) In Situ Burning of Offshore Oil Spills: For the proposal, there is an 82-percent chance of one or more spills of at least 1,000 barrels with a most likely number of one spill. Only burns of spills of about 20,000-barrels-or-greater magnitude are likely to noticeably contaminate land, which would be at minimum 5 kilometers from the proposed sale area (Table IV-B-8). Spills of 20,000 barrels or greater from inshore pipelines would have to be in the nature of a slow, undetected leak over a couple of months. Only a fraction of the volume of such a spill would be burnable when detected. Over the 26 years of oil exploration and production expected for Sale 97, perhaps one spill could potentially burn and locally contaminate coastal or inland areas. Such an occurrence would also require onshore northerly winds rather than the existing predominant easterly winds. Sea breezes would not be an important consideration because large fires create their own breezes. Any contamination could also be washed away by subsequent summer rain and snow-melt runoff and therefore would be temporary. Measurable precipitation occurs on 25 percent of all days and includes annual rainfall averages of 5.1 centimeters at Point Barrow and 6.6 centimeters at Barter Island (Brower, Diaz, and Prechtel, 1977). In addition, air-quality criteria allow particulate limits to be exceeded once a year. Thus, air-quality standards at any specific location would be very unlikely to be exceeded, and effects would be NEGLIGIBLE.

(4) Summary: Effects from emissions of air pollutants during normal operations would exceed DOI air-quality-exemption criteria for nitrogen oxides and VOC's during production only. This conclusion is based upon conservative assumptions placing all operations at one location 5 kilometers offshore, with steady onshore winds. Consequently, the emissions levels will likely be less than projected and the effects relative to attainment of standards will not exceed MINOR. Secondary effects from emissions from effects on the tundra vegetation have been examined. The small amounts of emissions available in each case, even with conservative assumptions that tend to increase potential effects, do not result in long-term secondary effects and are considered NEGLIGIBLE in each case. Overall, the secondary effects of emissions on the environment are deemed NEGLIGIBLE.

(5) Conclusion: Direct effects to air quality from the proposal as limited by air-quality standards are expected to be MINOR. Secondary effects from air emissions are expected to be NEGLIGIBLE.

b. Cumulative Effects: Combined pollutants from existing oil-exploration and -production facilities for Sales BF, 71, and 87 and the onshore North Slope development complex would add roughly a 30-fold increase

Table IV-B-7
Emissions from Burning
20 Metric Tons Per Day of Natural Gas During a
Blowout (in Metric Tons)

	Duration of Blowout		
	1 Day	4 Days	7 Days
Total Suspended Particulates	0.009	0.04	0.06
Sulfur Dioxide	0.0003	0.001	0.002
Volatile Organic Compounds	0.004	0.02	0.03
Carbon Monoxide	0.009	0.04	0.07
Nitrogen Oxides	0.04	0.15	0.26

Source: Calculated from emission factors in Frazier et al., 1977.

Table IV-B-8
Emissions from Burning Crude Oil
(Metric Tons)

	Size of Burn		
	1,000 barrels	20,000 barrels	100,000 barrels
Total Suspended Particulates 1/	0.5	9	50
Sulfur Dioxide 2/ 3/	8.6	170	860
Volatile Organic Compounds 2/	0.05	0.9	5
Carbon Monoxide 2/	0.4	8.3	41
Nitrogen Oxides 2/	1.1	23	110

Source: MMS, Alaska OCS Region.

1/ Estimated as 5 percent of the total burn. See text.
2/ Burning assumed to be the same as residual oil firing in industrial burners. Emissions calculated from factors in Frazier et al., 1977.
3/ Assumes a sulfur content of 2.9 percent.

to those of Sale 97 alone; however, the Prudhoe Bay facilities have not caused significant deterioration of air quality relative to air-quality standards (USDOD, U.S. Army COE, Environmental Research and Technology, Inc., 1984).

Thus, cumulatively, oil and gas activities are not likely to have more than local effects on air quality. With the use of available emission-control technologies, the PSD level (Table IV-B-9) for any pollutant other than total suspended particulates is unlikely to be approached.

The Canadian Beaufort Sea operations are so distant that they would have little or no effect on air quality in the Sale 97 area.

The cumulative secondary effects of air emissions would remain small and localized even in the aggregrate.

CONCLUSION: Cumulative effects relative to attainment of air-quality standards are not expected to be more than MINOR; secondary effects are expected to be NEGLIGIBLE.

Table IV-B-9
State of Alaska Ambient-Air-Quality Standards
Relevant to the Beaufort Sea
(measured in micrograms per cubic meter)

Criteria Pollutant 1/	Annual	Averaging Time 24 hr	8 hr	3 hr	1 hr	30 min
Total Suspended Particulates	60 2/	150	-- *	--	--	--
Class II 3/	19 2/	37 4/	--	--	--	--
Carbon Monoxide	--	--	10,000	--	40,000	--
Ozone 5/	--	--	--	--	235	--
Nitrogen Dioxide	100 6/	--	--	--	--	--
Lead	1.5 7/	--	--	--	--	--
Sulfur Oxide 8/	80 6/	365	--	1,300	--	--
Class II 3/	20 6/	91 4/	--	512	--	--
Reduced Sulfur Compounds 8/	--	--	--	--	--	50

Sources: 80 18 AAC 50.010, 18 AAC 50.020; State of Alaska, Dept. of Environmental Conservation, 1982; 40 CFR 52.21 (43 FR 26388).

1/ All averaging times (except annual standards) not to be exceeded more than once each year.
2/ Annual geometric mean.
3/ The standards for Class II areas refer to the EPA Prevention of Significant Deterioration Program. The standards express maximum allowable increments in air quality attributable to proposed emission sources above baseline (existing) air-quality conditions.
4/ Maximum, no exceedence allowed.
5/ The State's ozone standard compares with U.S. EPA standards for photochemical oxidant(s), which are measured as ozone.
6/ Annual arithmetic mean.
7/ Quarterly arithmetic mean instead of annual.
8/ Measured as sulfur dioxide.
* No standard for exposure interval indicated.

IV
C

C. Alternative II - No Lease Sale

The cancellation of proposed Sale 97 could reduce future OCS oil and gas production, perpetuate the need for imported oil, and add to a national need to develop alternative-energy sources. Appendix A of this EIS identifies alternative-energy resources and describes their environmental risks and current and projected uses. Briefly, the following energy actions or sources might be used as substitutes: energy conservation; conventional oil and gas supplies; coal; nuclear power-fission; nuclear power-fusion; oil shale; tar sands; hydroelectric power; solar energy; energy imports, oil imports, natural-gas-pipeline imports, and liquefied-natural-gas imports; geothermal energy; other energy sources; or a combination of alternatives. It should be noted that some of these actions are not feasible at this time and may not be during the estimated life of this production area. Table II-B-1 shows the amount of energy needed from other sources to replace anticipated oil and gas production from the proposal. The effects on biological resources and social and economic systems as described in the proposal (Alternative I) would not occur and are indicated below.

1. Effects on Lower-Trophic-Level Organisms: There would be no adverse effects on marine plants and invertebrates as a result of this alternative. Refer to Section IV.B.1.b for a discussion of cumulative effects that may result from other sources.

2. Effects on Fishes: There would be no adverse effects on fishes as a result of this alternative. Refer to Section IV.B.2.b for a discussion of cumulative effects that may result from other sources.

3. Effects on Marine and Coastal Birds: There would be no adverse effects in the Beaufort Sea or associated coastal areas as a result of this alternative. Refer to Section IV.B.3.b for a discussion of cumulative factors that may affect marine and coastal birds.

4. Effects on Pinnipeds, Polar Bears, and Beluga Whales: There would be no adverse effects in the Beaufort Sea or associated coastal areas as a result of this alternative. Refer to Section IV.B.4.b for a discussion of cumulative factors that may affect marine mammals.

5. Effects on Endangered and Threatened Species: There would be no adverse effects on endangered and threatened species as a result of this alternative. Refer to Section IV.B.5.b for a discussion of cumulative effects that may result from other sources.

6. Effects on Caribou: There would be no adverse effects on caribou as a result of this alternative. Refer to Section IV.B.6.b for a discussion of cumulative effects that may result from other sources.

7. Effects on Population: There would be no change in the level or trend of the forecasted population of the North Slope Borough as a result of this alternative. The effect of this alternative is expected to be NEGLIGIBLE. Refer to Section IV.B.7 for a discussion of cumulative effects that may result from other projects.

8. Effects on North Slope Sociocultural Systems: Sale 97 is expected to have only a MINOR effect with regard to the major forces causing changes in NSB sociocultural systems, except for potential MODERATE detrimental attitudes toward governing and administrative institutions (as noted in Section IV.B.8). The cancellation of Sale 97 is expected to provide a MINOR, positive benefit to the North Slope sociocultural systems. Refer to Section IV.B.8 for a discussion of cumulative effects that may result from other projects.

9. Effects on Subsistence-Harvest Patterns: There would be no adverse effects or unavoidable adverse effects on subsistence use and dependence as a result of this alternative. Refer to Section IV.B.9 for a discussion of cumulative effects that may result from other projects.

10. Effects on the Economy of the North Slope Borough: The effects of proposed Sale 97 described in Section IV.B.10.a would not occur. In the absence of the proposed sale, NSB revenues and employment in the North Slope region would be as projected in Section III.D.1.

11. Effects on Land Use Plans and Coastal Management Programs: Projects identified for Sale 97 build on existing development. Eliminating the sale would remove one portion of future development. This would minimize overall levels of change in the environment, and the effects of the proposal noted in Section IV.B.11 would not occur. Because this sale is just one element of the potential development on the North Slope, cumulative effects without this sale are expected to remain MODERATE, with the potential for MAJOR effects in the case of development along the Chukchi coast or in the event international activities adversely affect the Porcupine caribou herd.

12. Effects on Archaeological Resources: This alternative would not result in any adverse effects on archaeological resources. See Section IV.B.12.b for an evaluation of potential cumulative effects from other projects anticipated to occur in the region.

13. Effects on Recreation and Tourism Resources: This alternative would not result in any adverse effects on recreation and tourism resources. See Section IV.B.13.b for an evaluation of potential cumulative effects from other projects that may occur in the region.

14. Effects on Water Quality: There would be no degradation of water quality as a result of this alternative. This alternative would reduce oil spillage in the cumulative case to the point that a spill of 100,000 barrels or greater would no longer be anticipated. The cumulative effect of oil spills and the overall effect of all agents on water quality are expected to be reduced to MINOR with this alternative. Refer to Section IV.B.14 for further discussion of cumulative agents that may affect water quality.

15. Effects on Air Quality: No effects would occur from this alternative. Cumulative effects on attainment of air-quality standards are expected to be MINOR and secondary effects are expected to be NEGLIGIBLE because of potential effects from Sales BF, 71, and 87 and from existing and planned State leases onshore and nearshore at Prudhoe Bay. The EPA and the State require application of Best Available Control Technology to emissions under State jurisdiction, regardless of whether ambient-air-quality standards are already met.

D. Alternative III - Delay the Sale

With this alternative, the proposed lease sale would be delayed for a period of 2 years. Delaying the sale could provide additional time for ongoing research to acquire data that might be used in assessing effects that petroleum exploration, development and production, and transportation might have on the environment. Although additional information would be useful, MMS has successfully used the existing database in the past to provide an adequate analysis of the consequences of oil and gas activities in the Beaufort Sea Planning Area. Table IV-D-1 identifies potential studies that could be conducted during the 2-year delay, based on the 1986 and 1987 proposed studies list for the Alaska Regional Studies Program. Additional studies could be proposed for 1988. The following sections assess the effects of such a delay.

IV
D

1. Effects on Lower-Trophic-Level Organisms: Effects associated with this alternative are expected to be qualitatively the same as those discussed for the proposal (Sec. IV.B.1.a). However, the magnitude of the effects could vary depending on the population status of potentially affected species (e.g., species in the Stefansson Sound Boulder Patch) at the end of the delay or upon the initiation of activities.

CONCLUSION: A MINOR effect is expected under Alternative III.

Cumulative Effects: Delaying the sale would postpone some of the potential cumulative effects of oil spills, release of drilling fluids, and construction activities on lower-trophic-level organisms. Cumulative effects would be spread out over a longer timespan and thus may have a lesser effect; but the level of effect on lower-trophic-level organisms is not expected to be different than the proposal: in general, MINOR. MODERATE effects are possible for the Stefansson Sound Boulder Patch community if it were contacted by oil or if drilling discharges and construction activities occurred too close to the community.

2. Effects on Fishes: Effects associated with this alternative should be essentially the same, qualitatively, as those discussed for the proposal (Sec. IV.B.2). However, the magnitude of the effects could vary depending on the population status of the potentially affected species (e.g., anadromous species, especially arctic cisco and capelin) at the end of the delay or upon the initiation of activities. Although a MINOR effect on fishes is expected, MODERATE effects on capelin and anadromous fishes are possible if spawning year individuals, aggregated multi-aged assemblages, or a year class of young were affected.

CONCLUSION: Alternative III is expected to have a MINOR effect on fishes.

Cumulative Effects: Delaying the sale could postpone some of the potential cumulative effects of oil spills on fishes. The effect of cumulative causeway construction on fishes is the issue of greatest concern for fishes in the Sale 97 area. No long causeways are projected under the proposal, so delaying the sale may not affect the anadromous fishes of concern. However, effects on anadromous fish populations (especially for arctic cisco) from already scheduled activities could make populations more vulnerable. Some risk from oil spills should also be delayed by delaying the sale.

Table IV-D-1
Studies Pertinent to the
Beaufort Sea Area that
May Be Conducted During a 2-Year
Delay of Sale

Year	Study Title
1986-87	Circulation Model and Oil-Spill-Risk Analysis
1987	Quantification of the Relative Magnitude of Noise Associated with Oil and Gas Exploration and Development Compared with Other Sources of Potential Acoustic Disturbance to Marine Mammal Habitats in Alaska (ongoing)
1987	Monitoring Seabird Populations Near Offshore Activity
1987	Laboratory Investigations of the Adherence of Oil to the Skin of Bowhead Whales
1987	Normal Behavior of Davis Strait Bowhead Whales: A Control Group for the Western Arctic Stock
1987	Aerial Surveys of Endangered Whales in the Northern Bering, Chukchi, and Beaufort Seas
1987	Application of Satellite-Linked Methods of Large Cetacean Tagging and Tracking Capabilities in Offshore Lease Areas (ongoing)
1987	Enclave Model Application for Select Communities in the Bering Sea
1987	Commercial Fishing Harvest and Employment Forecast
1985-87	Coastline and Surf Zone Oil Spill Smear Model
1986-87	Quality Assurance
1987	Past, Present, and Predicted Petroleum Discharge in Alaskan Waters
1986	Summary of the Abundance and Distribution of Beluga Whales in Alaskan Waters
1986	Simulation Modeling of the Effects of Oil Spills on the Population Dynamics of Key Marine Mammal Species
1985-87	Ice Freezeup and Breakup: Sediment-Oil-Ice Interaction
1986-87	Remote Sensing Data Acquisition
1986-88	Monitoring Relationships of Ringed Seal Distribution, Abundance and Reproductive Success to Habitat Characteristics and Industrial Activities (ongoing study providing additional results annually)
1986-87	Marine Meteorology Update
1986	Weathering of Oil in the Presence of Multi-Year Ice (applies generally - due summer 1986)
1986	Behavior Responses of Feeding Gray Whales in the Coastal Waters of Alaska
1986-88	Wage and Salary Employment Data for Individual Communities
1986	Validation of Social Indicators for Offshore Monitoring
1986	Rural Village Economics and Subsistence
	Economic and Employment Analysis - Statewide Projections
1986-87	Environmental Observations of the Arctic Shelf
1986-87	Arctic Ocean Buoy Programs
1986-87	Beaufort Sea Mesoscale Circulation
1986-87	Arctic Fish Habitats and Sensitivities

Cumulative effects are expected to be the same as for the proposal: MAJOR, due mainly to expected cumulative effects of causeway construction on arctic ciscoes.

3. Effects on Marine and Coastal Birds: Effects associated with this alternative would be essentially the same, at least quantitatively, as those discussed for the proposal (Sec. IV.B.3). The magnitude of effects could vary, depending on the population status of affected bird species at the time of the end of the delay or the time when the undesirable effects occur.

CONCLUSION: Effects of Alternative III on marine and coastal birds are expected to be the same as the effects of the proposal--MODERATE.

Cumulative Effects: The combined effects are expected to be the same as those of the proposal--MINOR.

4. Effects on Pinnipeds, Polar Bears, and Beluga Whales: Effects associated with this alternative would be essentially the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.4). The magnitude of effects could vary, depending on the population status of affected marine mammal species at the time of the end of the delay, or when the undesirable effects would occur.

CONCLUSION: Effects of Alternative III on pinnipeds, polar bears, and beluga whales are expected to be the same as the effects of the proposal--MINOR.

Cumulative Effects: The cumulative effects are expected to be the same as those of the proposal--MINOR.

5. Effects on Endangered and Threatened Species: Effects associated with this alternative would be the same as those discussed for the proposal (Sec. IV.B.5). The magnitude of effects could vary, depending on the population status of affected species at the end of the delay. The population of the gray whale appears to be increasing gradually (Reilly, Rice, and Wolman, 1983). Should this trend continue, a delay of the sale may allow this species to better withstand the potential adverse effects of the lease sale.

CONCLUSION: Effects would be the same as those of the proposal, MINOR for bowhead and gray whales and NEGLIGIBLE for the arctic peregrine falcon.

Cumulative Effects: Delay of the sale would postpone some potential cumulative effects on endangered species and would lessen these cumulative effects until termination of the delay. The delay would provide additional time for populations of some species to increase to the point where they may be more capable of enduring the adverse effects of oil and gas exploration and development. Upon termination of the delay, however, cumulative effects are expected to be the same as those of the proposal: MODERATE for gray and bowhead whales and MINOR for the arctic peregrine falcon.

6. Effects on Caribou: Effects associated with this alternative would be the same qualitatively as those discussed for the proposal (Sec. IV.B.6). However, the magnitude of effects could vary, depending on the population status of the affected caribou herds when the undesirable effects would occur.

CONCLUSION: Effects of Alternative III on caribou are expected to be the same as those of the proposal--MINOR.

Cumulative Effects: The cumulative effects on caribou are expected to be the same as the effects of the proposal--MODERATE.

7. Effects on Population: If the sale were delayed, the resident population of the North Slope Borough would decline more rapidly through 1988. The sale as proposed has the effect of moderating the initial decline in the population due to reduced NSB operating and CIP revenues. These revenues would not be augmented by the sale until later. The growth rate of the resident population following 1988 would be slightly less and would peak earlier if the sale were delayed.

CONCLUSION: Delaying the sale would have the same effect as the proposal, i.e., NEGLIGIBLE effects on the population of the North Slope Borough are expected.

Cumulative Effects: The effects of delaying Sale 97 would not make any difference in the expected cumulative effects of the proposal. Thus, cumulative effects from both onshore and offshore development are still expected to be MINOR.

8. Effects on North Slope Sociocultural Systems: The NSB's anticipated economic difficulties in the 1990's will have a number of consequences for Inupiat sociocultural systems. High levels of alcohol and drug abuse and associated levels of domestic violence now require social services that depend on Borough funding. In addition, Inupiat households depend on the income from wage employment for important purchases such as heating oil. This income also is used to finance the technology for subsistence activities, which form such a critical part of Inupiat culture. Revenues to the NSB from Sale 97 are expected to amount to only 3 percent of the Borough's operating expenses during the peak production years. A delay in such a small amount of revenues should make little difference to the difficult cash-flow situation that the NSB is expected to experience at this time.

In addition, recent personal communications from Nuiqsut indicate a shift in community opposition to onshore development. A delay in the sale, and thus a delay in the potential consequences of an offshore oil spill, might provide time for increased flexibility in community attitudes towards OCS development. Changing community attitudes may lessen the stress anticipated for Inupiat households if oil spills should disrupt subsistence activities and the angry reactions that governing and administrative entities would experience under these circumstances. However, this possibility is very speculative, given the widespread opposition to OCS activities, and community attitudes are subject to a variety of competing influences that might intervene during the long lag period before OCS production. Although an oil spill (or spills) is expected to have MODERATE consequences for community governing and administrative institutions, the overall effect should not cause long-term, chronic disruption of the entire sociocultural system or lead to the displacement of the broad range of social and cultural institutions discussed in this analysis.

CONCLUSION: In all likelihood, a delay in the sale would make no difference in the expected effects of the proposal; that is, overall MINOR effects are expected.

Cumulative Effects: A delay of the sale is not expected to have any effect on the MAJOR cumulative consequences expected from offshore and onshore energy development.

9. Effects on Subsistence-Harvest Patterns: A delay of the sale would not change the effects projected for subsistence use. A delay might provide additional planning time for the North Slope Borough to implement its geographic-information system and to integrate subsistence, cultural-resource, and related data into the NSB planning system. A delay also may allow somewhat greater spacing between this and other lease sales planned for the area. However, a delay would not significantly alter the effects of the proposal.

CONCLUSION: The effects of Alternative III on North Slope subsistence-harvest patterns are expected to be MODERATE--the same as those of the proposal.

Cumulative Effects: The cumulative effects are expected to be the same as the effects of proposal--MAJOR.

10. Effects on the Economy of the North Slope Borough: If the sale is delayed, the revenue and employment effects in the North Slope region would be the same as those indicated in Section IV.B.10.a but would be delayed.

CONCLUSION: The economic effects of this alternative are expected to be classified the same as those of the proposal--NEGLIGIBLE.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

11. Effects on Land Use Plans and Coastal Management Programs: Delaying the sale may alter the sequence of development with respect to other activities occurring on the North Slope; these effects are discussed in the cumulative case (Sec. IV.B.11.b). A delay also would provide those administering the land use program an opportunity to benefit from new studies. However, the delay alternative makes no other substantive changes.

CONCLUSION: Effects on land use plans and coastal management programs are expected to remain the same as those of the proposal--MINOR along the Beaufort Sea coast and MAJOR along the Chukchi Sea coast.

Cumulative Effects: A delay might change the order in which development occurs. In the Beaufort Sea, benefits of following, rather than preceding, other oil and gas developments might arise if new information permitted administrators to develop mitigating measures that would achieve desired results without being overly restrictive. The drawback to development later in the sequence is that such development might be placed in a less-favorable position than preceding development. This situation occurred when the causeway for the offshore Lisburne development was denied following the approval of the causeway for the Endicott project. However, the overall level of effects is expected to remain MAJOR, the same as for the proposal.

12. Effects on Archaeological Resources: Delaying the sale would delay the effects of the proposal on archaeological resources.

CONCLUSION: Alternative III would delay any potential effects to archaeological resources, but effects would remain the same as those of the proposal--MINOR.

Cumulative Effects: The cumulative effects are expected to be the same as those of the proposal--MINOR.

13. Effects on Recreation and Tourism Resources: Delaying the sale would delay the effects of the proposal on recreation and tourism resources.

CONCLUSION: Alternative III would delay any potential effects to the recreation and tourism resources, but effects are expected to remain the same as those of the proposal--MINOR.

Cumulative Effects: The cumulative effects are expected to be the same as the effects of the proposal--MINOR.

14. Effects on Water Quality: Effects associated with this alternative would be essentially the same as those discussed for the proposal (Sec. IV.B.14). In particular, oil spillage is estimated as proportionate to the quantity produced and transported; timing or rate of production does not affect the spillage estimate. No breakthroughs in ability to clean up oil spills at sea are anticipated in the next 2 years that would guarantee that spilled oil would not affect water quality.

CONCLUSION: Alternative III would delay the potential effects of the proposal on water quality, but it is not expected to change them from MINOR.

Cumulative Effects: Delay of the sale would postpone some of the cumulative effects and spread them over a longer time period. Exploration activity would be decreasing when Sale 97 exploration occurred. Peak exploration drilling and resultant discharges would be 9 percent lower. However, Alternative III would neither decrease the cumulative oil resource nor lessen projected spillage. The cumulative effect of oil spills and the overall cumulative effect on water quality are expected to remain MODERATE.

15. Effects on Air Quality: The effects associated with this alternative would be substantially the same as the effects of the proposal.

CONCLUSION: Alternative III would delay the potential effects of the proposal on air quality, but they are expected to remain MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

Cumulative Effects: Delay of the sale would postpone some of the cumulative effects and extend them over a longer period of time; however, the cumulative effects are expected to be the same as those of the proposal--MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

E. Alternative IV - Barrow Deferral Alternative

Alternative IV, the Barrow Deferral Alternative, would defer 201 blocks, approximately 412,354 hectares, in the vicinity of Point Barrow from the proposed sale area; see Figure I-1. MMS estimates the mean-case oil resources of the deferral alternative to be about 630 MMbbls; the mean-case resource estimate for the proposal is 650 MMbbls. (This estimate is a result of the very low probability assigned for the occurrence of petroleum in the deferral area. However, because of the uncertainty involved in making resource estimates for frontier areas, there remains a very small probability that the deferral area contains petroleum.) Thus, as noted in Section II.A.6, the basic scenario assumptions for this alternative would be same as they are for the proposal.

1. Effects on Lower-Trophic-Level Organisms: The lower-trophic-level organisms of greatest concern in the Alternative IV area due to their abundance or trophic relationships include: (1) planktonic and epontic communities, with special emphasis on primary production and trophic linkages; (2) the abundant epibenthic invertebrates in nearshore waters that are fed on extensively by anadromous and some marine fishes; and (3) the Stefansson Sound Boulder Patch, an apparently unique, kelp-dominated community.

IV E

These marine plants and invertebrates are most likely to be adversely affected by oil spills, but the Boulder Patch community also could be vulnerable to effects from drilling discharges and construction activities. However, these latter effects are highly unlikely to occur under either the proposal or this deferral alternative since available lease tracts are situated far from the Boulder Patch community. Therefore, deferring the area of Alternative IV is not expected to have any effect on the Boulder Patch community.

Planktonic and epontic communities are widespread in the Alternative IV area, and no single target or specific set of targets identifies areas of concern. Probabilities associated with ice/sea segments are used as a representative focus. Combined probabilities of a spill of 1,000 barrels and greater occurring and contacting ice/sea segments under this deferral alternative do not change from those associated with the proposal for the open-water season (Appendix F, Table F-19).

For epibenthic invertebrates in nearshore waters, this deferral alternative offers no real advantages, as combined probabilities of a spill of 1,000 barrels and greater occurring and contacting land within 10 days in the open-water season do not change from those associated with the proposal.

The Stefansson Sound Boulder Patch is best approximated by Land Segment 36; and here as well, combined probabilities do not change relative to the proposal.

Alternative IV, the Barrow Deferral Alternative, would not significantly alter the probability of oil spills occurring and contacting marine plants and invertebrates of greatest concern. The expected effect of oil spills on these organisms is viewed to be the same as under the proposal, MINOR, although MODERATE effects are possible for the Stefansson Sound Boulder Patch if it were contacted by oil. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative.

CONCLUSION: The level of effect under Alternative IV is expected to be the same as under the proposal--MINOR.

Cumulative Effects: Cumulative effects under this alternative are expected to be similar to those under the proposal--MINOR.

2. Effects on Fishes: The fish species of greatest concern in the Alternative IV area are the anadromous fishes that are abundant in the warm, brackish-water nearshore zone during the open-water season and the abundant and trophically important marine species, the arctic cod. The location of oil spills is the factor associated with oil exploration and development and production that is most likely to affect fishes and yet is most likely to be affected by the deferral alternatives.

Anadromous fishes are most likely to be affected in the nearshore zone. Within this zone, the river deltas are viewed as being the most sensitive and important habitat. This deferral alternative does not change, relative to the proposal, the probability of an oil spill of 1,000 barrels and greater occurring and contacting land during the open-water season within 10 days. Thus, this deferral alternative offers no advantage to anadromous fishes.

The arctic cod is a marine species with a very widespread and patchy distribution. At times it can be very abundant in nearshore waters. As mentioned above, this deferral alternative does not change the probability of oil contacting land. During the winter, there is a negligible (1%) reduction in the probability that oil will contact land. Examination of combined probabilities of an oil spill of 1,000 barrels and greater occurring and contacting ice/sea segments in the open-water season (for 10-day figures: no change relative to the proposal) and for the entire winter season (several ice/sea segments show a 1% reduction in probability), indicate that this alternative probably would not significantly alter effects on arctic cod as compared to the proposal.

Capelin may be vulnerable to oil spills in nearshore waters as they come into coastal areas to spawn in July and August. Capelin are not abundant in the Alternative IV area. Because the probability of oil contacting land is not reduced, this alternative offers no advantage to capelin.

Alternative IV, the Barrow Deferral Alternative, would insignificantly affect the probability of oil spills occurring and contacting fishes of greatest concern. Thus, the level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for anadromous species and capelin if spawning-year individuals, aggregated multi-aged assemblages, or a year class of young were affected. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative.

CONCLUSION: The level of effect under Alternative IV is expected to be the same as for the proposal--MINOR.

Cumulative Effects: Cumulative effects under this alternative are expected to be similar to those under the proposal--MAJOR.

3. Effects on Marine and Coastal Birds: This alternative would defer all exploration activities associated with the two exploration platforms within most of the high-density seabird-feeding area near Point Barrow and would slightly reduce oil-spill risk and potential effects on birds in the seabird-feeding area north of Point Barrow from the spill risk assumed for the proposal (Fig. IV-20, SMA). However, oil-spill risks and effects on high numbers of birds (greater than 50/km^2) in the Elson and Simpson Lagoon coastal-concentration areas (Seabird Areas 2 and 3, Fig. IV-20) would be the same as for the proposal. Oil-spill risks to other coastal-lagoon habitats east of Prudhoe Bay would also be the same as the risks under the proposal. Under this alternative, potential noise and disturbance effects on birds nesting on the Plover Islands and in the Peard Bay area could be avoided or greatly reduced; and bird-habitat alterations due to pipeline construction could be reduced, particularly near Barrow and Elson Lagoon. However, birds and their habitats east of Elson Lagoon would be affected by noise and disturbance and habitat alterations similarly as they would be affected by the proposal.

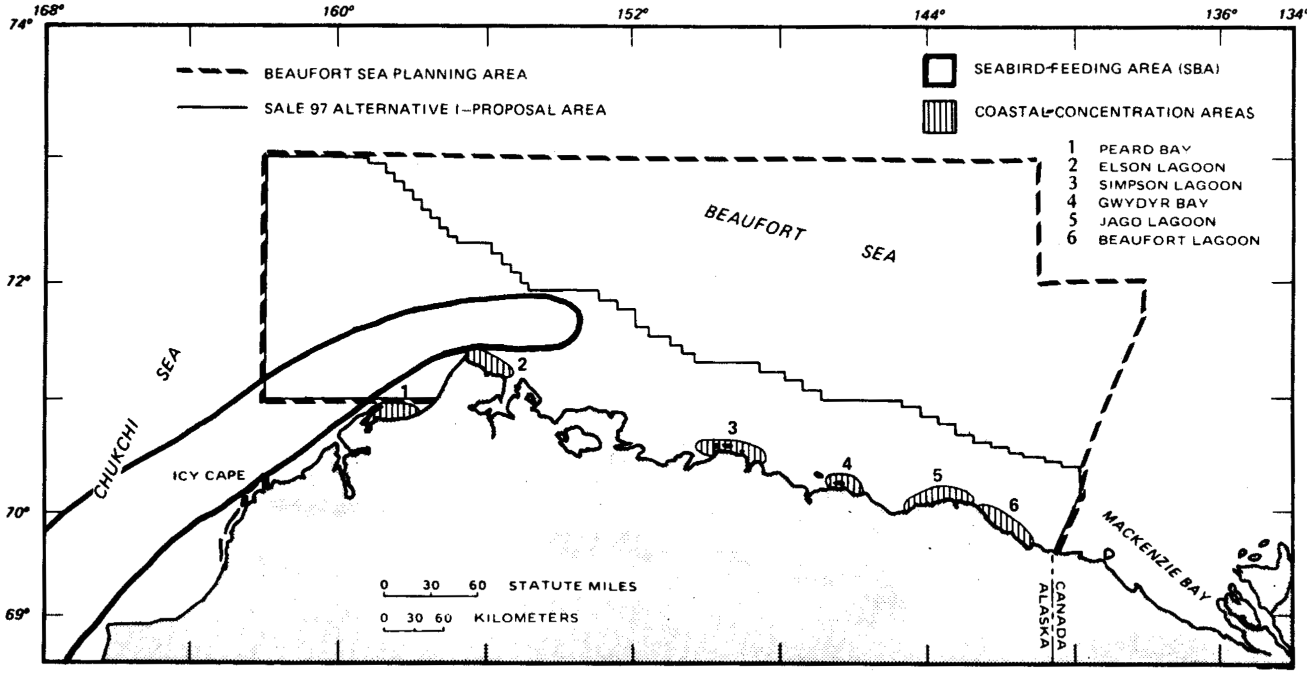
The same transportation scenario under the proposal--with a pipeline running across NPR-A for offshore leases northwest of Point Barrow--is assumed for the Barrow Deferral Alternative. Therefore, onshore and coastal-habitat effects on birds from pipelines and associated construction activities would be the same as the effects of the proposal.

In summary, this alternative could slightly reduce potential oil-spill effects on thousands of seabirds that forage in the concentration area off Point Barrow by deferring exploration drilling near Barrow and Elson Lagoon. Disturbance effects on birds using Elson Lagoon and the Plover Islands could be prevented or greatly reduced by deferring exploration activities near these habitats; however, oil-spill, noise and disturbance, and adverse-habitat effects on marine and coastal birds in other parts of the planning area would be the same as those of the proposal.

CONCLUSION: The effect of this alternative on marine and coastal birds is expected to be MODERATE, the same level of effect as that of the proposal.

Cumulative Effects: Cumulative effects effects are expected to be essentially the same as for the proposal--MODERATE.

4. Effects on Pinnipeds, Polar Bears, and Beluga Whales: This alternative could slightly reduce oil-spill risks and potential oil-spill effects on marine mammals and their habitats north and west of Point Barrow during the spring migration and the winter season from those oil-spill risks assumed to occur under the proposal (Fig. IV-21, SMA, Ice/Sea Segments 1, 2, and 3). However, marine mammal habitats offshore of Smith Bay east to Demarcation Point show no reduction in oil-spill risks under this alternative (Fig. IV-21, Ice/Sea Segments 4-11). Deleting tracts near the Plover Islands-Elson Lagoon would reduce oil-spill risks to the beluga whale spring-migration area off Point Barrow by eliminating potential platform and pipeline spills from this area. Thus, the Barrow Deferral Alternative could reduce, somewhat, potential oil-spill effects on beluga whales, particularly during spring migration, and oil-spill effects on walrus and on ringed, bearded, and spotted seal that migrate into the northern Chukchi and Beaufort Seas during the summer open-water season. Noise and disturbance from air and boat traffic and



SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS

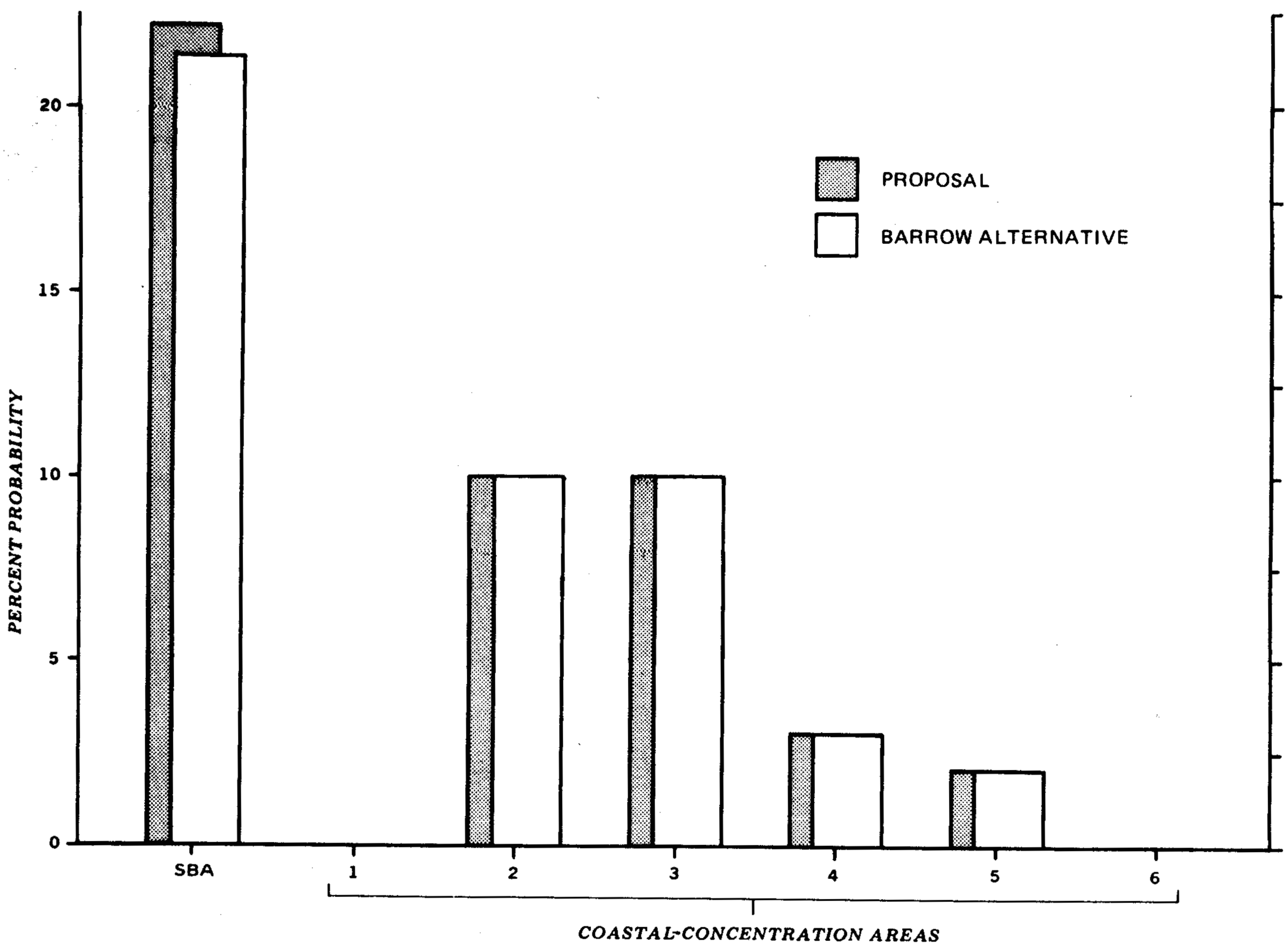


FIGURE IV-20. COMBINED PROBABILITIES OF ONE OR MORE OIL SPILLS OCCURRING AND CONTACTING SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS DURING THE OPEN-WATER SEASON WITHIN 10 DAYS OVER THE PRODUCTION LIFE OF THE LEASE AREA

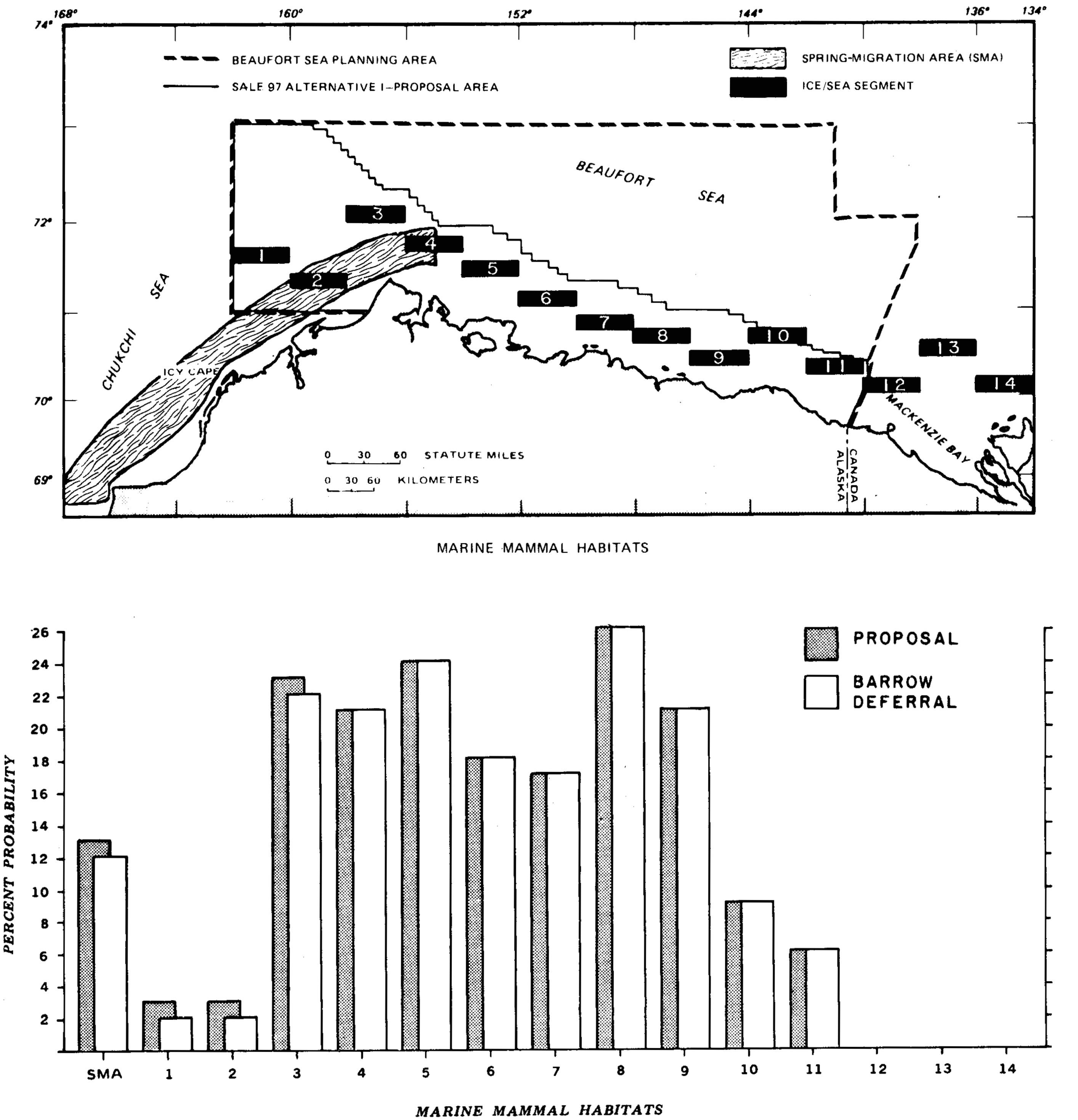


FIGURE IV-21. COMBINED PROBABILITY OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS DURING THE ENTIRE WINTER SEASON FOR ICE/SEA SEGMENTS AND APRIL 1 TO JUNE 15 FOR THE SPRING-MIGRATION AREA OVER THE EXPECTED PRODUCTION LIFE OF THE LEASE AREA

habitat alterations from oil-related industrial activities could be noticeably reduced locally in the Point Barrow-Elson Lagoon areas. Oil activities would be less likely to interfere with subsistence-hunting activities in the Point Barrow area. However, the combined effects of potential oil spills, noise and disturbance, and habitat alterations on marine mammals occurring east of Point Barrow-Plover Islands would not be appreciably reduced from the effects discussed for the leasing proposal.

In summary, this deferral alternative could reduce oil-spill effects on marine mammals and their habitats near Point Barrow. Noise and disturbance of marine mammals and habitat alterations due to industrial activities also could be reduced locally in this area. However, overall effects on nonendangered marine mammals are expected to be MINOR (the same as the proposal), since ringed seals, polar bears, walruses, and other species would be exposed to potential oil spills and other effects in other parts of the planning area.

CONCLUSION: The effects of this alternative on pinnipeds, polar bears, and beluga whales are expected to be MINOR, the same level of effect as that of the proposal.

Cumulative Effects: The cumulative effects are expected to be essentially the same as those assumed for the proposal, which are MINOR.

5. Effects on Endangered and Threatened Species: This alternative would defer from petroleum exploration and development/production the major coastal spring and fall bowhead whale-migration corridor from 71° N. latitude in the Chukchi Sea (just north of Peard Bay) north and east to about 22 kilometers east of Point Barrow.

Under this alternative, there would be a low probability (about 12%) that one or more spills of 1,000 barrels or greater would occur and contact the Bowhead Spring-Migration-Corridor A (Table F-15, Fig. IV-16) during the April 15 to June 15 period when bowheads are likely to be present. This oil-spill risk to the bowhead whale would not be reduced substantially as compared with the risks of the proposal. Should oil contact a whale-habitat area, the effects would be as discussed under the proposal. Up to several hundred bowhead whales may briefly contact lightly weathered crude oil as a result of a spill. The entire population would not likely contact the oil, since the migration would take approximately 2 months to pass through the area; and the oil slick would likely move out of the whale-migration corridor within a few days. Bowheads passing through the oiled area would likely contact oil for only a few minutes. Oil may adhere to roughened areas of bowhead skin but should be washed off rapidly without producing adverse effects. Bowheads that feed in oiled areas may experience baleen fouling, which would reduce feeding efficiency. This reduced efficiency would likely last only a few hours after bowheads return to feeding in unoiled waters.

Bowheads that contact oil after several hours of weathering should not be harmed by inhaling petroleum vapors, since toxic vapor concentrations would dissipate rapidly. However, in the unlikely case that a very low number of whales (probably less than 10) might be trapped in the vicinity of a fresh oil spill or meltout, the whales could suffer pulmonary distress or death from inhaling toxic petroleum vapors. Some bowheads may ingest small quantities of spilled oil, but it is unlikely that this would result in adverse effects. There could be localized reductions in bowhead prey organisms, but bowhead food sources are by nature patchy; and a few localized reductions should not result in a significant adverse effect. About 24 square kilometers of sea bottom would be disturbed by pipeline installation, but this would be a rather insignificant reduction in potential feeding habitat.

As a result of this deferral, noise and habitat disturbance associated with the proposal from drilling units, postlease geophysical surveys, artificial-island construction, and production platforms to bowhead whales migrating through the area during the spring and fall would be virtually eliminated because these activities would not occur within the deferral area. Aircraft disturbance may continue to a lesser degree, because support aircraft may overfly the deferral area from Barrow to offshore units in leased portions of the Beaufort or Chukchi Seas. Similarly, vessel disturbance at a low level may occur as traffic enroute to offshore units may traverse the deferral area. However, vessel traffic would most often occur during the summer months when bowheads are absent from the proposed deferral area.

Bowheads migrating through leased portions of the lease-sale area are expected to experience effects as described under the proposal. A low number of bowheads may be startled and dive as a result of aircraft overflights once or twice per day. These individuals should resume normal activities within a few minutes of aircraft passage. A few bowheads may encounter vessels either transporting supplies to an offshore facility or moving ice away from drilling units. In most cases, bowheads will avoid vessel paths or avoid approaching within a few kilometers of vessels. Occasionally, vessels will move rapidly through groups of whales resulting in group disruption and causing whales to flee rapidly. This may result in individual whales being disturbed for several hours but should not result in serious or long-lasting effects on individuals or the population. Overall, vessel activities may result in small deflections in individual migration paths, but they should not result in significant adverse effects on the species. Bowheads have shown conspicuous reaction to seismic-survey activity only when approached to within 5 to 7 kilometers. Because of the small amount of the relatively quiet, high-resolution seismic surveys expected to result from Sale 97, seismic activities are not expected to adversely affect bowheads. Stationary offshore noise sources appear less disturbing to bowheads than moving sources, and bowheads have been observed within a few kilometers of operating drillships and dredges. Bowheads would likely avoid approaching within a range of a few kilometers to over 10 kilometers of these sound sources but should not suffer substantial adverse effects. Elimination of most petroleum-industry noise in the Barrow deferral area through adoption of the alternative would allow the bowhead migration to occur as it has in the past without the concern for whales diverting their migration paths away from noise sources. As a result, with the deferral, few if any adverse affects to migrating or feeding bowhead whales would occur.

In the event of a spill, a few gray whales could contact oil. The most likely effects would be short-term and noninjurious contact with skin and baleen. Localized areas of feeding habitat might be degraded. The probability of one or more spills contacting the Gray Whale Area is 3 percent under this alternative (Table F-14, Fig. IV-16). As much as 24 square kilometers of sea bottom could be disturbed as a result of pipeline installation; however, this would result in an insignificant reduction in gray whale-feeding habitat. Postlease seismic activity, drilling units, and production platforms would not occur within the gray whale summer-feeding area offshore of Peard Bay. As a result, gray whales would not be displaced from this feeding area; neither would they have their habitat altered by OCS activities. A few gray whales occasionally would be startled and perhaps temporarily displaced by aircraft and vessel operations in the deferral area, but this should not result in a significant adverse effect on the population. Because most gray whales found within the Beaufort Sea Planning Area occur within this deferral area, the deferral alternative would offer these whales considerable protection; and the effect of the sale on the gray whale population is expected to be reduced to NEGLIGIBLE.

In summary, this alternative would reduce effects on migrating bowhead and summering gray whales since exploratory activities would not occur in the nearshore Chukchi Sea area and around Barrow, but the potential for some adverse effects from aircraft and vessel disturbance and oil spills would remain. Bowheads would be affected by industrial activities in portions of the sale area outside of the deferral area proposed under this alternative. However, most gray whales in the sale area are found within the Barrow Deferral Area, and effects on the gray whale would be greatly reduced under this alternative. Potential effects on the peregrine falcon would remain the same as under the proposal.

CONCLUSION: The combined potential effects of this alternative on bowhead whales are expected to be MINOR, the same as the effects of the proposal. The effect of this alternative on the gray whale is expected to be NEGLIGIBLE, as compared with MINOR for the proposal. The effect on the arctic peregrine falcon is expected to be NEGLIGIBLE, the same as for the proposal.

Cumulative Effects: Cumulative effects to the bowhead and gray whale under this alternative may be slightly reduced as compared with the effects expected under the proposal. However, the effect of OCS development on bowhead and gray whales would be determined to a great extent by projects within other portions of these species' ranges as described in Section IV.B.5.b. Consequently, deferral of this area would not alter the overall cumulative effects on bowhead or gray whales, which are expected to remain MODERATE, the same as for the cumulative case under the proposal. Peregrine falcons are unlikely to be found adjacent to this deferral area, and the cumulative effects on this species are expected to remain MINOR, the same as for the cumulative case under the proposal.

6. Effects on Caribou: The deferral of leasing blocks in the Point Barrow-Elson Lagoon area would not reduce the potential oil-spill effects of the proposal on caribou, since caribou of the Western Arctic herd and of the Teshekpuk Lake herd do not normally use Point Barrow or the Plover Islands (adjacent to the Barrow Deferral tracts) as insect-relief areas. Spill risks to other insect-relief habitats are expected to be the same as under the proposal. This alternative is also assumed to include the same onshore pipeline-transportation systems as the proposal; thus, potential onshore disturbance and habitat effects on caribou are expected to be MINOR, the same as the effects of the proposal.

CONCLUSION: This alternative is expected to have MINOR effects on caribou, the same level of effect expected for the proposal.

Cumulative Effects: Onshore petroleum development in NPR-A and ANWR and from other projects would contribute most of the disturbance and habitat effects on the caribou herds. Thus, the cumulative effects are expected to be essentially the same as those of the proposal--MODERATE.

7. Effects on Population: Since the development infrastructure of Sale 97 would be only slightly different in this alternative than in the proposal, the effect of this alternative on NSB population would be the same as the effect of the proposal. The sale as proposed has the effect of moderating the initial decline in the population due to reduced Borough operating and CIP revenues. Such revenues associated with the development infrastructure of this alternative would be less than those associated with the proposal; hence, the growth rate of the resident population following 1988 would be slightly less and its peak would be lower.

CONCLUSION: The Barrow Deferral Alternative is expected to have the same effects as those of the proposal, i.e., NEGLIGIBLE effects on the population of the North Slope Borough.

Cumulative Effects: The effects of this alternative would not make any difference to the expected cumulative effects of the proposal. Thus, cumulative effects from both onshore and offshore development are still expected to be MINOR.

8. Effects on North Slope Sociocultural Systems: Revenues occurring to the NSB from Sale 97 are expected to be slight (see Sec. III.D.1.a--NSB Revenues). The deletion of the Barrow tracts should have very little effect on this overall revenue picture. Whatever revenues might accrue from the remaining tracts would be administered through NSB administration. Oil-industry use of enclaves and the small potential for spending within the local economy would make very little difference to Native private-sector entrepreneurial opportunities. A Barrow Deferral Alternative with a subsequent disruptive oil spill in the Kaktovik and/or Wainwright areas could worsen the existing differences between the small coastal communities and their attitudes towards the concentration of administrative decisionmaking in Barrow. That is, given that most administrative decisions are made in Barrow, an oil spill anywhere but in the Barrow area may be perceived as discrimination against the sovereignty of the small coastal communities. However, even with these conditions, the most drastic scenario should not exceed the expectations of the effects of the proposal. Thus, although an oil spill (or spills) may have MODERATE consequences for community governing and administrative institutions, the overall effect is not expected to mean long-term, chronic disruption of the entire sociocultural system or of the development of the broad range of social and cultural institutions discussed in this analysis.

CONCLUSION: The effects of the Barrow Deferral Alternative are expected to be no worse than the effects of the proposal; that is, overall MINOR effects are expected.

Cumulative Effects: The Barrow Deferral Alternative would have little if any effect on the expected MAJOR cumulative consequences to North Slope sociocultural systems that are outlined in the effects of the proposal.

9. Effects on Subsistence-Harvest Patterns: Three sources of effects on subsistence are of greatest concern in the Sale 97 area: oil spills; noise and traffic disturbance; and the placement of exploration, development and production, and support facilities.

For the winter season, under this deferral alternative, there is a 1-percent reduction in the chance of an oil spill of 1,000 barrels or greater occurring and contacting land or ice/sea segments. For the open-water season, there is no reduction in this probability. Thus, this alternative would not essentially change the likely biological effects of oil spills on species harvested for subsistence purposes. On the other hand, subsistence activities occur locally and many--such as Barrow whaling, seal and walrus hunting, and spring bird hunting--occur with high frequency in the environs near Point Barrow. The Barrow deferral would remove many possible sources of oil spills from the immediate vicinity, and an oil spill that might originate in another part of the sale area and contact the Point Barrow area may be in a more weathered state than it would be otherwise. Thus, even though oil spills would tend to be carried toward Point Barrow because of the region's currents, this alternative would offer some mitigation from their effects. However, the probability of an oil spill occurring and contacting the Barrow-Atqasuk subsistence-harvest area would not be decreased enough under this alternative to decrease the MODERATE effect of oil spills on Barrow-Atqasuk's marine mammal harvest.

Noise and traffic disturbance from the proposal may be the largest source of effects to Barrow's subsistence activities. While this deferral alternative would not substantially change biological effects to regional populations of subsistence species, it would eliminate nearshore tracts in the immediate vicinity of Barrow and thus might offer some mitigation of noise and traffic disturbance to the Barrow-Atqasuk subsistence harvest. Particularly, noise from the construction and operation of exploration and production platforms would be eliminated from an area used intensively by these hunters; but this mitigation would be only partial. Since most of the proposal lies to the east, barge and other maritime-supply traffic would still pass through the open-water areas at Point Barrow. This might be a particular problem in the spring and fall when these same areas are used for bowhead whaling, although disruption is likely to be short term and temporary. During a year when the weather and ice conditions are poor and the whalers' ability to harvest whales is limited, the noise disruption could occur during the only brief period when harvesting a whale is possible. Such a curtailment of the whaling season for the year due to noise and traffic disturbance associated with Sale 97 would cause the bowhead whale to become locally unavailable for no more than 1 year, representing MODERATE effects on the bowhead whale harvests of Barrow-Atqasuk and Wainwright. This alternative would virtually eliminate exploration and development and production activities from the area used by Wainwright's hunters. However, as in Barrow-Atqasuk, some maritime-supply traffic would still pass through this area and is expected to continue to cause MODERATE effects, the same as for the proposal.

According to the scenario for the proposal, no onshore-support facilities are likely for the Barrow area. Thus, Alternative IV would have little effect with regard to onshore activities. However, areas immediately surrounding offshore exploration and production platforms may be closed to some types of subsistence activities. Alternative IV may offer some mitigation by eliminating the possibility of such closures in the vicinity of Barrow, an area used intensively for the hunting of marine mammals. Effects on Nuiqsut's and Kaktovik's subsistence-harvest patterns are expected to be the same as for the proposal--MODERATE. According to the scenario for the proposal, under Alternative IV a pipeline landfall and inshore support facility will still occur at Point Belcher. For this reason effects in Wainwright's subsistence harvest patterns are expected to be the same as for its proposal--MAJOR.

In summary, while Alternative IV, the Barrow Deferral Alternative, would not reduce effects of noise and traffic disturbance on Wainwright's and Barrow-Atqasuk's subsistence-harvest patterns, the overall effects are expected to remain MODERATE for Barrow-Atqasuk and MAJOR for Wainwright. Nuiqsut's and Kaktovik's subsistence harvests would not be affected by this alternative, and effects are expected to remain MODERATE. The overall effects on the subsistence-harvest patterns in the sale area are expected to remain MAJOR.

CONCLUSION: Overall effects on subsistence are expected to remain MAJOR, the same as the effects of the proposal.

Cumulative Effects: As for the proposal, cumulative effects under this alternative are expected to remain MAJOR.

10. Effects on the Economy of the North Slope Borough: The revenue and employment effects of this alternative would be virtually identical to those of the proposal, because the resource estimates for this alternative are only 3-percent less than those for the proposal. Consequently, the resulting employment effects would probably be the same as those for the proposal.

CONCLUSION: The economic effects of this alternative are expected to be the same as those of the proposal--NEGLIGIBLE.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

11. Effects on Land Use Plans and Coastal Management Programs: Although the Barrow deferral reduces potential negative effects in that area for many resources and for subsistence, overall effects are reduced only for gray whales and archaeological resources. The transportation scenario for the western portion of the sale area also remains the same. Because most regional effects and the transportation scenario do not change, land use changes and potential conflicts with NSB Land Management Regulations and ACMP policies would remain the same.

CONCLUSION: Potential conflicts with NSB Land Management Regulations and ACMP policies are expected to remain the same as for the proposal--MINOR for development along the Beaufort Sea coast and MAJOR on the Chukchi Sea coast.

Cumulative Effects: Effects of the cumulative case with the Barrow Deferral Alternative are expected to be almost identical to those of the proposal, which are MAJOR.

12. Effects on Archaeological Resources: The Barrow Deferral Alternative is expected to reduce the effects of the proposal from MINOR to NEGLIGIBLE by reducing oil and gas activity north of Barrow (near OSRA Segment 20). This area has the largest number of shipwrecks and many onshore archaeological sites.

CONCLUSION: The effects of this alternative on archaeological resources are expected to be NEGLIGIBLE as compared to MINOR for the proposal.

Cumulative Effects: The cumulative effects of Alternative IV are expected to be the same as those of the proposal--MINOR.

13. Effects on Recreation and Tourism Resources: This alternative is expected to reduce the effects of the proposal from MINOR to NEGLIGIBLE by reducing activities associated with oil development north of Barrow (near OSRA Segment 20), where the largest number of recreationists and tourists come for outdoor activities.

CONCLUSION: The effects associated with the Barrow Deferral Alternative are expected to be NEGLIGIBLE as compared to MINOR for the proposal.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

14. Effects on Water Quality: Alternative IV does not significantly reduce the oil resource, number of wells, number of platforms, or the amount of pipeline needed; therefore, this alternative does not significantly reduce the level of effect on water quality for any of the agents discussed in Section IV.B.14. There would be some lessening of pollution risks from artificial-island construction or removal and local, deliberate (permitted) discharges. Oil-spill risk to the deferral area is mostly from spills outside the deferral area. Both long-term and short-term local effects would still occur.

CONCLUSION: The effects of Alternative IV on water quality are expected to be MINOR--the same as those of the proposal.

Cumulative Effects: The intensity of effect-causing agents and, therefore, the effects of the cumulative case with Alternative IV are expected to be almost identical to those of the cumulative case with the proposal, which are MODERATE.

15. Effects on Air Quality: Because the reduction in oil resources associated with this alternative is only about 3 percent, the exploration, development and production, and transportation scenarios for Alternative IV would be basically the same as they are for the proposal. Thus, the effects on air quality are expected to be substantially the same as for the proposal. Emissions would be approximately proportionate to the mean-case oil resource.

CONCLUSION: The effects of Alternative IV on air quality are expected to be the same as those of the proposal, MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

Cumulative Effects: The cumulative effects are expected to be the same as those of the proposal, MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

F. Alternative V - Kaktovik Deferral Alternative

The Kaktovik Deferral Alternative would defer 161 blocks, about 327,022 hectares, located between Kaktovik (Barter Island) and the Canadian border. MMS estimates the mean-case oil resources in the deferral alternative to be 560 MMbbls; the mean-case resource estimate for the proposal is 650 MMbbls. (This estimate is a result of the low probability assigned for the occurrence of petroleum in the deferral area. However, because of the uncertainty involved in making resource estimates for frontier areas, there remains a small probability that the deferral area contains petroleum.) Thus, as noted Section II.A.6, the basic scenario assumptions for this alternative would remain the same as they are for the proposal.

1. Effects on Lower-Trophic-Level Organisms: The lower-trophic-level organisms of greatest concern in the Alternative V area due to their abundance or trophic relationships include: (1) the planktonic and epontic communities, with special emphasis on primary production and trophic linkages; (2) the abundant epibenthic invertebrates in nearshore waters that are fed on extensively by anadromous and some marine fishes; and (3) the Stefansson Sound Boulder Patch, an apparently unique, kelp-dominated community.

These marine plants and invertebrates are most likely to be adversely affected by oil spills, but the Boulder Patch community also could be vulnerable to effects from drilling discharges and construction activities. However, these latter effects are highly unlikely to occur under either the proposal or this deferral alternative since available lease tracts are situated far from the Boulder Patch community. Therefore, deferring the area of Alternative V is not expected to have any effect on the Boulder Patch community.

Planktonic and epontic communities are widespread in the Alternative V area, and no single target or specific set of targets identifies areas of concern. Probabilities associated with ice/sea segments are used as a representative focus. Combined probabilities of a spill of 1,000 barrels and greater occurring and contacting ice/sea segments under this deferral alternative do not change appreciably from those associated with the proposal for the open-water season (Appendix F, Tables F-19 and 20). The combined probabilities for several sea/ice segments drop by 1 to 2 percent, but this difference is not viewed as being significant.

For epibenthic invertebrates in nearshore waters, this deferral alternative offers some advantage, as the combined probability of a spill of 1,000 barrels and greater occurring and contacting land within 10 days in the open-water season changes from 20 percent for the proposal to 15 percent for the deferral alternative.

The Stefansson Sound Boulder Patch is best approximated by Land Segment 36, for which combined probabilities do not change relative to the proposal.

Alternative V, the Kaktovik Deferral Alternative, offers some moderate advantage to epibenthic invertebrates in nearshore waters by reducing the probability of an oil spill contacting land. For other marine plants and invertebrates of concern, the alternative does not change effects significantly. The expected effect of oil spills is viewed to be the same as under the proposal, MINOR, although MODERATE effects are possible for the Stefansson

Sound Boulder Patch if it were contacted by oil. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative.

CONCLUSION: The level of effect of Alternative V is expected to be the same as for the proposal--MINOR.

Cumulative Effects: Cumulative effects under this alternative are expected to be similar to those under the proposal--MINOR.

2. Effects on Fishes: The fish species of greatest concern in the Alternative V area are the anadromous fishes that are abundant in the warm, brackish-water nearshore zone during the open-water season, and the abundant and trophically important marine species, the arctic cod. The location of oil spills is the factor associated with oil exploration and development and production that is most likely to affect fishes and yet is most likely to be affected by the deferral alternatives.

Anadromous fishes are most likely to be affected in the nearshore zone. Within this zone, the river deltas are viewed as being the most sensitive and important habitat. With this deferral alternative, the probability of an oil spill of 1,000 barrels and greater occurring and contacting land during the open-water season within 10 days would be reduced from 20 percent for the proposal to 15 percent. Although this change apparently affords greater protection to fishes in nearshore environments, the change in probability for land segments of particular interest (e.g., river deltas) is negligible (the only change is for Land Segment 38, near the Canning River, from 2% to 1%). Thus, this deferral alternative offers no appreciable advantage to anadromous fishes.

The arctic cod is a marine species with a very widespread and patchy distribution. At times, it can be very abundant in nearshore waters. As mentioned above, this deferral alternative does change the probability of oil contacting land somewhat. Figures for the open-water season are given above. For the entire winter season, probabilities of contact decline 1 percent for several land segments of interest (35, 36, 38, and 41--respectively, the Sagavanirktok River area, near the Boulder Patch, the Canning River, and the Barter Island/Jago Lagoon area) and decline 4 percent (from 28 to 24%) for land, in general. Examination of combined probabilities of an oil spill of 1,000 barrels and greater occurring and contacting ice/sea segments in the open-water season (for 10-day figures: several ice/sea segments show a 1-2% reduction in probability of oil contact relative to the proposal) and for the entire winter season (several ice/sea segments show reductions ranging from 1-9% probability) indicate that this alternative might reduce the probability of oil contacting arctic cod; however, the effect is unpredictable, given the patchy and unpredictable distribution of the cod. This deferral alternative most probably would not significantly alter effects on arctic cod as compared to the proposal.

Although capelin are not abundant in the Alternative V area, they may be vulnerable to oil spills when they come into coastal areas to spawn in July and August. Since the probability of oil contacting land declines somewhat (5%) under this alternative, the risks to capelin are also slightly reduced.

Alternative V, the Kaktovik Deferral Alternative, would reduce somewhat the probability of oil spills occurring and contacting fishes of greatest concern; however, its overall effect is probably not significant. The level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for anadromous species and capelin if spawning-year individuals, aggregated multi-aged assemblages, or a year class of young were affected. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative.

CONCLUSION: The level of effect under Alternative V is expected to be the same as for the proposal--MINOR.

Cumulative Effects: Cumulative effects under this alternative are expected to be similar to those under the proposal--MAJOR.

3. Effects on Marine and Coastal Birds: This deferral alternative would essentially eliminate oil-spill risks and potential oil-spill effects of the proposal on bird coastal habitats from Kaktovik east, particularly Jago and Beaufort Lagoons (Fig. IV-22, Areas 5 and 6). Therefore, potential oil-spill effects on moderate numbers of birds ($25/km^2$) frequenting these coastal habits could be substantially reduced, even though these birds may be affected by activities associated with existing leases in this area. However, potential oil-spill effects on large numbers of birds (greater than $50/km^2$) in Elson Lagoon (Fig. IV-22, Area 2) would be the same as those effects described for the proposal. Oil-spill risks and potential effects on large numbers of birds using Simpson Lagoon, Gwydyr Bay, and the offshore-feeding area north of Point Barrow could be slightly reduced (Fig. IV-22, SBA and Area 3).

Assuming for this alternative (as for the proposal) that offshore pipelines would be built to support oil development and production in the eastern part of the proposed sale area, this alternative would not reduce onshore habitat and disturbance effects on marine and coastal birds from those effects described under the proposal.

In summary, this alternative would substantially reduce potential oil-spill effects to moderate numbers of birds in habitats east of Kaktovik, but it would only slightly reduce potential oil-spill effects to high numbers of birds. It would not reduce noise and disturbance and habitat-alteration effects to greater numbers of marine and coastal birds throughout other parts of the planning area. Therefore, effects on marine and coastal birds are expected to be MODERATE, the same level of effect as that of the proposal.

CONCLUSION: Effects on marine and coastal birds for this alternative are expected to be MODERATE, the same level of effect as that of the proposal.

Cumulative Effects: The cumulative effects are expected to be essentially the same as for the proposal--MODERATE.

4. Effects on Pinnipeds, Polar Bears, and Beluga Whales: This alternative would significantly reduce oil-spill risks to offshore marine mammal habitats east from Prudhoe Bay to Kaktovik (Fig. IV-23, Ice/Sea Segments 8-10). Noise disturbance from air and marine traffic, construction

activities, and habitat alterations from drill-platform and pipeline construction also could be reduced in this area. No additional habitat effects would occur east of Kaktovik and Jago Lagoon. This alternative would eliminate further potential disturbance and oil-spill effects on ringed seals and polar bears and their coastal habitats near Kaktovik eastward to Demarcation Bay described under the proposal (other than potential effects associated with existing Sale 87 leases in this area). However, potential oil-spill, disturbance, and habitat-alteration effects on walrus, bearded seal, beluga whale, and important marine mammal habitats west of Prudhoe Bay would not be significantly reduced (Fig. IV-23, Ice/Sea Segments 1-7).

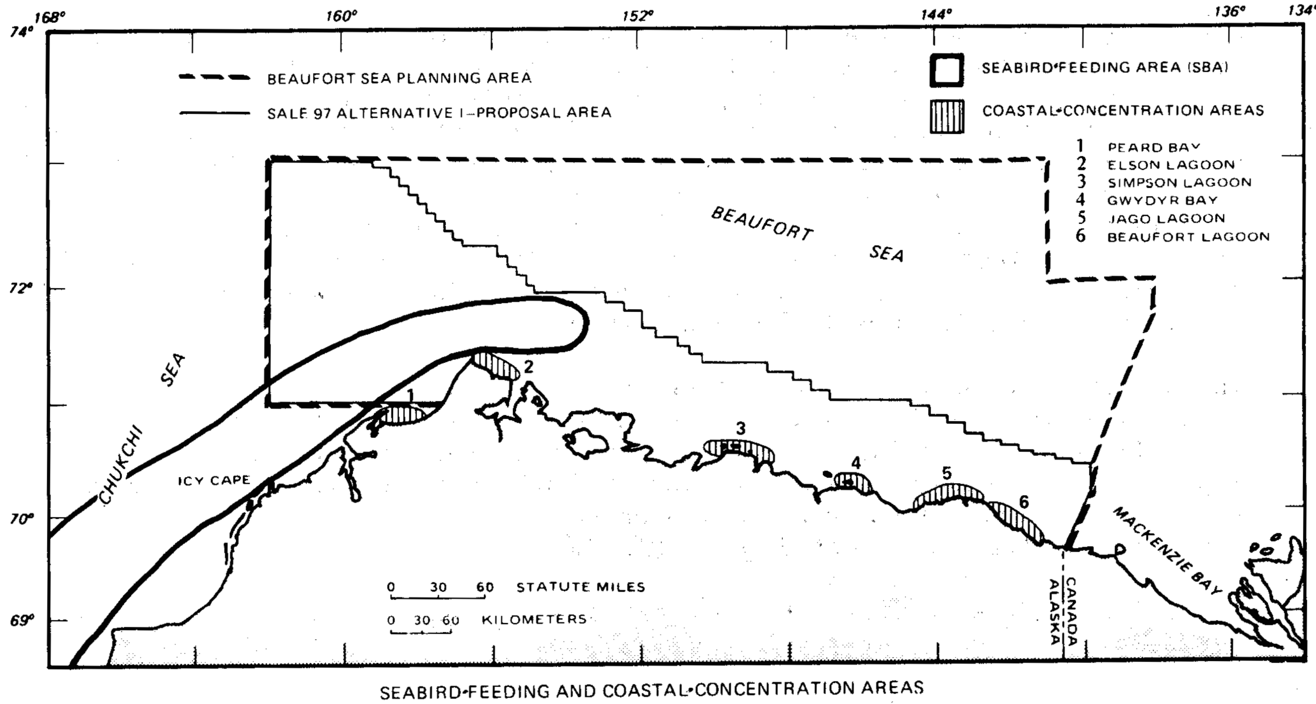
In summary, although oil-spill, disturbance, and habitat-alteration effects on marine mammals would be reduced or eliminated in offshore habitats east of Kaktovik, effects on large numbers of walrus, bearded seal, beluga whale, and important marine mammal habitats west of Prudhoe Bay would not be reduced from those effects described under the proposal. Effects on marine mammals under this alternative are expected to be MINOR.

CONCLUSION: Effects under this alternative are expected to be MINOR, the same level of effect as under the proposal.

Cumulative Effects: Cumulative effects are expected to be MINOR, the same as for the proposal.

5. Effects on Endangered and Threatened Species: This alternative would defer from petroleum exploration and development and production an area east and north of Kaktovik used by bowhead whales for feeding and migration during the late summer and fall. Under this alternative, oil-spill risks to the bowhead whale would be slightly reduced as compared with the proposal. The greatest reduction in oil-spill risk under this alternative would occur for the Bowhead Spring-Migration-Corridor B, for which the probability of one or more spills of 1,000 barrels or greater occurring and contacting the area when bowheads are likely to be present would be reduced from 26 percent under the proposal to 22 percent (Tables F-15 and 16, Fig. IV-16). All other areas would experience a 3-percent-or-less reduction in the probability of contact by oil spills. If spilled oil were to contact a whale-habitat area, resulting effects would be as discussed under the proposal and the Barrow Deferral Alternative. Some bowhead whales (up to several hundred) could experience one or more of the following: skin contact and possible irritation, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, and the consumption of contaminated prey items. The result of these factors would be temporary discomfort and reduction in feeding efficiency for the affected individual without substantial effects on the population.

Noise and habitat disturbance from drilling units, postlease geophysical surveys, artificial-island-construction activities, 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 proposed deferral area. However, leases have been granted adjacent to the proposed deferral area as a result of Sale 87, and aircraft and vessel traffic would cross the proposed deferral area enroute to these leased blocks. This traffic could startle 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



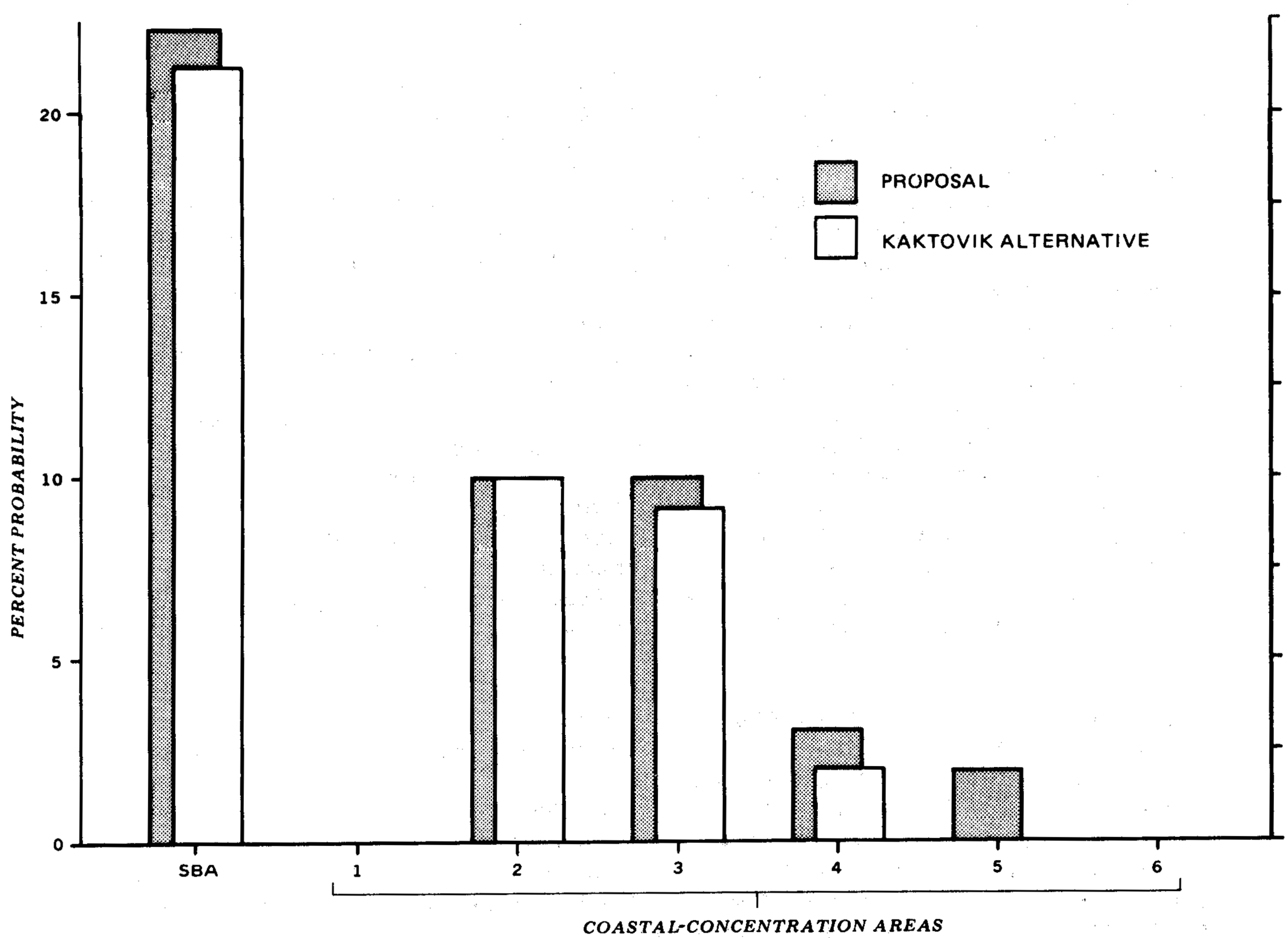
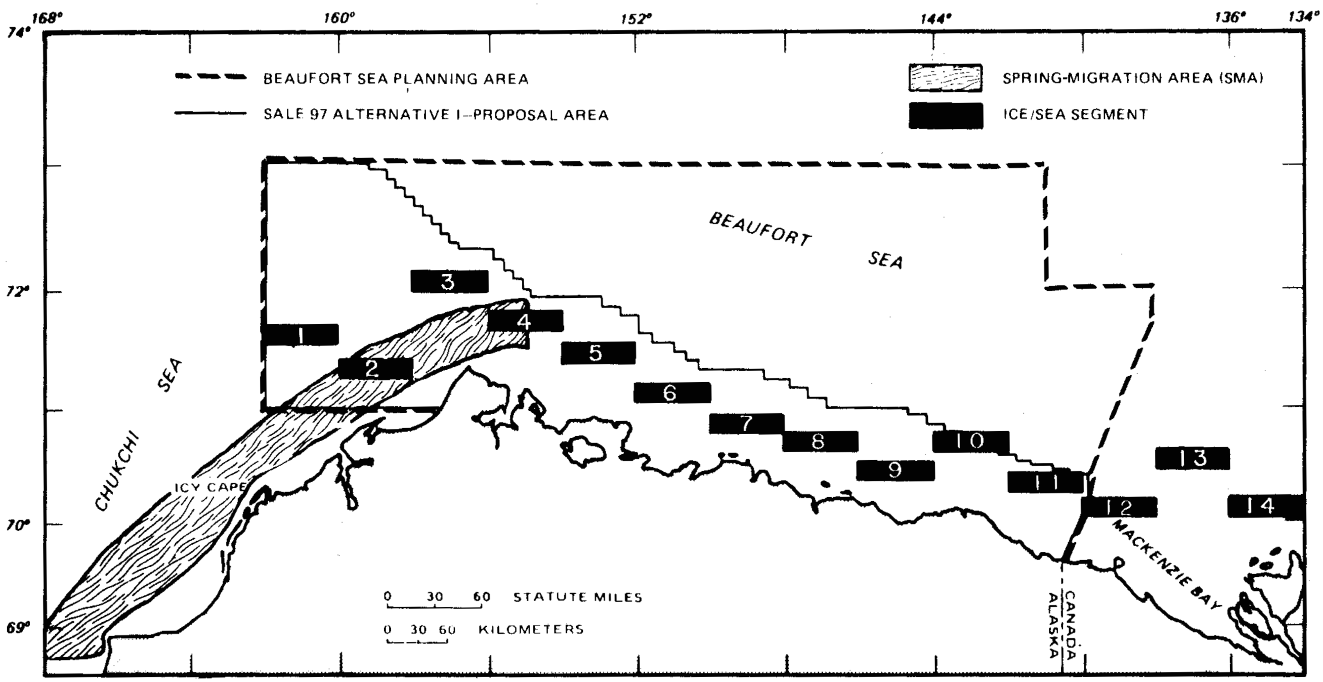


FIGURE IV-22. COMBINED PROBABILITIES OF ONE OR MORE OIL SPILLS OCCURRING AND CONTACTING SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS DURING THE OPEN-WATER SEASON WITHIN 10 DAYS OVER THE PRODUCTION LIFE OF THE LEASE AREA



MARINE MAMMAL HABITATS

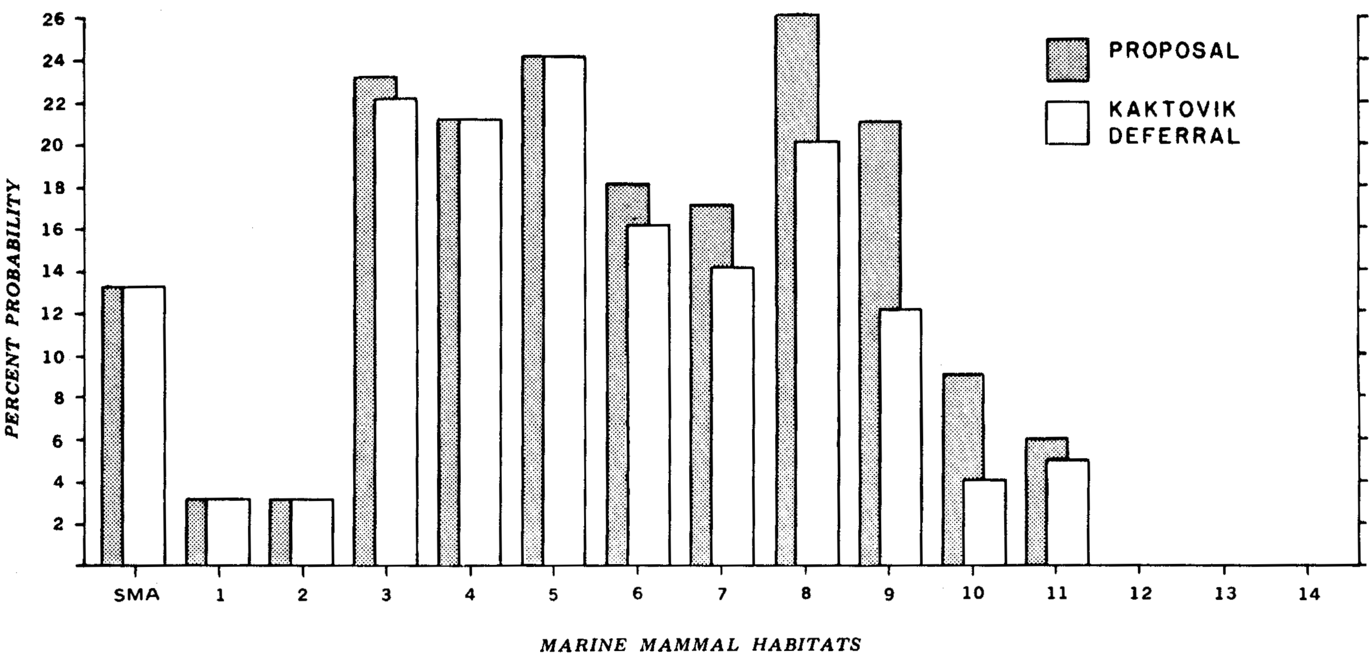


FIGURE IV-23. COMBINED PROBABILITY OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS DURING THE ENTIRE WINTER SEASON FOR ICE/SEA SEGMENTS AND APRIL 1 TO JUNE 15 FOR THE SPRING-MIGRATION AREA OVER THE EXPECTED PRODUCTION LIFE OF THE LEASE AREA

from seismic surveys within leased blocks could be transmitted into the deferral area and might mask some bowhead vocalizations, although the sound intensity within the proposed deferral area would be at reduced levels and would be unlikely to significantly displace feeding or migrating whales in the deferral area. Outside the deferral area, the effect on bowheads would be as described for the proposal, with whales avoiding areas within a few kilometers of vessels, seismic surveys, drilling units, and production platforms. Gray whales are seldom found east of Point Barrow; consequently, the effect of this alternative on the gray whale is expected to be the same as for the proposal--MINOR.

In summary, bowhead whales feeding in or migrating through the proposed deferral area may occasionally be disturbed by aircraft or vessel traffic, adjacent seismic surveys, or drilling and production activities. However, the level of disturbance in the proposed deferral area would be less with the deferral than without it. Bowhead-feeding activities in the deferral area would be less disturbed under this alternative. Bowheads would be subject to the same level of disturbance in the sale area outside of the proposed deferral area as they would be under the proposal; consequently, the overall effect levels is expected to remain the same as for the proposal--MINOR. Effects on the gray whale and the arctic peregrine falcon are expected to also be the same as for the proposal--MINOR and NEGLIGIBLE, respectively.

CONCLUSION: This alternative is expected to have the same overall levels of effect on endangered species as the proposal, with MINOR effects likely on the bowhead and gray whale and NEGLIGIBLE effects on the arctic peregrine falcon.

Cumulative Effects: Under this alternative, cumulative effects on the bowhead whale are expected to be slightly reduced as compared with the cumulative case under the proposal, since areas in which bowheads feed and migrate through during the fall would be deferred from leasing. However, the potential for the bowhead to be adversely affected by projects described in Section IV.B.5 in other portions of its range would remain great. Consequently, the cumulative effects on the bowhead whale under this alternative are expected to remain MODERATE, the same as for the cumulative case under the proposal. Gray whales and peregrine falcons are seldom found near the deferral area; consequently, cumulative effects on these species are expected to remain the same as for the cumulative case under the proposal, which are MODERATE for the gray whale and MINOR for the peregrine falcon.

6. Effects on Caribou: This alternative could reduce potential disturbance of caribou and possible oil-spill effects on caribou using coastal barrier islands and beaches between Jago Lagoon and Demarcation Bay for insect relief. However, caribou of the Western Arctic herd and of the Central Arctic herd would still be exposed to disturbance sources and habitat alteration associated with onshore-pipeline transportation of oil from leases in other parts of the Sale 97 area. Caribou of these two herds would still be displaced during construction of the onshore pipelines and roads, although their use of summer-forage range is not likely to be greatly affected by the proposal or this alternative. Therefore, effects on caribou are expected to be MINOR.

CONCLUSION: This alternative is expected to have MINOR effects on caribou, the same effect level as that of the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as for the proposal--MODERATE.

7. Effects on Population: Since the development infrastructure of Sale 97 would be only slightly different in this alternative than in the proposal, the effect of this alternative on NSB population would be the same as that of the proposal. The sale as proposed has the effect of moderating the expected initial decline in the population due to reduced Borough operating and CIP revenues. Such revenues associated with the development infrastructure of this alternative would be less than expected for the proposal. Hence, the growth rate of the resident population following 1988 would be slightly less, and its peak would be lower.

CONCLUSION: The Kaktovik Deferral Alternative is expected to have the same effect as the proposal; NEGLIGIBLE effects on the population of the North Slope Borough are expected.

Cumulative Effects: The effects of this alternative would not make any difference to the cumulative effects of the proposal. Thus, cumulative effects from both onshore and offshore development are still expected to be MINOR.

8. Effects on North Slope Sociocultural Systems: Because there is only a slight reduction in the oil resources, the sociocultural consequences of the Kaktovik Deferral Alternative would, for most of the Sale 97 area, be about the same as for the proposal. However, Kaktovik, a small community with a high cost of living and an economy dominated by public-sector employment, is particularly susceptible to the recent decrease in NSB employment. Even a few jobs generated by Sale 97 would be a definite plus for the community. On the other hand, Kaktovik is more isolated than the larger communities on the North Slope--Wainwright and Barrow. Recent research by Jacobson and Wentworth (1982), Worl (1982), and especially Smythe and Worl (1985) attest to the importance of extended families and the significance of communal subsistence activities in the lives of the Kaktovik Inupiat. These circumstances--a smaller, more tightly integrated community dependent on subsistence activities--indicate that a significant oil spill would have important consequences for community sharing and kinship and would increase tensions between the City Council and NSB administrative entities. The City Council's long-term opposition to Beaufort Sea development and its particular fear that development activities may interfere with bowhead whale and caribou harvests are additional testimony to these concerns. Thus, the Kaktovik Deferral Alternative is expected to have MODERATE consequences for the community of Kaktovik.

CONCLUSION: Alternative V would not alter the expected MINOR consequences for North Slope sociocultural systems.

Cumulative Effects: The Kaktovik Deferral Alternative is expected to have little if any effect on the possible MAJOR cumulative consequences to North Slope sociocultural systems that are outlined in the effects of the proposal.

9. Effects on Subsistence-Harvest Patterns: Three sources of effects on subsistence are of greatest concern in the Sale 97 area: oil spills; noise and traffic disturbance; and the placement of exploration, development, and support facilities.

Under this alternative, the greatest shift in the risk of oil spills occurs during the summer months. At this time, the probability of an oil spill of 1,000 barrels or greater occurring and contacting land within 10 days drops from 20 percent for the proposal to 15 percent for Alternative V. While this shift would not change the regionwide biological effects to subsistence resources, subsistence occurs on a more localized level. The change in probabilities of oil contact for land segments is not great, but it occurs in areas heavily used by Kaktovik's hunters both for caribou and marine mammals. (For example, the probability of contact for Land Segment 38, near the Canning River, drops from 2% to 1%.) Also, the Kaktovik deferral would remove many possible sources of oil spills from the immediate vicinity; and an oil spill that might originate in another part of the sale area and contact this area may be in a more weathered state than it would be otherwise. Thus, this alternative would offer some mitigation from the effects of oil spills. However, the probability of an oil spill occurring and contacting the Kaktovik subsistence-harvest area would not be decreased enough under this alternative to decrease the expected MODERATE effect of oil spills on Kaktovik's marine mammal harvest.

Noise and traffic disturbance from the proposal may be the largest source of effects to Kaktovik'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 are not, presently, those most intensely used by Kaktovik for marine mammal and caribou hunting. However, such protection may be particularly significant, since the western half of Kaktovik's subsistence-harvest area has and will be affected by offshore oil development.

Nuiqsut's, Barrow-Atqasuk's, and Wainwright's subsistence-harvest patterns would not be affected by this alternative, and effects are expected to remain MODERATE.

In summary, under Alternative V, the Kaktovik Deferral Alternative, the overall effects for Kaktovik's subsistence-harvest patterns are expected to remain MODERATE. Nuiqsut's, Barrow-Atqasuk's, and Wainwright's subsistence-harvest patterns would not be affected by this alternative. Effects are expected to remain MODERATE for Nuiqsut and Barrow-Atqasuk and MAJOR for Wainwright. The overall effects on the subsistence-harvest patterns in the sale area are expected to remain MAJOR.

CONCLUSION: Overall effects on subsistence are expected to remain MAJOR, the same as the effects of the proposal.

Cumulative Effects: Cumulative effects under this alternative are expected to remain MAJOR.

10. Effects on the Economy of the North Slope Borough: The employment effects of this alternative would be only slightly less than those of the proposal, because the resource estimates for this alternative are only 14-percent less than those for the proposal. This difference in resource estimates probably would not change the number of production platforms installed and operated, but it might reduce slightly the number of production wells drilled. The employment effects of this alternative would, therefore, probably be about 95 percent as great as the effects indicated for the proposal in Section IV.B.10.

CONCLUSION: The economic effects of this alternative are expected to be the same as those of the proposal--NEGLIGIBLE.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

11. Effects on Land Use Plans and Coastal Management Programs: Deferring the area around Kaktovik would slightly reduce the oil resources of the proposal with a consequent reduction in the risk of oil spills to marine habitats east of Jago Lagoon (see Sec. IV.F.4). However, production is expected to occur from this eastern portion of the sale area regardless of this lease sale. Therefore, effects on land use and conflicts with NSB Land Management Regulations and ACMP policies would not be significantly different from those anticipated for the proposal.

CONCLUSION: This alternative does not alter the land use changes anticipated with the proposal. Potential conflicts are expected to remain MINOR for development along the Beaufort Sea coast and MAJOR along the Chukchi Sea coast.

Cumulative Effects: Cumulative effects would not decrease if the area around Kaktovik were deferred. Production is expected to occur in the eastern Beaufort Sea as a result of discoveries from Sale 87 leases and from the Mackenzie Delta. Therefore, MAJOR conflicts with land use plans and regulations and coastal management policies are still expected to occur.

12. Effects on Archaeological Resources: Because there is only a slight reduction in the oil resources associated with Alternative V, the archaeological resources of the Sale 97 area would be affected by the same level of activities as was discussed for the proposal in Section IV.B.12.

CONCLUSION: The effects of the Kaktovik Deferral Alternative are expected to be the same as for the proposal--MINOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as for the proposal--MINOR.

13. Effects on Recreation and Tourism Resources: Because there is only a slight reduction in the oil resources of the Kaktovik Deferral Alternative, the recreation and tourism resources of the Sale 97 area would be affected by the same level of activities as was discussed for the proposal in Section IV.B.13.

CONCLUSION: The effects of this alternative are expected to be the same as they are for the proposal--MINOR.

Cumulative Effects: The cumulative effects associated with the Kaktovik Deferral Alternative are expected to be the same as for the proposal--MINOR.

14. Effects on Water Quality: Alternative V would not significantly reduce the projected oil spillage or level of effects on water quality for any of the agents discussed in Section IV.B.14. There would be some lessening of pollution risks from artificial-island construction or removal and local deliberate (permitted) discharges. This alternative would eliminate the slight risk of spills occurring or contacting waters of the deferred area. Both long-term and short-term local effects would still occur.

CONCLUSION: The effect of Alternative V on water quality is expected to be MINOR--the same as that of the proposal.

Cumulative Effects: Most spill risk to the deferred area would come from cumulative development, not from proposed Sale 97. Effects of the cumulative case with Alternative V are expected to be almost identical to those of the cumulative case with the proposal, which are MODERATE.

15. Effects on Air Quality: Because the reduction in oil resources associated with this alternative is only about 11 percent, the exploration, development and production, and transportation scenarios for Alternative V would be basically the same as they are for the proposal. Thus, the effects on air quality would be substantially the same as for the proposal. Emissions would be approximately proportionate to the mean-case oil resource.

CONCLUSION: Effects of Alternative V on air quality are expected to be the same as those of the proposal, which are MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

Cumulative Effects: The cumulative effects are expected to be the same as for the proposal, which are MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

G. Alternative VI - Chukchi Deferral Alternative

Alternative VI, the Chukchi Deferral Alternative, would defer an area consisting of 1,592 blocks, about 3,595,670 hectares, located seaward of the Barrow Deferral Area on the Chukchi Sea Shelf and upper part of the continental slope. MMS estimates the mean-case oil resources of the deferral alternative to be about 620 MMbbls; the mean-case resource estimate for the proposal is 650 MMbbls. (This estimate is a result of the very low probability assigned for the occurrence of petroleum in the deferral area. However, because of the uncertainty involved in making resource estimates for frontier areas, there remains a very small probability that the deferral area contains petroleum.) Thus, as noted in Section II.A.6, the basic scenario assumptions for this alternative would be the same as they are for the proposal. For the purpose of environmental effects analysis, it was assumed that one production platform and 120 kilometers of pipeline could be located in the Chukchi Sea north of Point Belcher (Sec. II.A.3). The potential development of the blocks in the Chukchi Deferral Alternative would be eliminated if this area were deferred from leasing; however, given the estimated oil resources outside the Chukchi Deferral Area, the Chukchi production platforms and pipeline could be located in the Beaufort Sea part of the Sale 97 area.

1. Effects on Lower-Trophic-Level Organisms: The lower-trophic-level organisms of greatest concern in the Alternative VI area due to their abundance or trophic relationships include: (1) planktonic and epontic communities with special emphasis on primary production and trophic linkages; (2) the abundant epibenthic invertebrates in nearshore waters that are fed on extensively by anadromous and some marine fishes; and (3) the Stefansson Sound Boulder Patch, an apparently unique, kelp-dominated community.

These marine plants and invertebrates are most likely to be adversely affected by oil spills, but the Boulder Patch community also could be vulnerable to effects from drilling discharges and construction activities. However, these latter effects are highly unlikely to occur under either the proposal or this deferral alternative because available lease tracts are situated far from the Boulder Patch community. Therefore, deferring the area of Alternative VI is not expected to have any effect on the Boulder Patch community.

Planktonic and epontic communities are widespread in the Alternative VI area, and no single target or specific set of targets identifies areas of concern. Probabilities associated with ice/sea segments are used as a representative focus. Combined probabilities of a spill of 1,000 barrels and greater occurring and contacting ice/sea segments under this deferral alternative do not change from those associated with the proposal for the open-water season (Appendix F, Tables F-19 and 20).

For epibenthic invertebrates in nearshore waters, this deferral alternative offers no real advantages, as the combined probabilities of a spill of 1,000 barrels and greater occurring and contacting land within 10 days in the open-water season do not change from those associated with the proposal.

The Stefansson Sound Boulder Patch is best approximated by Land Segment 36; and here as well, combined probabilities do not change relative to the proposal.

Alternative VI, the Chukchi Deferral Alternative, would not significantly alter the probability of oil spills occurring and contacting marine plants and invertebrates of greatest concern. The expected effect of oil spills is viewed as being the same as under the proposal, MINOR, although MODERATE effects are possible for the Stefansson Sound Boulder Patch if it were contacted by oil. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative.

CONCLUSION: The level of effect is expected to be the same as for the proposal--MINOR.

Cumulative Effects: Cumulative effects under this alternative are expected to be similar to those under the proposal--MINOR.

2. Effects on Fishes: The fish species of greatest concern in the Alternative IV area are the anadromous fishes that are abundant in the warm, brackish-water, nearshore zone during the open-water season and the abundant and trophically important marine species, the arctic cod. The location of oil spills is the factor associated with oil exploration and development and production that is most likely to affect fishes and yet is most likely to be affected by the deferral alternative.

Anadromous fishes are most likely to be affected in the nearshore zone. Within this zone, the river deltas are viewed as being the most sensitive and important habitat. This deferral alternative does not change, relative to the proposal, the probability of an oil spill of 1,000 barrels and greater occurring and contacting land during the open-water season within 10 days. Thus, this deferral alternative offers no advantage to anadromous fishes.

The arctic cod is a marine species with a very widespread and patchy distribution. At times, it can be very abundant in nearshore waters. As mentioned above, this deferral alternative does not change the probability of oil contacting land. During the winter, there is an insignificant (1%) reduction in the probability that oil will contact land. Examination of combined probabilities of an oil spill of 1,000 barrels and greater occurring and contacting ice/sea segments in the open-water season (for 10-day figures: no change relative to the proposal) and for the entire winter season (several ice/sea segments show reductions in probability of several percent or less) indicate that this alternative probably would insignificantly alter effects on arctic cod as compared to the proposal.

Capelin may be vulnerable to oil spills in nearshore waters as they come into coastal areas to spawn in July and August. Capelin are not abundant in the Alternative VI area. Since the probability of oil contacting land is not reduced, this alternative offers no advantage to capelin.

Alternative VI, the Chukchi Deferral Alternative, would not significantly affect the probability of oil spills occurring and contacting fishes of greatest concern. The level of effect is expected to be the same as for the proposal, MINOR, although MODERATE effects are possible for anadromous species and capelin if spawning-year individuals, aggregated multi-aged assemblages, or a year class of young were affected. Effects from other oil-associated activities should not be appreciably affected by this deferral alternative.

CONCLUSION: The level of effect under Alternative VI is expected to be the same as for the proposal--MINOR.

Cumulative Effects: Cumulative effects under this alternative are expected to be similar to those under the proposal--MAJOR.

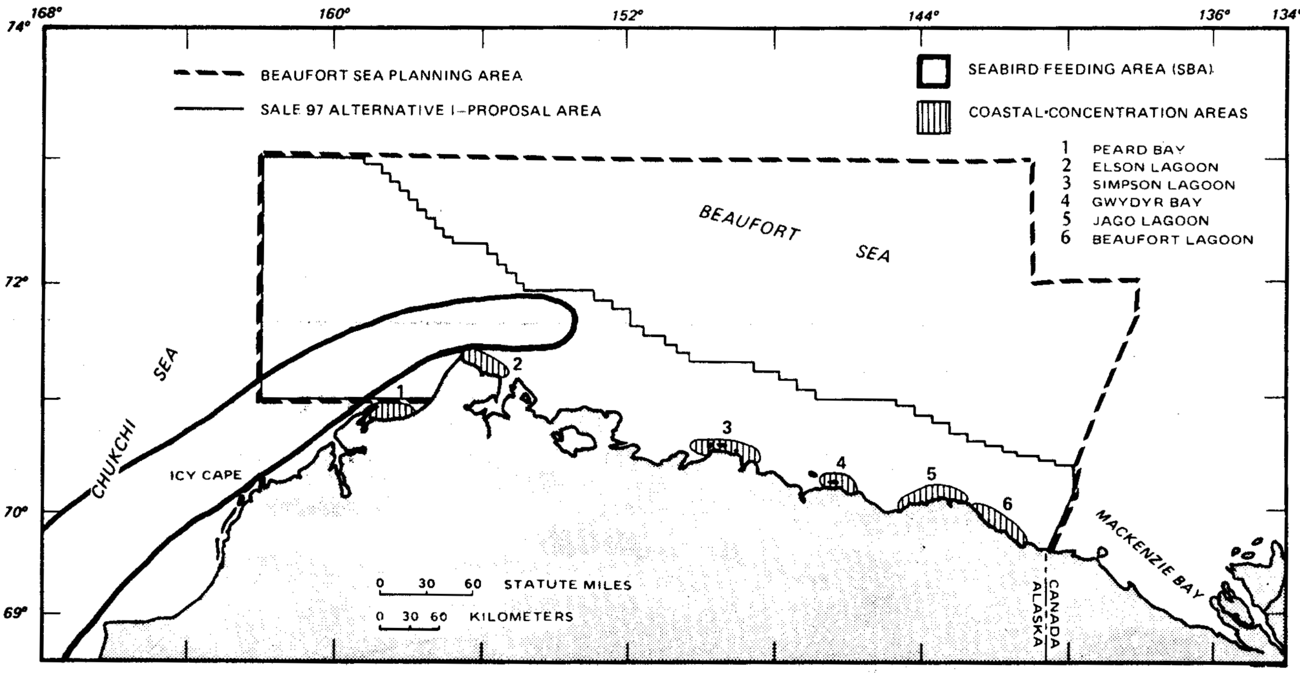
3. Effects on Marine and Coastal Birds: This alternative would defer all exploration activities in 3,595,670 hectares of offshore habitat northwest of Point Barrow but would not reduce the combined oil-spill risk to seabirds, such as Ross' gull, that feed offshore in the northern Chukchi Sea northwest of Point Barrow from the spill risk assumed for the proposal (Fig. IV-24, Seabird-Feeding Area). Oil-spill risks to bird coastal-concentration areas from Point Barrow eastward are not reduced from those spill risks under the proposal. Bird-habitat alterations due to drilling platform and pipeline construction (one exploratory platform versus two under the proposal) could be reduced, particularly in the far western part of the planning area. However, birds and their habitats east of Point Barrow would be affected by noise and disturbance and habitat alterations similar to those described for the proposal. Under this alternative, the onshore pipeline from Point Belcher to TAP is still assumed to occur. Thus, the same level of bird-nesting and -feeding habitat on the North Slope would be affected by onshore activities under this alternative as under the proposal.

In summary, this alternative could reduce noise and disturbance effects and habitat effects on birds that feed in offshore habitats northwest of Point Barrow in the Chukchi Sea; however, oil-spill risks and potential oil-spill, disturbance, and habitat effects on birds using coastal habitats in the rest of the sale area would be essentially the same for this alternative as for the proposal. Therefore, effects on marine and coastal birds are expected to be MODERATE, the same as for the proposal.

CONCLUSION: This alternative is expected to have MODERATE effects on marine and coastal birds--the same as those of the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as for the proposal--MODERATE.

4. Effects on Pinnipeds, Polar Bears, and Beluga Whales: This alternative would defer all exploration activities in 3,595,670 hectares of offshore habitat northwest of Point Barrow and would slightly reduce oil-spill risks to marine mammal habitats offshore north and west of Point Barrow from those spill risks assumed to occur with the proposal (Fig. IV-25, Ice/Sea Segments 1, 2, and 3). However, marine mammal habitats offshore of Smith Bay east to Demarcation Point show no reduction in oil-spill risks for this alternative (Fig. IV-9, Ice/Sea Segments 4-11). Deleting tracts offshore and west of Point Barrow and offshore of Peard Bay in the Chukchi Sea reduces oil-spill risks and potential effects on over 150,000 walruses, including females and calves summering in the northern Chukchi Sea, by eliminating potential platform and pipeline spills from this area. Thus, Alternative VI could substantially reduce potential oil-spill and disturbance effects on walruses and other marine mammals, particularly during the summer open-water



SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS

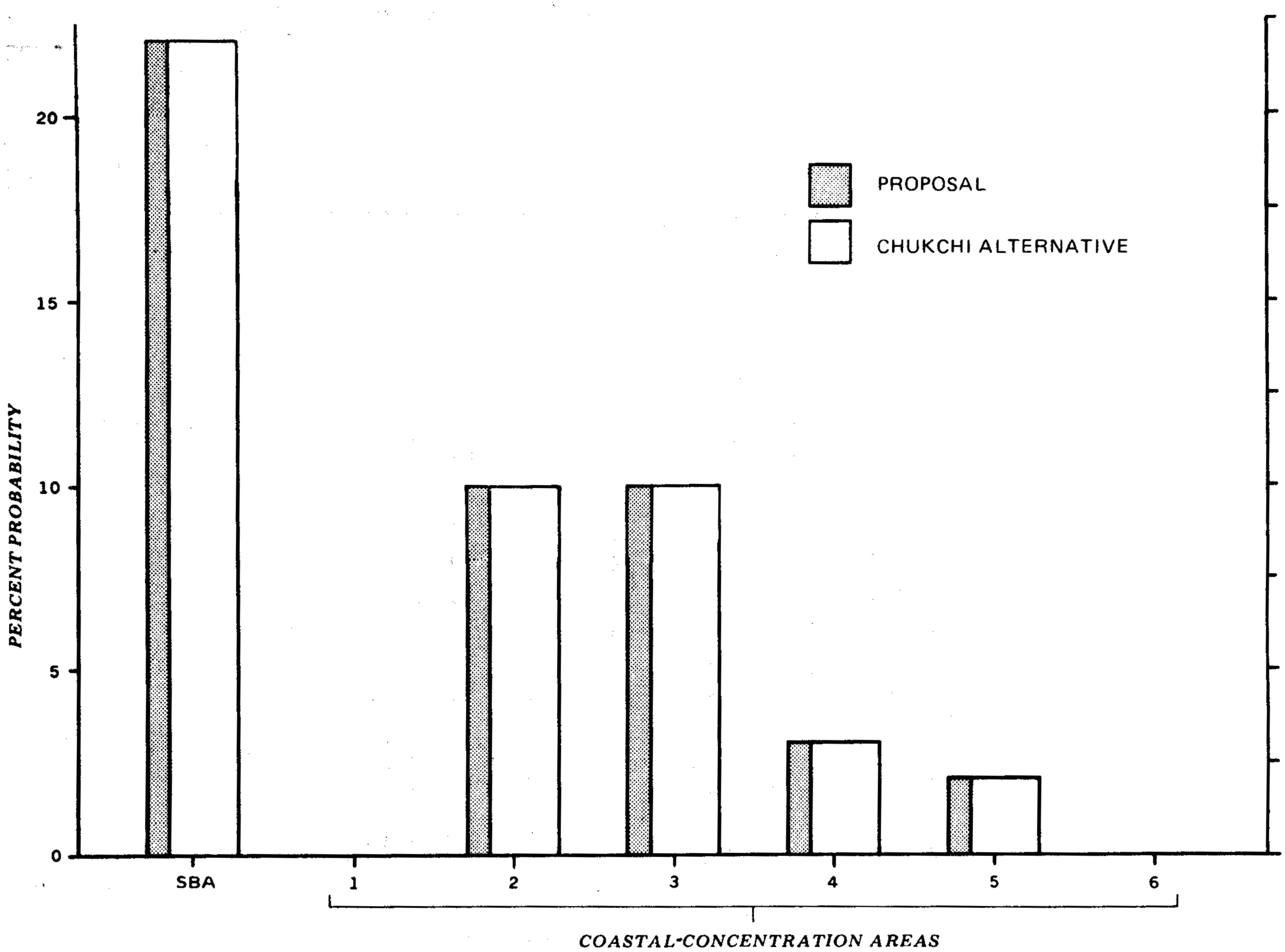
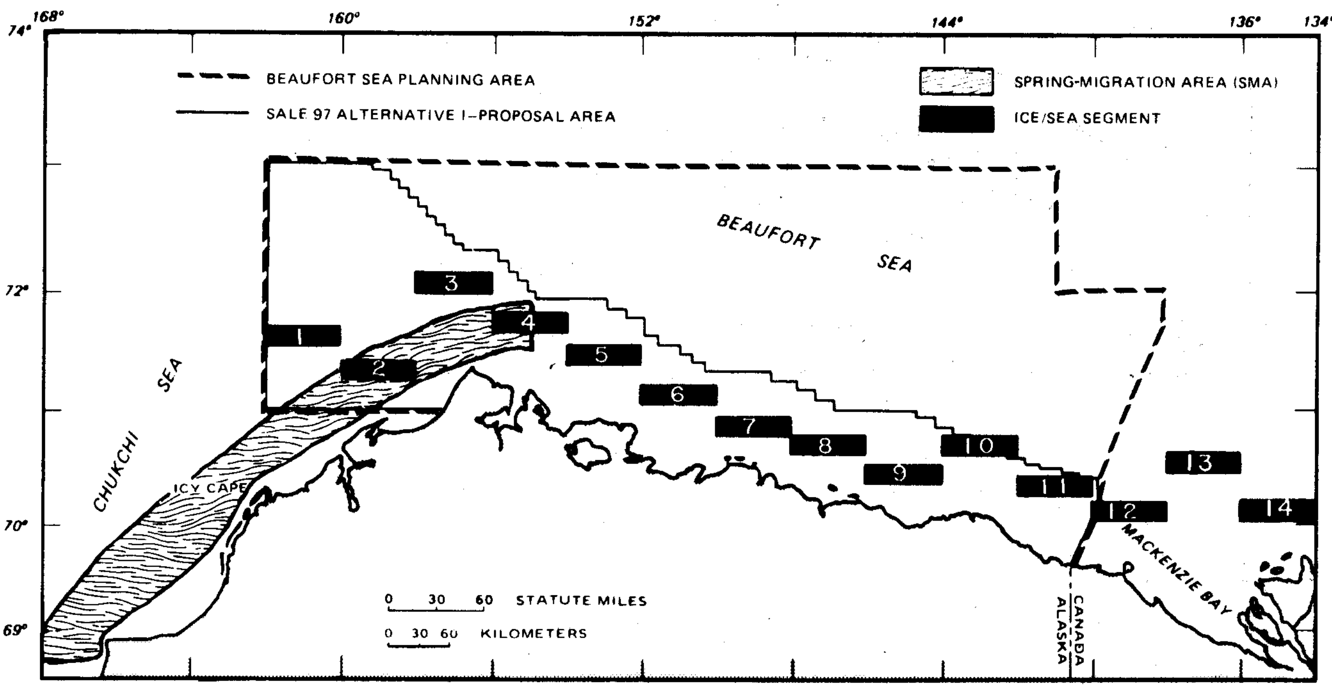


FIGURE IV-24. COMBINED PROBABILITIES OF ONE OR MORE OIL SPILLS OCCURRING AND CONTACTING SEABIRD-FEEDING AND COASTAL-CONCENTRATION AREAS DURING THE OPEN-WATER SEASON WITHIN 10 DAYS OVER THE PRODUCTION LIFE OF THE LEASE AREA



MARINE MAMMAL HABITATS

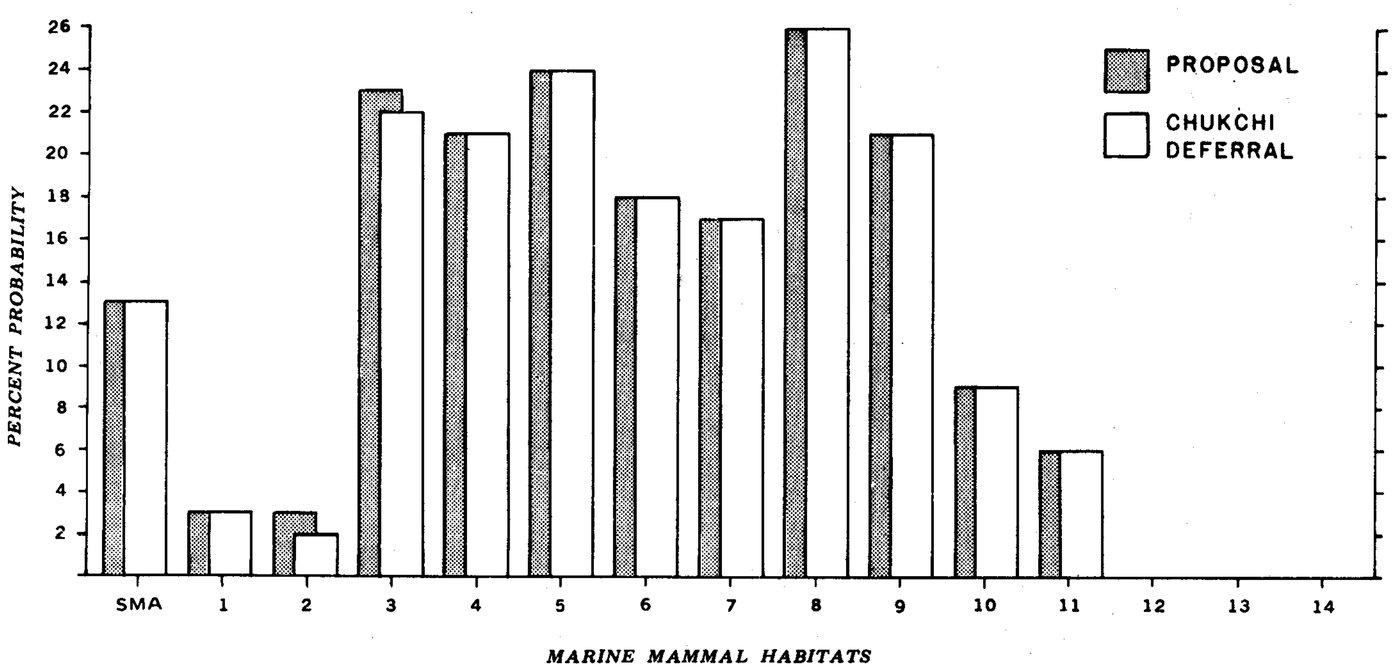


FIGURE IV-25. COMBINED PROBABILITY OF ONE OR MORE OIL SPILLS OF 1,000 BARRELS OR GREATER OCCURRING AND CONTACTING MARINE MAMMAL HABITATS DURING THE ENTIRE WINTER SEASON FOR ICE/SEA SEGMENTS AND APRIL 1 TO JUNE 15 FOR THE SPRING-MIGRATION AREA OVER THE EXPECTED PRODUCTION LIFE OF THE LEASE AREA

season. Noise and disturbance from air and boat traffic and habitat alterations near a Chukchi Sea exploration platform would be avoided under this alternative.

The combined effects of potential oil spills, noise disturbance, and habitat alterations on marine mammals occurring east of Point Barrow would not be reduced from the effects of the proposal. However, the far western portion of the Beaufort Sea Planning Area is important habitat to greater numbers of marine mammals--such as over 150,000 walruses and over 400,000 ice seals--than the rest of the proposed lease area, with lower numbers of marine mammals (e.g., 40,000 ringed seals in the Alaskan Beaufort winter season). Species such as the walrus probably would be more vulnerable to oil-spill contact and disturbance from aircraft northwest of Point Barrow during the summer season than they would be from spills and noise occurring in the eastern part of the proposed Sale 97 area (see discussion on noise and disturbance under the proposal, Sec. IV.B.4).

In summary, this alternative could reduce oil-spill effects to marine mammals, particularly walruses, and their habitats west of Point Barrow. Noise and disturbance of marine mammals and habitat alterations due to drill-platform and pipeline construction also would be reduced in this area. Therefore, effects on nonendangered marine mammals are expected to be reduced from MINOR under the proposal to NEGLIGIBLE for this alternative.

CONCLUSION: Effects of this alternative on nonendangered marine mammals are expected to be reduced to NEGLIGIBLE versus MINOR under the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as for the proposal--MINOR.

5. Effects on Endangered and Threatened Species: This alternative would defer from petroleum exploration and development and production an area used by a low number of summering gray whales and most fall-migrating bowhead whales. Bowhead whales migrate westerly in the fall apparently in a broad front across the southern half of the deferral area.

Under this alternative, oil-spill risk to the bowhead and gray whale as portrayed in the OSRA would be virtually the same as under the proposal (Tables F-15, 16, 19, 20, Fig. IV-16). If spilled oil were to contact a whale-habitat area, resulting effects would be as discussed under the proposal and the Barrow Deferral Alternative. Some bowhead whales (up to several hundred) could experience one or more of the following: skin contact and possible irritation, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, and the consumption of contaminated prey items. The most likely result of these factors would be temporary discomfort and reductions in feeding efficiency for affected individuals without substantial effects on the population.

Noise-disturbance and habitat-alteration effects would not occur in the deferral area because oil-related industrial activities would not occur. Some sound from seismic surveys might be transmitted into the area from adjacent leased areas and might mask some whale vocalizations; however, the sound intensity is unlikely to be of a level that would disturb endangered whales in the deferred area.

Noise-disturbance and habitat-alteration effects to endangered bowhead and gray whales within the deferral area would be virtually eliminated. Bowhead and gray whales could remain subject to disturbance by OCS activities outside the proposed deferral area, and effects outside the deferral area would be the same as described for the proposal. Whales would avoid areas within a few kilometers of vessels, seismic surveys, drilling units, and production platforms. Because these species are more commonly found outside the deferral area, the overall effect levels would remain the same as for the proposal. Peregrine falcons are not expected to occur over the proposed deferral area and would not be affected by this alternative.

CONCLUSION: The overall level of effect on endangered and threatened species is expected to remain the same as for the proposal, MINOR for bowhead and gray whales and NEGLIGIBLE for the peregrine falcon.

Cumulative Effects: Bowhead whales are found within the deferral area for only a short period of time during migration, gray whales are found in the area in low numbers, and peregrine falcons are not expected over the deferral area. Consequently, cumulative effects on these species under this alternative are expected to remain the same as for the cumulative case under the proposal, MODERATE for the bowhead and gray whale and MINOR for the peregrine falcon.

6. Effects on Caribou: The deferral of leasing blocks offshore and northwest of Point Barrow would not reduce potential oil-spill-contact risks to coastal habitats on the western part of the North Slope that are used by caribou for insect relief (see Appendix F, Land Segments 1-19). Therefore, possible oil-spill effects on caribou are likely to be the same as for the proposal--NEGLIGIBLE. This alternative is assumed to include the same onshore oil-pipeline-transportation system as the proposal; thus, onshore disturbance and habitat effects on caribou are expected to be the same as those of the proposal--MINOR.

CONCLUSION: This alternative is expected to have MINOR effects on caribou, the same level of effect as that of the proposal.

Cumulative Effects: Cumulative effects are expected to be essentially the same as for the proposal--MODERATE.

7. Effects on Population. Since the development infrastructure of Sale 97 would be only slightly different in this alternative than in the proposal, the effect of this alternative on the North Slope Borough's population is expected to be the same as the effect of the proposal. The sale as proposed has the effect of moderating the initial decline in the population expected to result from reduced Borough operating and CIP revenues. These revenues associated with the development infrastructure of this alternative would be less than the proposal; and, hence, the growth rate of the resident population following 1988 would be slightly less, and its peak would be lower.

CONCLUSION: The Chukchi Deferral Alternative is expected to have the same effect as that of the proposal, i.e., NEGLIGIBLE effects on the population of the North Slope Borough.

Cumulative Effects: The effects of this alternative are not expected to make any difference to the expected cumulative effects of the proposal. Thus, cumulative effects from both onshore and offshore development are still expected to be MINOR.

8. Effects on North Slope Sociocultural Systems: A deferral of the Chukchi tracts should make little difference to North Slope sociocultural systems as outlined in the effects of the proposal (Sec. IV.B.8). Revenues would be only slightly affected, and the potential consequences of oil spills from the Barrow and Kaktovik tracts should do little to alter the analysis contained in the effects of the proposal.

CONCLUSION: The effects of Chukchi Deferral Alternative are expected to be no worse than the effects of the proposal, which are overall MINOR effects.

Cumulative Effects: The Chukchi Deferral Alternative is expected to have little if any effects on the possible MAJOR cumulative consequences to North Slope sociocultural systems that are outlined in the effects of the proposal.

9. Effects on Subsistence-Harvest Patterns: Three sources of effects on subsistence are of greatest concern in the Sale 97 area: oil spills; noise and traffic disturbance; and the placement of exploration, and development and production, and support facilities.

In general, this alternative does not change, relative to the proposal, the probability of an oil spill of 1,000 barrels or greater occurring and contacting land within 10 days during either the winter or open-water season. For this reason, with one exception, Alternative VI would not alter the regionwide biological effects on subsistence resources. The exception is walrus--an important secondary resource for Barrow-Atqasuk and Wainwright hunters. According to the analysis, regionwide biological effects on this species are expected to drop from MINOR to NEGLIGIBLE because migrating herds would be unlikely to experience an oil spill. For this reason, Alternative VI would offer, to Barrow-Atqasuk and Wainwright subsistence hunters, the communities that harvest walrus most heavily, some mitigation of effects from oil spills. However, effects on other marine mammal harvests are expected to remain MODERATE.

Noise and traffic disturbance from the proposal may be the largest source of effects to Barrow-Atqasuk's subsistence activities. While this deferral would not substantially change biological effects to regional populations of subsistence species, the elimination of this alternative's tracts would substantially reduce the possibility of a western find. This would reduce, to a degree, noise and traffic disturbance around the Barrow-Atqasuk subsistence-harvest area, but this mitigation would be only partial. Since most of the proposal lies to the east, barge and other maritime-supply traffic would still pass through the open-water areas at Point Barrow. This may be a particular problem in the spring and fall when these same areas are used for bowhead whaling. Moreover, if a western find occurs, the area might still experience some noise and traffic disturbance from supply activities, although such disruption is likely to be short term and temporary. During a year when the weather and ice conditions are poor and the whalers' ability to harvest whales is limited, the noise disruption could occur during the only brief period when harvesting a whale is possible. Such a curtailment of the whaling season for the year due to noise and traffic disturbance associated with Sale 97 is expected to cause the bowhead whale to become locally unavailable for no more than 1 year, representing MODERATE effects on Barrow-Atqasuk's bowhead whale harvest.

According to the scenario for the proposal, no onshore-support facilities are likely for the Barrow area. Thus, Alternative VI is expected to have little effect in this regard. The deferral of these tracts, however, would substantially reduce the possibility of a western find. This would make a pipeline landfall at Point Belcher unlikely. Therefore, the possibility of effects due to construction activities at Point Belcher is expected to be reduced from MAJOR to NEGLIGIBLE, reducing the overall effects on Wainwright's subsistence damages from MAJOR to MODERATE.

In summary, under Alternative VI, the Chukchi Deferral Alternative, the overall effects are expected to remain MODERATE for Barrow-Atqasuk's subsistence-harvest patterns. Effects on Wainwright's subsistence-harvest patterns are expected to be reduced from MAJOR to MODERATE. Nuiqsut's and Kaktovik's subsistence-harvest patterns would be unaffected by this alternative and are expected to remain MODERATE. The overall effects on the subsistence-harvest patterns in the sale area are expected to be reduced from MAJOR to MODERATE.

<u>CONCLUSION</u>: Overall effects on subsistence are expected to be reduced from MAJOR for the proposal to MODERATE.

<u>Cumulative Effects</u>: Cumulative effects under this alternative are expected to remain the same as those under the proposal--MAJOR.

10. <u>Effects on the Economy of the North Slope Borough</u>: The employment effects of this alternative are projected to be virtually identical to those of the proposal, because the resource estimates for this alternative are only 5 percent less than those for the proposal.

<u>CONCLUSION</u>: The economic effects of this alternative are expected to be the same as those of the proposal--NEGLIGIBLE.

<u>Cumulative Effects</u>: The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

11. <u>Effects on Land Use Plans and Coastal Management Programs</u>: Deferring the Chukchi Sea portion of the lease sale would reduce the level of effects on walrus and eliminate the need for a shore base at Point Belcher. The major changes in land use in the area would not occur, and archaeological sites near Point Belcher would be preserved. Development along the Beaufort Sea would be comparable to that expected for the proposal.

<u>CONCLUSION</u>: By removing that portion of the proposal most closely associated with MAJOR effects, the overall effect of the lease sale on land use plans and coastal management programs is expected to be MINOR under this alternative.

<u>Cumulative Effects</u>: Cumulative effects are expected to remain MAJOR even if the Chukchi Sea portion were removed because (1) the Point Belcher landfall

site would be constructed to support development associated with Sale 109, which is scheduled for the Chukchi Sea, and (2) development along the Beaufort Sea coast would not be affected.

12. Effects on Archaeological Resources: The Chukchi Deferral Alternative is expected to reduce the effects of the proposal from MINOR to NEGLIGIBLE by reducing activities associated with oil development west of Point Belcher (OSRA Segment 15). The largest number of shipwrecks and many archaeological sites are located in this area.

CONCLUSION: The effects of this alternative on archaeological resources are expected to be NEGLIGIBLE.

Cumulative Effects: The cumulative effects of Alternative VI on archaeological resources are expected to be the same as they are for the proposal--MINOR.

13. Effects on Recreation and Tourism Resources: Because there is only a slight reduction in the oil resources of the Chukchi Deferral Alternative, the recreation and tourism resources of the Sale 97 area would be affected by the same level of activities as discussed for the proposal in Section IV.B.13. The land segments near the deferral area contain fewer recreation and tourism resources than other segments near the proposed sale area. Thus, with this alternative, there would be very little, if any, reduction in the effects caused by petroleum activities when compared to the effects of the proposal.

CONCLUSION: The effects of the Chukchi Deferral Alternative on recreation and tourism resources are expected to be the same as those of the proposal--MINOR.

Cumulative Effects: The cumulative effects of this alternative are expected to be the same as those of the proposal--MINOR.

14. Effects on Water Quality: Alternative VI would not significantly reduce the projected oil spillage or level of effects on water quality for any of the agents discussed in Section IV.B.14. There would be some lessening of pollution risks from artificial-island construction or removal and local deliberate (permitted) discharges in the deferred area. This alternative would eliminate the risk of spills occurring in the deferred area but would not greatly reduce the number or likelihood of spills contacting the deferred area or the part of the sale area that would remain under this alternative. (Any spills in the deferred area would move westward out of the planning area.) Both long-term and short-term local effects are still expected to occur.

CONCLUSION: The effect of the Chukchi Deferral Alternative on water quality is expected to be MINOR--the same as that of the proposal.

Cumulative Effects: Most spill risk to the deferred area would come from cumulative development to the east, not in the proposed Sale 97 area. The effects of the cumulative case with Alternative VI are expected to be almost identical to those of the cumulative case with the proposal, which are MODERATE.

15. Effects on Air Quality: Because the reduction in oil resources associated with this alternative is only about 5 percent, the exploration,

development and production, and transportation scenarios for Alternative VI would be basically the same as they are for the proposal. Thus, the effects on air quality are expected to be substantially the same as they are for the proposal. Emissions would be approximately proportionate to the mean-case oil resources.

CONCLUSION: Effects of Alternative VI on air quality are expected to be the same as those of the proposal, which are MINOR relative to attainment of air-quality standards and NEGLIGIBLE for secondary effects.

Cumulative Effects: The cumulative effects on air quality are expected to be the same as those of the proposal--MINOR.

H. Unavoidable Adverse Effects

1. Lower-Trophic-Level Organisms: Accidental oil spills are considered to be unavoidable adverse effects. Their effects on marine plants and invertebrates in the Beaufort Sea are described in Section IV.B.1. The possible effects include the death of organisms in localized areas, with consequent changes in species composition; alterations in primary and secondary production; reduced reproduction and/or recruitment; and a variety of sublethal effects. Long-term changes could result if sediments become contaminated and if emigration, reproduction, and/or recruitment were reduced in affected areas. In general, unavoidable effects are expected to be MINOR for marine plants and invertebrates; however, MODERATE effects are possible for the Boulder Patch community if it were contaminated by oil.

2. Fishes: Unavoidable adverse effects are expected to result from accidental oil spills. The overall effect of such spills on fishes in the Beaufort Sea Planning Area is described in Section IV.B.2. Possible effects include the death of eggs, larvae, and adults; sublethal effects; and delays in migrations, perhaps leading to reductions in fecundity. In general, unavoidable adverse effects are expected to be MINOR for fishes; however, MODERATE effects are possible for capelin and anadromous species if spawning-year individuals, aggregated multiyear assemblages, or a year class of young were killed.

3. 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.B.1.c).

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 proposal. 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 MINOR to MODERATE effects on some populations.

Assuming oil development occurs throughout the proposed sale area, oil spills and local-habitat alterations near platform and facility sites are estimated to have unavoidable MODERATE effects on birds, depending on the extent and nature of hydrocarbon development, oil-spill occurrence, and efficiency of oil-spill cleanup.

4. Pinnipeds, Polar Bears, and Beluga Whales: In this discussion, most oil spills are considered unavoidable; most human disturbance of non-endangered 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.B.1.c).

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 proposal. 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 event is expected to affect some seals, walruses, and polar bears if they happened to be in the area of the spill. An unavoidable spill is expected to result in MINOR effects on regional marine mammal populations.

Assuming oil development occurs throughout the proposed sale area, oil spills and local-habitat alterations near platforms and other facility sites could have unavoidable MINOR effects on nonendangered marine mammals, depending on the extent and nature of hydrocarbon development, oil-spill occurrence, and efficiency of oil-spill cleanup. Unavoidable adverse effects on marine mammals, particularly walruses, are expected to be reduced to NEGLIGIBLE under Alternative VI, the Chukchi Deferral Alternative.

5. Endangered and Threatened Species: Under the proposal, the magnitude of unavoidable adverse effects on bowhead whales and peregrine falcons appears to be NEGLIGIBLE, assuming that the mitigating measures recommended in this EIS are accepted and are effectively implemented. The major risk to migrating bowhead whales from oil spills is expected to be minimized through adoption of Stipulation 4, Seasonal Drilling Restriction for Protection of Bowhead Whales from Potential Effects of Oil Spills. Noise disturbance of threatened and endangered species is expected to become NEGLIGIBLE through adoption of Stipulation 6, Endangered Whales, and adoption and compliance with the ITL's on Bird and Marine Mammal Protection and the Arctic Peregrine Falcon. Unavoidable adverse effects include some oil-spill risks for the small number of gray whales that use the sale area; consequently, unavoidable effects on this species are expected to remain MINOR. Mitigating measures are expected to reduce effects to NEGLIGIBLE for the bowhead whale. Unavoidable adverse effects on the peregrine falcon and gray whale are expected to be the same as for the proposal, NEGLIGIBLE and MINOR, respectively.

6. Caribou: Most sale-related land-vehicle disturbance of caribou and caribou-habitat alterations are probably unavoidable. Unavoidable adverse effects of oil and gas exploration are expected to be NEGLIGIBLE. MINOR, unavoidable disturbance effects on caribou from development and production are expected.

7. Population: Unavoidable adverse effects of this proposal would include a NEGLIGIBLE increased hunting pressure on fish and wildlife resources.

8. Economy of the North Slope Borough: Based on the results of existing onshore petroleum development and the experiences with offshore exploration in the region--which have been overwhelmingly beneficial for the NSB economy--unavoidable adverse effects of this proposal are expected to be NEGLIGIBLE.

9. North Slope Sociocultural Systems: If a government and community commitment were coupled with the necessary fiscal resources, then many of the sociocultural consequences of Sale 97 could be mitigated. One area of unavoidable adverse effects involves the potential repercussions to the sharing of subsistence resources and the adverse effects in community attitudes towards their governing and administrative institutions from an oil spill, should one occur.

10. Subsistence-Harvest Patterns: The proposed lease sale would add another oil and gas sale to a list of over 20 oil and gas development projects now planned or ongoing on the North Slope. If an oil spill occurred due to the proposal, individual ringed seals, polar bears, black brant, oldsquaw, and eider ducks are expected to be affected. A small increase in competition for wildlife resources used for subsistence would be likely. Additional stress associated with industrial development in the local area would be felt by residents of Kaktovik, Nuiqsut, Atqasuk, Barrow, and Wainwright.

11. Land Use Plans and Coastal Management Programs: Many of the potential biological and social effects of this lease sale are considered unavoidable. To the extent that these events would conflict with coastal management policies noted in Section IV.B.11, unavoidable adverse effects also could be attributed to the coastal management program. This may not be the case, however, since activities that are conducted pursuant to the national interest are permissible, as long as the maximum protection possible has been achieved. Therefore, all conflicts with coastal policies might be considered avoidable.

12. Archaeological Resources: Accidental sale-related occurrences such as pipeline breaks, tanker accidents, or blowouts could increase activities onshore. These activities (listed in the proposal, Alternative I) are expected to have a MINOR effect on archaeological resources if carried out according to the National Historic Preservation Act (NHPA) and Executive Order 11593.

13. Recreation and Tourism Resources: Such accidental occurrences as pipeline breaks, tanker accidents, or blowouts could increase onshore activities along the beaches. These sale-related activities (listed in the proposal, Alternative I) are expected to have a MINOR effect on recreation and tourism if carried out according to existing laws.

14. Water Quality: The only unavoidable adverse effect on water quality anticipated from the proposed action is 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, and MINOR effect for water quality.

15. Air Quality: An increase in emissions of air pollutants would occur as a result of Sale 97. Most of the emissions could be appreciably reduced with existing control technologies, and air-quality standards would not be exceeded at the shoreline. MINOR degradation of regulated air quality, however, is expected from the proposal. Secondary effects on tundra vegetation could occur from air emissions, that are not addressed by standards. However, only a localized geographic area could be affected, even if no allowance is made for dispersion of air emissions by variable winds and the likelihood that operations will be farther than 5 kilometers from shore. Therefore, there would NEGLIGIBLE secondary effects from emissions.

I. Worst-Case Analysis

The worst-case analysis for the endangered bowhead whale addresses scenarios drawn from scientific-study results. Because the major variable factors in cause and effect involve different degrees of uncertain and unknown conditions, it is necessary to assume some specific level or condition to perform realistic analysis. This information is presented below.

1. Worst-Case Assumptions:

	Assumption	Estimated Probability of Assumption
1.	Whales will migrate through the area	High
2.	Whales will feed in the area during the spring migration	Medium
3.	A large spill will be present during the spring migration	Medium to Low
4.	Noise disturbance will mask communications, interrupt social activities, disrupt feeding, adversely affect breeding or calving, or displace migration routes and/or timing	Medium
5.	An oil spill will kill a substantial quantity of food resources	Low
6.	Oil-contaminated baleen will interfere with feeding	Low
7.	Oil will remain on bowhead skin long enough to cause significant adverse effects	Low
8.	Whales will contact a large oil spill during the life of the field (6-percent probability of one or more spills of 100,000 barrels or greater)	Low
9.	Two exploratory drilling units will be operating in or near the bowhead migration corridor during the migration period	Medium

2. Scenario: The following is a speculative assessment of a worst-case analysis under these basic assumptions for a large-volume oil spill and noise associated with OCS activities that could interact with migrating bowhead whales.

1. A platform or pipeline spill occurs in broken ice during the winter-spring months, releasing 100,000 barrels of crude oil.

2. The spill occurs east and offshore of Point Barrow, and cleanup efforts are ineffective until the open-water season (July 1).

3. Bowhead whales will be in the lead system off Point Barrow during April 15 to June 15 and will be feeding at this time.

4. Oil will be released into the lead systems through which the bowhead whales migrate.

5. Bowhead whales will not detect or avoid the oil spill in the lead system.

IV I

6. Physiological stress will occur due to toxic vapors, ingestion of oil, ingestion of oil-contaminated prey, and/or absorption of hydrocarbons through the skin.

7. Extensive noise (geophysical surveys, drillships, aircraft, dredging, and vessel traffic) will be present east of Barter Island in the Alaskan Beaufort Sea during August and September.

8. Bowhead whales will be assimilating the last major portion of their nutrient requirements in this area before beginning their fall migration.

9. Exploratory drilling units will be operating within the fall bowhead-migration corridor and within fall-feeding areas.

10. Seismic-survey operators will not consistently detect migrating or feeding whales and will approach within 5 kilometers of some bowheads.

11. Stress will occur due to the noise-producing activities, thus displacing whales from traditional feeding areas and migration activities.

3. Analysis of the Worst-Case Scenario: Assuming an oil spill/whale interaction occurs within the spring lead system, it is possible that most of the Beaufort Sea bowhead whale population would come in contact with spilled oil. If a large quantity of oil were spilled into such a lead, the bowheads present (probably less than 50 individuals) could inhale toxic hydrocarbon vapors and may suffer respiratory distress or die. Oil could come in contact with skin and eyes, causing irritation; coat the baleen, temporarily decreasing feeding efficiencies; and/or be ingested, causing gastric problems. Massive acute reactions are possible, though unlikely; chronic problems are more likely. These could include increased susceptibility to disease and increased concentrations of petroleum hydrocarbons in the tissues. Petroleum hydrocarbons might be incorporated in the blubber and released as the blubber is metabolized. Blubber would be metabolized during increased demands upon the body, such as during the overwintering period or during migration, pregnancy, or lactation. Petroleum hydrocarbons released from the blubber at this time may have adverse physiological effects upon the body, possibly resulting in reduced fitness. The bioaccumulated hydrocarbons might be passed through the milk to the offspring, where they could have toxic effects or result in poor survival for a low number of calves (probably less than 20).

Geophysical surveys, which are the most intense source of noise associated with oil exploration, will not occur during the bowhead spring migration. However, bowheads will react to noise from helicopters and drilling units associated with the lease sale. Low-flying helicopters (less than 450 m in altitude) may cause bowheads near the aircraft to dive. However, assuming the aircraft maintains a direct course, the disturbance should not prevent whales from continuing their migration. Based upon the expected level of helicopter activity (one visit per drilling unit per day), it is unlikely that bowheads will be disturbed significantly or will alter their migration route substantially. Many bowheads will alter their migration route somewhat to avoid approaching within a range of several to over 10 kilometers of drilling units and production platforms; however, this alteration in migration route should not significantly affect the fitness of the species population.

Assuming that extensive noise-producing activities (geophysical surveys, drillships, dredging, and aircraft and vessel traffic) are present during the late summer and early fall (August and September) in an area where bowheads mill and feed in the eastern Alaskan Beaufort Sea, noise/whale interaction would occur. The resulting stress could be enough to cause several hundred whales to prematurely migrate from this feeding area. The abandonment of this area may alter the timing of the migration and the length of time bowheads are present in Alaskan waters. Displacement from feeding areas could, in the worst case, result in several hundred bowheads not acquiring necessary nutrient levels, thus decreasing blubber accumulation. This may stress the population during the fall-through-spring period of fasting or reduced food intake and might result in a reduced rate of reproduction. Also, noise displacement of bowheads from fall-feeding areas could further stress individuals already stressed or weakened from exposure to a spring oil spill. This additional stress might reduce the survivability of these individuals (probably less than 50).

Conclusion: Direct effects of an oil spill and noise disturbance on bowhead whales probably would be chronic rather than acute. In the unlikely event that all negative effects occurred, a low number of whales (less than 100) might be killed; and the overall effect would be to slow the recovery of the bowhead whale population to a nonendangered status. Effects are expected to be MODERATE.

J. Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity

In this section, the short-term effects and uses of various components of the environment of the Beaufort Sea Sale 97 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 proposal, but some even shorter term uses and effects are considered. Long term refers to that time beyond the lifetime of the proposal. The producing life of the field development in the Beaufort Sea Sale 97 area has been estimated to be about 27 years--based on the mean-case resource estimate. 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. The definitions for short term and long term as used in this section differ from those used in Sections IV.B through IV.G and IV.L; also, see Table S-2.

Many of the effects discussed in Section IV are considered to be short term (being greatest during the construction, exploration, and early production phases), which could be further reduced by the mitigating measures discussed in Section II.B.1.c.

Major construction projects would cause definite changes in both the short term and long term. Some species may have difficulty repopulating altered habitats and could be permanently displaced. In the short term, biological productivity would be reduced or lost on all onshore lands used in the proposed project; however, the productivity of these areas could be largely regained in the long term with proper management. Although restoration may not be entirely feasible, the overall local loss is expected to be a minor adverse effect.

In offshore areas, construction projects could cause long-term changes by preempting habitat of some marine organisms, or by impeding movements and/or migration patterns of anadromous fishes. Short-term oil pollution and the possibility of long-term, cumulative, oil-pollution effects are expected to cause serious adverse effects on all components of the marine ecosystem. Even though these effects are unlikely, the potential must be recognized.

Water pollution from onshore activities is a long-term but local effect. Offshore, a long-term decrease in water quality may be considered to be a tradeoff for obtaining oil and gas resources.

The biota would be threatened in the short term by oil pollution. Displacement could be significant through the combined effects of harassment by humans and the increased volume and frequency of noise from vessel traffic or overflying aircraft. In the long term, such disturbances are expected to alter behavior patterns and could drive fauna away from some traditional feeding and breeding grounds or to other habitat areas within their range, reducing the local populations of species over a long period of time.

Habitat destruction could cause a local reduction in subsistence species, which could threaten the regional economy. The improved accessibility to primitive areas from increased construction is a short-term and possible long-term result of this proposal. The overall wilderness value of the coast is expected to decrease from increased land use.

Increased population, minor gains in revenues, and the consequences of oil spills 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.

Archaeologic and historic finds discovered during development would enhance long-term knowledge. Overall, finds may help to locate other sites, but destruction of artifacts would represent long-term losses.

Consumption of offshore oil and gas would be a long-term use of nonrenewable resources. 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. If additional supplies were discovered and developed, the proposed production system would enhance extraction.

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. Regional planning would aid in controlling changing economics and populations and, thus, in moderating any adverse effects.

As explained in the preceding effect sections, alternatives to the proposal such as cancellation, delay, and partial deferral options reduce to varying degrees both the long- and short-term environmental effects as well as the long- and short-term energy-supply benefits.

K. Irreversible and Irretrievable Commitment of Resources

1. Minerals Resources: The conditional, mean, economically recoverable resource estimate for the proposed action is 650 million barrels of oil. Should these resources be discovered and produced, they would be irretrievably consumed.

2. Biological Resources: Installation of gravel islands is expected to result in a temporary loss of benthic habitat. The effect on benthic organisms is expected to be MINOR, given the small area affected. General industry activities, such as increased ship traffic, seismic-exploration activities, aircraft noise, and land-based activities, could displace marine and coastal birds and mammals (particularly ringed seal and caribou) into less favorable environments. This would eventually result in reduced population levels. This displacement could become irretrievable if permanent alterations to the environment and habitat were maintained by man.

3. Endangered Species: Under the proposal, it is possible that endangered whales 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 whale resources (see Sec. IV.B.5, Effects on Endangered and Threatened Species).

4. Social Systems: Many important aspects of Inupiat society and culture are centered around subsistence activities (see Sec. III.C.3). Virtually every family on the North Slope participates in the hunting of the bowhead whale and the sharing of its meat. In the event that oil spills or offshore noise and 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 97 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.

5. Archaeological Resources: Irretrievable material products of prehistoric culture such as archaeological sites may be lost through looting and indiscriminate or accidental activity on known and unknown sites. The orientation program and the archaeological resource stipulations (Sec. II.B.1.c) would protect against some such losses.

L. Effects of Natural Gas Development and Production

Natural gas also may be discovered in the Sale 97 area during exploration drilling. Although gas resources are not considered economic to exploit at this time (Cooke, 1985), they may be developed and produced in the future; natural gas production probably would not occur until after oil production has begun. Thus, leases containing nonassociated natural gas that may be recoverable in the future probably will be retained by the leaseholder. (Associated and dissolved gases that are recovered along with the crude oil are expected to be reinjected or used as fuel, depending on the amount recovered.) Hence, the effects of potential gas development and production on the environment of the Sale 97 and adjacent areas that are in addition to the effects associated with oil development and production are described in this section.

Additional facilities and infrastructure would be needed if and when the nonassociated natural gas is developed and produced. The gas could be produced through wells drilled from gas-production platforms.

A large-diameter pipeline would be installed to transport the produced gas from the production platforms to an onshore gas-processing facility; the gas pipeline would be separated from any existing oil pipelines to the extent necessary to minimize risks that occur during installation and operation. No offshore booster-pump stations would be required between the platforms and the gas facility. Both the offshore and onshore sections of the gas pipeline would be buried.

Onshore, the gas pipeline would parallel an oil pipeline to take advantage of existing roads. A new facility would be needed to process gas produced from offshore reservoirs or from other North Slope reservoirs outside of the Prudhoe Bay Unit (PBU); the gas facility that was built at Prudhoe Bay in 1986 is dedicated to the PBU and would not have adequate capacity to handle the added production. Because gas from offshore production would be taken into account in the final design of the Alaska Natural Gas Transportation System or the Trans-Alaska Gas System, the pipeline to market would be appropriately sized to accommodate the offshore production of gas. The gas would be refrigerated before it is pumped into the pipeline; at the refrigerated temperatures, there would be no threat to the permafrost.

The effects of natural gas development and production on the biological resources, social systems, and physical regimes of the Sale 97 and adjacent areas might be caused by gas blowouts; installing offshore pipelines and gas-production systems; drilling gas-production wells; installing onshore pipelines and a gas-processing facility; marine-, surface-, and air-traffic noise and disturbance; and construction activities.

Accidental emissions of natural gas could be the result of a gas-well blowout or a pipeline rupture. In the unlikely event that it occurred, a gas-well blowout probably would not persist for more than 1 day and would release perhaps 20 metric tons of gaseous hydrocarbons; as noted in Section IV.B.15.a(2), 60 percent of all blowouts since 1974 have lasted 1 day or less. From such a blowout, a hazardous plume of gas could extend downwind for about a kilometer but would quickly dissipate once the blowout ceased. The amount of volatile organic compounds (VOC) released by such a blowout would be less than that evaporated from an oil spill of 1,000 barrels or greater.

The rupture of a gas pipeline would result in a short-term (less than 1 hour) release of gas. A sudden decrease in the gas pressure would automatically initiate procedures to close those valves that would isolate the ruptured section of the pipeline and thus prevent further escape of gas.

1. Effects on Lower-Trophic-Level Organisms and Fishes: If a natural gas blowout occurred--with possible explosion and fire--marine plants, invertebrates, and fishes in the immediate vicinity probably would be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site but is not expected to be hazardous for more than 1 kilometer downwind or for more than 1 day. It is not likely that the plume would affect any marine plants, invertebrates, and fishes except individuals present in the immediate vicinity of the blowout. In order to affect these organisms, the blowout would have to occur below or on the surface of the water.

Trenching activities associated with laying a gas pipeline would have localized effects on marine organisms. For mobile animals like fishes, virtually no adverse effects are expected; however, longer-term but extremely localized effects over a small area are possible for benthic organisms.

The estimated level of effect on marine plants, invertebrates, and fishes resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

2. Effects on Marine and Coastal Birds: The most likely effects on marine and coastal birds associated with natural gas development and production would include some habitat alterations and noise and disturbance from air-support traffic and road traffic along the gas-pipeline route, at the production-platform sites, and at the gas-processing-facility site. These effects would be similar to those noise and disturbance and habitat-alteration effects associated with oil development and production.

If there were a natural gas blowout with explosion and fire, birds in the immediate vicinity would be killed. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site; thus, it is not likely that fumes would affect birds or their food sources except those very near the source of the blowout.

The additional short-term and local effects of noise and disturbance and blowouts indicate that the estimated level of effect on marine and coastal birds resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MODERATE).

3. Effects on Pinnipeds, Polar Bears, and Beluga Whales: The most likely effects of natural gas development and production on pinnipeds, polar bears, and beluga whales would come from air traffic to and from the production platforms and the support facility (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.

The effect of installing gas-production platforms and laying gas pipelines would be similar to the effect of installing oil-production platforms and laying oil pipelines. These activities would temporarily (one to three seasons) alter the availability of some food organisms of marine mammals near the gas-production platforms and along the pipeline routes. Although this effect could be additive to the habitat alterations associated with oil development, the changes in availability of some food organisms of marine mammals are expected to be short term and local.

If a natural gas blowout occurred, with possible explosion and fire, marine mammals in the immediate vicinity of the blowout could be killed, particularly if the explosion occurred below the water surface. Natural gas and gas condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site; it is not likely that these pollutants would affect any marine mammals except individuals present in the immediate vicinity of the blowout. For any marine mammals to be exposed to high concentrations of gas vapors or condensates, the blowout would have to occur below or on the surface of the water, not from the top of the platform or gravel island.

The additional short-term and local effects of blowouts, noise and disturbance, and platform- and pipeline-installation activities indicate that the estimated level of effect on pinnipeds, polar bears, and beluga whales resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

4. Effects on Endangered and Threatened Species: Should natural gas development and production occur, trenching for the gas pipeline would disturb a small amount of habitat that may support benthic invertebrates, a primary food source for gray whales and a secondary food source for bowhead whales. However, the amount of seafloor disturbed would be insignificant when compared with the habitat available. Endangered whales may avoid approaching within a few kilometers of the vessels involved in trenching or pipelaying operations. 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--endangered whales in the immediate vicinity probably would be killed, particularly if the explosion occurred under the water surface. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site. It is not likely that they would affect any endangered whales except individuals present in the immediate vicinity of the blowout; and, in the case of a platform blowout, it is not expected that endangered whales would often be found near a platform.

For any endangered whales to be exposed to high concentrations of gas vapors or condensates, the blowout would have to occur below or at the surface of the water, not from the top of the production platform. It is conceivable, although unlikely, that a gas blowout under ice cover would result in the formation of gas pockets under the ice. Should bowheads surface and breathe in these gas pockets, they would be exposed to concentrated gas vapors. After several minutes of repeated inhalation, whales might become sufficiently disoriented to impair their ability to find an uncontaminated breathing hole. The threat would decrease over a period of weeks or months, as the gas percolated through brine channels in the ice, to be released into the atmosphere (Milne, 1977). The greatest vapor concentrations would likely occur if a blowout occurred during the winter months, but bowheads are unlikely to be present at this time. During the spring when bowheads would be present, the rate of gas dissipation through the ice would be most rapid and would tend to reduce the time period when such exposure might occur (Geraci and St. Aubin, 1986). Also, one might expect that gas pockets would be more prevalent under landfast ice rather than under moving ice, through which bowheads would be expected to migrate.

Any effects of natural gas development and production are expected to be limited to potential disturbance of a few migrating peregrine falcons for a single season during construction of the gas pipeline. However, effects on the falcon population would likely be NEGLIGIBLE because it is expected that any gas pipelines would be buried and would parallel oil pipelines to take advantage of existing roads.

The additional short-term and local effects of pipeline installation and blowouts indicate that the estimated level of effect on endangered and threatened species resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR for bowhead and gray whales and NEGLIGIBLE for peregrine falcons).

5. Effects on Caribou: The most likely effects of natural gas development and production on caribou would come from motor-vehicle traffic and construction activities associated with installing the onshore part of the pipeline 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.

The estimated level of effect on caribou resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

6. Effects on Population: Construction of separate gas pipelines from the production platforms to the Prudhoe Bay area and the installation of a gas-processing-facility module in the Prudhoe Bay area would only marginally increase employment of NSB residents. This is because most of the residents of the NSB who possess the requisite skills and potentially could be employed by the petroleum industry would already be working, and industry would be unlikely to recruit and train less qualified residents.

The estimated level of effect on the NSB population resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (NEGLIGIBLE).

7. Effects on North Slope Sociocultural Systems: Effects on sociocultural systems would be due to changes in employment and population and effects on subsistence-harvest patterns. In the event of natural gas development and production in the Beaufort Sea for Sale 97, there would be a slight increase in employment and population in the region adjacent to the Sale 97 area. However, these increases in employment and population are expected to be limited to an insignificant number and would not have any measurable effect on the sociocultural systems above that estimated to result from oil development and production. Effect levels of gas development and production on subsistence-harvest patterns in and adjacent to the Sale 97 area are not expected to exceed those already occurring from oil development and production; thus, there would not be an increased level of effect on the sociocultural systems because of disruptions in subsistence harvests.

The estimated level of effect on sociocultural systems resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

8. Effects on Subsistence-Harvest Patterns: Effects on subsistence-harvest patterns from natural gas development and production could occur from natural gas blowouts, noise and traffic disturbance, and construction activities. These effects of natural gas development and production on the biological resources harvested for subsistence use are discussed in the above Sections IV.L.1 through 5. If a natural gas blowout occurred, the subsistence harvest of any species in the vicinity could be affected. Gas would affect organisms exposed to high concentrations, but it is dispersed rapidly (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would be short term and localized and would not be likely to have any measurable effect on the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. However, this disruption would be short term and would not cause any species to become locally unavailable for more than one season.

The effects of installing and constructing gas-production platforms, laying gas pipelines, and activities associated with constructing onshore pipelines to connect the offshore-production platforms with the onshore-processing facility would be similar to the effects of installing and constructing oil-production platforms and pipelines. As with construction activities associated with oil development and production, effects are likely to be short term, occurring only during the period of construction (which could disrupt subsistence harvests for the entire season in the vicinity where those activities were occurring).

Air and boat traffic--as well as road traffic along the pipeline route--associated with natural gas development and production would be additional sources of disturbance to subsistence harvests. However, the estimated level of noise and traffic disturbance is not expected to be greater for natural gas development and production than the level estimated for oil development and production.

Thus, the additional short-term and local effects of blowouts, noise and disturbance, and construction activities indicate that the estimated level of effect on subsistence-harvest patterns resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MAJOR).

9. 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 the declining production from the Prudhoe Bay area. The long-term downtrends in population and employment would not be reversed.

The estimated level of effect on the economy of the NSB resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (NEGLIGIBLE).

10. Effects on Land Use Plans and Coastal Management Programs: If natural gas development and production occurred concurrently with oil development and production as assumed in the scenario, the project would be consistent with the major siting elements of the energy-facility-siting policy of the Alaska Coastal Management Program (ACMP) and with the Land Management Policies of the NSB Land Management Regulations. The gas-processing plant and pipelines would be located in areas already used for oil and gas development. The greatest disruptions would occur during construction of the gas pipeline, creating effects comparable to those experienced during installation of the oil pipelines. Because these disruptions can be identified in advance, potential problems could be circumvented, thereby facilitating resolution of any conflicts with the NSB Land Management Regulations and coastal management policies.

The estimated level of conflict with land use plans and coastal management programs resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR for the Beaufort Sea coastal area and MAJOR for the Chukchi Sea coastal area).

11. Effects on Archaeological Resources: Offshore archaeological resources could be affected by activities associated with potential gas-production-platform installation and pipeline installation. Such activities would require surveying of the area if there were a medium or high probability of finding archaeological resources. However, there would not be a need to survey for prehistoric resources in the Sale 97 area because of extensive ice

gouging in the area (see Appendix H, Archaeological Analysis, Table 1). Offshore shipwrecks are more likely to be affected by activities associated with gas-production-platform installation and pipeline installation than prehistoric resources. The area northeast of Barrow would be the only known offshore area where shipwrecks could be disturbed. Lease blocks with a medium or high probability of shipwrecks are shown in Appendix H, Table H-1.

Onshore archaeological resources would be affected by activities associated with gas-processing-facility and gas-pipeline installations; disturbance of onshore archaeological resources could occur at the time of construction activity. Disturbance also might occur as a result of onshore activity associated with accidents such as a blowout or explosion. Cleanup after such accidents could result in disturbance by graders or bulldozers being transported overground to the accident site.

The estimated level of effect on archaeological resources resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

12. Effects on Recreation and Tourism Resources: Changes in the visual characteristics of the Sale 97 area by the addition of gas-production platforms and pipelines and gas-processing facilities could affect the quality of the recreation and tourism resources. A small increase in the number of gas-production personnel in the area could change the recreational and tourism use of the area slightly by increasing the number of visitors and residents. However, such a change in use would be small and should stabilize after the construction phases ended.

The estimated level of effect on recreation and tourism resources resulting from natural gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

13. Effects on Water Quality: The risk to water quality from gas blowouts due to natural gas development and production would be less than the risk from oil spills due to oil development and production. The effects of pipeline trenching on water quality would be the same as for oil pipelines. Because of gas-production-well drilling, additional drill cuttings would be discharged, but drilling muds would be recycled between oil and gas wells on the same platform without additional discharge. Production of an associated gas cap above an oil zone would result in no additional discharge of formation waters beyond that anticipated for oil development.

The estimated level of effect on water quality resulting from gas development and production is not expected to exceed the estimated level of effect resulting from oil development and production (MINOR).

14. Effects on Air Quality: The development drilling and platform and pipeline installation associated with natural gas resources would result in additional emissions of CO, NO_x, SO_2, and VOC. These emissions would be from the same kinds of sources as in oil development and production activities. However, the amount of activity and emissions is expected to be less than for oil-related activities. Production of natural gas would require new

onshore storage-and-treatment facilities. The primary air pollutant would be VOC, of which more than 90 percent can be controlled by existing technology. The emissions from gas-production platforms and storage-and-treatment facilities would be analogous to those discussed in Section IV.J.6 of the FEIS for Norton Basin Sale 100 (USDOI, MMS, 1985). The emissions from any gas blowouts (principally VOC) would be quickly evaporated or burned and dissipated by winds with minimal effect on air quality (USDOI, MMS, 1985).

The estimated level of effects on air quality resulting from natural gas development and production are not expected to exceed the estimated level of effects resulting from oil development and production, MINOR for attainment of air-quality standards and NEGLIGIBLE for secondary effects.

*U.S. GOVERNMENT PRINTING OFFICE:1987-181-407:62001