Environmental Evaluation Document
Statoil 2010 Chukchi Marine Seismic Survey
Chukchi Sea, Alaska

April 2010

Prepared for

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Contents

Tables

Figures

ACRONYMS AND ABBREVIATIONS

°C	degrees Centigrade
°F	degrees Fahrenheit
μg/m^3	micrograms per cubic meter
μPa	microPascal
2D	two-dimensional
3D	three-dimensional
4MP	Marine Mammal Monitoring and Mitigation Plan
AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
ACC	Alaskan Coastal Current
ACMA	Alaska Coastal Management Act
ACMP	Alaska Coastal Management Program
ACW	Alaska Coastal Water
ADCCED	Alaska Department of Commerce, Community, and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AMSA	Arctic Marine Shipping Assessment
ANSC	Alaska Native Science Commission
ANWR	Arctic National Wildlife Refuge
AO	Arctic Oscillation
AOOS	Alaska Ocean Observing System
AQCR	Air Quality Control Region
ASRC	Arctic Slope Regional Corporation
ATV	all-terrain vehicle
BO	Biological Opinion
B.P.	before present
BWASP	Bowhead Whale Aerial Survey Project
CAH	Central Arctic Herd

CBD	Center for Biological Diversity
CBS	Chukchi/Bering Seas
CFR	U.S. Code of Federal Regulations
cm	centimeter
CMP	Coastal Management Plan
cm/s	centimeters per second
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
CPAI	ConocoPhillips Alaska, Inc.
cu in	cubic inch
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Plan
dB	decibel
DPEIS	Draft Preliminary Environmental Impact Statement
DEW	Distant Early Warning
DPS	distinct population segment
E	east
EA	Environmental Assessment
ECA	Emission Control Area
EDMS	Emissions Data Management System
EED	Environmental Evaluation Document
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENE	east-northeast
ENSO	El Niño-Southern Oscillation
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FCAA	Federal Clean Air Act

FMP	Fishery Management Plan
FONSI	finding of no significant impact
ft	feet
G&G	geological and geophysical
GHG	greenhouse gases
GIS	geographic information system
GOM	Gulf of Mexico
HAPC	Habitat Area of Particular Concern
HNS	Hazardous and Noxious Substances
Hz	Hertz
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
in/s	inches per second
ITR	Incidental Take Regulation
ITS	Incidental Take Statement
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JISAO	Joint Institute for the Study of the Atmosphere and Ocean
kg	kilogram
kHz	kilohertz
km	kilometer(s)
kt/y	thousand tonne/year
lbs	pounds
LOA	Letter of Authorization
m	meter(s)
MARPOL	International Convention on the Prevention of Pollution from Ships
mg/m^3	milligrams per cubic meter
mi	mile(s)
mm	millimeter
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act

MMS	U.S. Department of the Interior, Minerals Management Service
mph	miles per hour
M/V	marine vessel
N	north
NAAQS	National Ambient Air Quality Standards
NE	northeast
NEPA	National Environmental Policy Act of 1969
NH_3	Ammonia
NIC	National Ice Center
NMFS	National Marine Fisheries Service
NHPA	National Historic Preservation Act
nm	nautical mile
NMML	National Marine Mammal Laboratories
NNE	north-northeast
NOAA	National Oceanic and Atmospheric Administration
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPR-A	National Petroleum Reserve-Alaska
NPS	National Park Service
NRC	National Research Council
NSB	North Slope Borough
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
NVIC	Navigation and Vessel Inspection Circular
NW	northwest
NWAB	Northwest Arctic Borough
O_3	ozone
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OPA 90	Oil Pollution Act of 1990

OPRC	Oil Pollution Preparedness, Response, and Cooperation
OSP	optimum sustainable population
Pb	lead
PDO	Pacific Decadal Oscillation
pH	acidity
$PM_{2.5}$	particulate matter
POC	Plan of Cooperation
POP	persistent organic pollutant
ppm	parts per million
PSD	Prevention of Significant Deterioration
PTS	permanent threshold shift (hearing)
re	relative
SCC	Siberian Coastal Current
SCICEX	Scientific Exploration Expedition
SE	southeast
SO_2	sulfur dioxide
SBS	southern Beaufort Sea
SOSUS	Sound Surveillance System
sq km	square kilometer(s)
sq mi	square mile(s)
SST	sea surface temperature
SSV	sound source verification
Statoil	Statoil USA E&P Inc.
std	standard
TCH	Teshekpuk Lake Caribou Herd
TCP	traditional cultural properties
TTS	temporary threshold shift (hearing)
UIC	Ukpeagvik Inupiat Corporation
U.N.	United Nations
USACE	U.S. Army Corps of Engineers
USAF	U.S. Department of the Air Force

USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VGP	Vessel General Permit
VOC	volatile organic compound
W	west
WAH	Western Arctic herd
WRAP	Western Regional Air Partnership

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Executive Summary

This document comprises an Environmental Evaluation Document (EED). The EED describes the physical, biological, and socio-economic resources in the vicinity of Statoil's proposed 2010 marine seismic survey in Alaska's Chukchi Sea and assesses the potential effects of the seismic survey on these resources. In February 2008, Statoil USA E&P Inc. (Statoil) acquired 16 lease holdings in the U.S. Department of the Interior, Minerals Management Service (MMS) Outer Continental Shelf (OCS) Lease Sale 193. The lease areas are located approximately 160 kilometers (km) [100 miles (mi)] northwest of Wainwright and 240 km (150 mi) west of Barrow. To support future oil and gas exploration, Statoil plans to conduct three dimensional (3D) and some two dimensional (2D) marine seismic acquisition in the vicinity of their leases during the 2010 open water season.

Statoil has its own corporate health safety, security, and environment and integrity and social responsibility guidelines for conducting impacts assessments. The impacts assessment process is a part of Statoil's overall management system. Each project, including seismic acquisition projects, must undergo a formal impacts assessment. The purpose of the impacts assessment process within Statoil is to manage risk and to improve the social and environmental performance throughout the life cycle of the project. Statoil's impacts assessment guidelines are based on World Bank International Finance Corporation guidelines and requirements regarding how an impacts assessment should be performed. (The International Finance Corporation is the private sector lending arm of the World Bank.) Ongoing stakeholder engagement is an integral component of Statoil's impacts assessment process.

Project Description. This project is specifically a seismic sound-source data acquisition project using a sound-source array towed by a seismic source vessel. This seismic source vessel, the *Geo Celtic*, and two support/environmental monitoring vessels, will mobilize out of Dutch Harbor, Alaska, to the project area in mid-July 2010; the actual departure date is dependent upon ice and weather conditions. It is anticipated that transit time to the project area will be approximately 5 days. Data acquisition is expected to take 60 days. Upon completion of data acquisition, all vessels will demobilize back to Dutch Harbor. Although data acquisition is expected to take 60 days, all permits have been requested for the period from July 15–November 30, 2010, to allow for contingencies and weather delays. The project data acquisition activities will be conducted by Fugro-Geoteam, Inc.

This project does not involve exploratory drilling or any other disturbances of the seabed and subsurface geology.

The **purpose of the EED** is to describe the scope of the seismic activity, explain the regulatory framework and provide regulatory agencies with supporting data and information to supplement their environmental assessment of several permit applications:

- Geological and Geophysical (G&G) permit from the MMS
- Letter of Authorization (LOA) from the U.S. Fish and Wildlife Service (USFWS)
- Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS)

RegulatoryProcess. MMS, utilizing their National Environmental Protection Act (NEPA) implementing rules, will prepare an Environmental Assessment (EA) specifically evaluating the effects of Statoil's planned seismic survey activity as presented in their G&G permit application. NMFS and USFWS will also prepare EAs for non-lethal, incidental take authorizations of whales and seals; and polar bears and Pacific walrus, respectively, under their authority in implementing the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The environmental analysis presented in this EED tiers off and incorporates by reference many of the analyses presented in the MMS NEPA review documents, such as the MMS EIS for the Chukchi Sea

Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea (2007). Statoil anticipates that MMS, NMFS, and USFWS will utilize the environmental information contained in this EED and the previous, recent Chukchi Sea NEPA reviews in preparing their respective EAs and accompanying Findings of No Significant Impacts (FONSIs).

Community Outreach and Stakeholder Engagement. Statoil intends to maintain an open and transparent process with all stakeholders throughout the life-cycle of activities in the Chukchi Sea. Statoil began the stakeholder engagement process in 2007 with several meetings with North Slope Borough officials, followed by outreach in 2009 with Chukchi Sea community leaders at the tribal, city, and corporate levels. Statoil participated in a pre-scoping meeting with NMFS for the EIS on the effects of Oil and Gas Activities in the Arctic Ocean December 2009.In January 2010, Statoil conducted Plan of Cooperation meetings as required by the NMFS and USFWS in the communities of Barrow, Wainwright, Pt. Lay, and Pt. Hope. Statoil attended Conflict Avoidance Agreement discussions with the Alaska Eskimo Whaling Commission February 12 and 13, 2010 in Barrow. Statoil will be an active participate in the NMFS Open Water meetings and subsequent peer review in March 2010. Statoil will continue to engage with leaders, community members, and co-management groups (as well as local, state, and federal regulatory agencies) throughout the exploration phase.

Affected Environment of the Marine Seismic Survey. Statoil's 2010 marine seismic survey area is located approximately 242 km (150 mi) west of Barrow, Alaska. The water depth within the project area ranges from 30–50 m (100–165 ft). The project area is one of the most remote locations where oil and gas exploratory work worldwide is being conducted. Statoil has collaborated with other leaseholders to conduct baseline studies to characterize the biological resources of the project area and to supplement the current baseline surveys being conducted by federal agencies.

The Chukchi Sea environment is covered by the arctic ice pack 7–10 months each year, but supports a diverse biological ecosystem driven primarily by the seasonal presence of sea ice. The ice pack shapes the habitat for many of the biological organisms, from the primary productivity of the plankton communities to the migration patterns of the bowhead whale. The Chukchi Sea ice conditions are influenced by weather, wind, ocean currents, and extreme daylight conditions. The sociocultural settings of the Chukchi Sea communities are closely intertwined with the biological resources and the ice conditions of the Chukchi Sea.

Subsistence is an essential part of local economies in the arctic, but it also plays an equally significant role in the spiritual and cultural realms for the people participating in a subsistence lifestyle (Brower 2004). Traditional stories feature animals that are used as subsistence resources, conveying the importance of subsistence species within Iñupiaq society. These stories are used to pass information pertaining to environmental knowledge, social etiquette, and history between generations, as well as to strengthen social bonds. The Iñupiaq way of life is dependent upon and defined by subsistence.

Economic Development. Future regional and local economic development depends on natural resource development. This very development has the potential to affect the environment and subsistence use areas. The resource development-based economy also provides jobs and opportunity. The cumulative effects of the proposed Chukchi Sea oil and gas development must be counterbalanced by the indirect and direct economic benefits and community development that could also result.

Arctic Slope Regional Corporation and the village corporations exert considerable economic force in the region, providing employment in all sectors of the regional economy. Aside from the multinational resource development corporations, other major players in the North Slope economy are the federal government, State of Alaska, and local governments. The NSB is at the center of the region's economy, providing public services and facilities - most funded by oil and gas tax revenues related to onshore and near shore resource development.

Environmental Consequences. Many of the Chukchi Sea's biological resources are seasonal and closely associated with the annual cycle of sea ice cover and open water. Statoil's 2010 marine seismic survey will be conducted only when the project area is free of ice. Therefore, the potential effects of this project are generally limited to the resources associated with open water such as whales, fishes, and birds. Marine mammals associated with the ice pack edge, such as seals, walruses, and polar bears, may also be near the project area, depending on the location of the ice pack edge during the seismic survey. Arctic ice and meteorology forecasting will be an integral operational aspect of the marine survey.

Sound energy from Statoil's proposed seismic survey is expected to be the primary source of potential effects on marine life. Statoil has developed a number of mitigation measures for this project that are expected to minimize incidental sound disturbances to marine mammals and other marine wildlife. Secondary, and less likely, sources of potential effects from the seismic survey project include vessel transiting, vessel emissions, vessel minor wastewater discharge volumes, and potential hydrocarbon release during a possible refueling operation. Effects on biological resources associated with the transit of the seismic source vessel and two support vessels are expected to be minimal and temporary.

Emissions and wastewater discharge volumes from the seismic survey vessels are generally below applicable Federal Clean Air Act and Clean Water Act permit requirements and presumably will have zero to minimal effect on the physical and biological environments. This project does not involve exploratory drilling or any other disturbances of the subsurface geology, thereby eliminating any possibility of a crude oil spill. The presence of the seismic survey vessel fleet can pose a potential hydrocarbon release, either from a vessel collision or an at-sea refueling mishap. The seismic survey project will be conducted during the long daylight environment, thereby reducing the likelihood of a vessel collision and any subsequent potential hydrocarbon release. Vessel refueling will be conducted primarily in Nome, with a contingency to have a single refueling event at sea. In the event of an at-sea fuel transfer operation, the seismic survey vessels will comply with all applicable MARPOL international, U.S. Coast Guard, and State of Alaska oil spill prevention and response requirements.

Monitoring and Mitigation. Potential effects of the proposed 3D seismic acquisition project on marine mammals, fish, marine birds, their habitat, and the subsistence use of these species are expected to be minimal and temporary. Statoil has designed the seismic acquisition project to reduce the potential effect on marine mammals. Although the mitigation measures have been designed to mitigate effects on marine mammals, they are also expected to mitigate effects on other marine life such as fish.

- The size of the 3D seismic acquisition area has been minimized to the smallest area practicable to obtain the required data for a total 3D survey area of 2,385 sq km (915 sq mi).
- The total airgun discharge has been reduced to the minimum volume needed to obtain the required data without compromising data quality. The total volume is 3,000 cu in.
- The airgun array has ten spare airguns to reduce the chance for shutdowns due to equipment failures, thus potentially reducing the total field time.
- An unusually large streamer array (twelve individual streamers) is being deployed, resulting in a larger than normal distance between source lines and fewer transects needed to cover the seismic acquisition area. Because there are fewer transects, fewer shotpoints are needed to collect the required data and the data acquisition can be completed in a shorter time.

Mitigation measures that will be employed include:

- Establishment and maintenance of acoustic safety radii
- Speed and course alterations to maintain safety radii
- Ramp-up, power-down, and shutdown procedures

Vessel-based MMOs will be located on all project vessels and will monitor for the presence of marine mammals in the project area as described below. At least one Alaska Native knowledgeable about marine mammals will be part of the MMO team located on each project vessel. At least one MMO (when practicable, two MMOs) will monitor for marine mammals during daylight operations and during nighttime startups.

1.0 INTRODUCTION

In February 2008, Statoil USA E&P Inc. (Statoil) acquired 16 lease holdings in the U.S. Department of the Interior, Minerals Management Service (MMS), Outer Continental Shelf (OCS) Lease Sale 193. The lease areas are in the Chukchi Sea and located approximately 160 kilometers (km) (100 miles [mi]) northwest of Wainwright and 240 km (150 mi) west of Barrow (Figure 1.0-1). As part of a project to support future oil and gas exploration, Statoil plans to conduct a marine seismic survey in the vicinity of their leases during the 2010 open water season.

The purpose of the proposed seismic survey is to collect seismic reflection data to reveal the sub-bottom profile for assessments of petroleum reserves in the area. The primary goal of the 2010 project will be obtaining three-dimensional (3D) data within a 2,368 square kilometer (sq km) (915 square mile [sq mi]) area. These ultra-deep 3D lines will be used to better evaluate the petroleum system evolution at the basin level. Some two-dimensional (2D) lines designed to tie the 3D data to the surrounding regional geology will be obtained as a secondary goal for Statoil's 2010 Chukchi Marine Seismic Survey.

1.1 Purpose and Need for Environmental Evaluation Document

Statoil's 2010 Chukchi marine seismic survey will require several federal permits and authorizations. In accordance with the National Environmental Policy Act of 1969 (NEPA), the federal government is required to evaluate effects on the environment and to communities that may occur as a result of any activity authorized by or funded by the federal government (Sec. 102, 42 USC §4332). In addition, evaluation of the proposed action is required to ensure authorized permits are in compliance with the Marine Mammal Protection Act (MMPA).

The purposes of the proposed actions are to obtain a Geological and Geophysical (G&G) permit from MMS and an Incidential Harassment Authorization (IHA) from NMFS under the MMPA, and to establish activity controls that ensure compliance with all applicable laws. The permits are needed to allow Statoil to collect seismic reflection data to reveal the sub-bottom profile for assessments of petroleum reserves during the 2010 open water season in the area of Statoil's 16 lease holdings obtained in the United States Department of the Interior, Minerals Management Service, Outer Continental Shelf Lease Sale 193. The primary goal of the 2010 project will be obtaining three-dimensional (3D) data within a 2,368 sq km area. These ultra-deep 3D lines will be used to better evaluate the petroleum system evolution at the basin level. Some two-dimensional (2D) lines designed to tie the 3D data to the surrounding regional geology will be obtained as a secondary goal for Statoil's 2010 Chukchi Marine Seismic Survey.

In addition to the IHA and G&G permit, Statoil also submitted a request for a Letter of Authorization (LOA) from the U.S. Fish and Wildlife Service (USFWS). This Environmental Evaluation Document (EED) has been prepared by Statoil to support evaluation of the proposed 2010 3D seismic acquisition project in the Chukchi Sea for potential effects on the environment and nearby communities. It is meant to support the Statoil permit applications. The EED lays the foundation for the Environmental Impact Assessment that will be required for the exploration phase in the life cycle of the project.

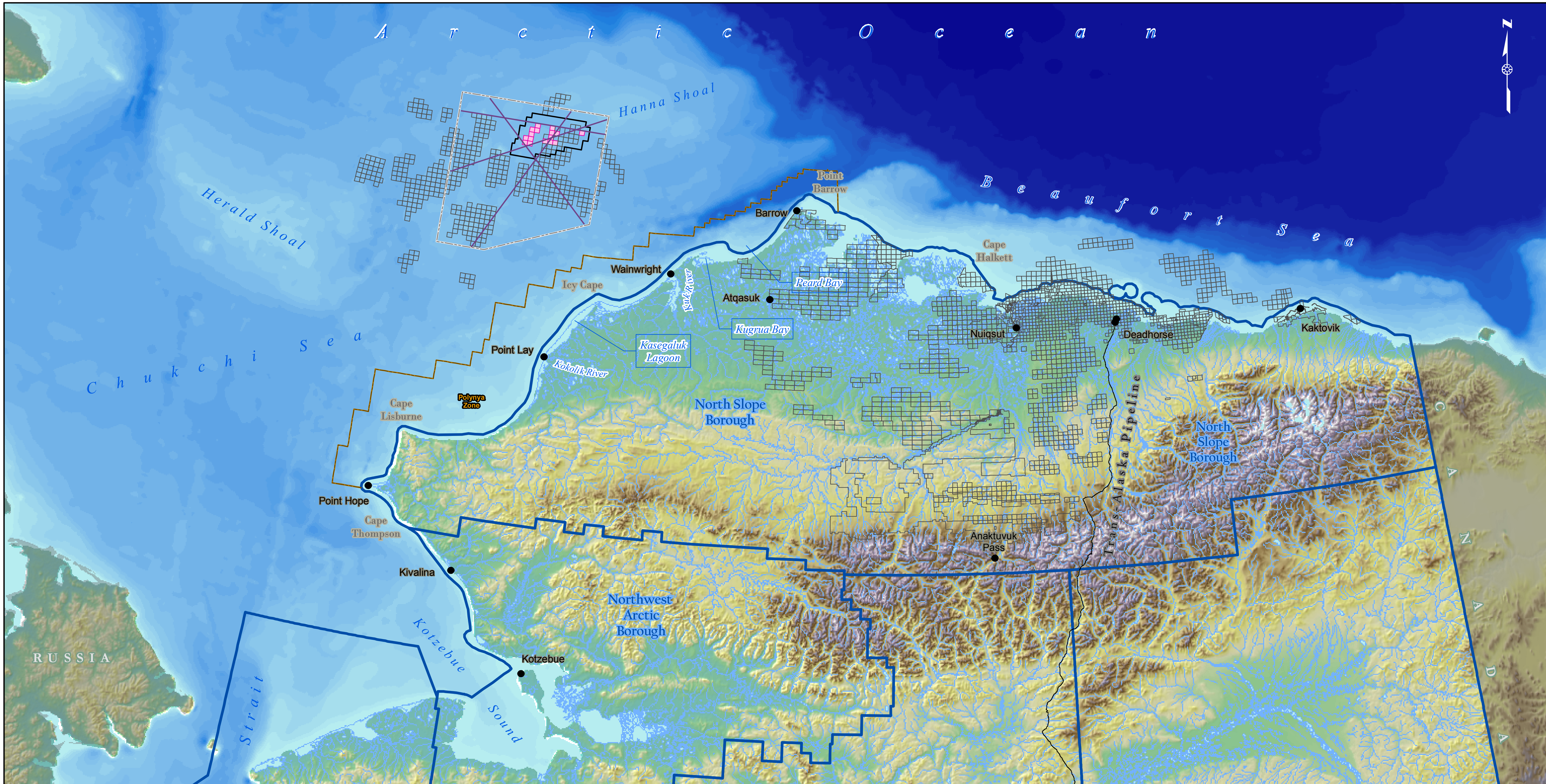
Statoil has its own corporate health safety, security, and environment and integrity and social responsibility guidelines for conducting impacts assessments. The impacts assessment process is a part of Statoil's overall management system. Each project, including seismic acquisition projects, must undergo a formal impacts assessment. The purpose of the impacts assessment process within Statoil is to manage risk and to improve the social and environmental performance throughout the life cycle of the project. Statoil's impacts assessment guidelines are based on World Bank International

Finance Corporation guidelines and requirements regarding how an impacts assessment should be performed. (The International Finance Corporation is the private sector lending arm of the World Bank.) Ongoing stakeholder engagement is an integral component of Statoil's impacts assessment process.

The National Marine Fisheries Service (NMFS) has recently issued a Notice of Intent (NOI) to Prepare an Environmental Impact Statement (EIS) on the Effects of Oil and Gas Activities in the Arctic Ocean on February 8, 2010. The EIS will analyze the environmental impacts of issuing Incidental Take Authorizations (ITAs) pursuant to the Marine Mammal Protection Act (MMPA) to the oil and gas industry for the taking of marine mammals incidental to offshore exploration activities (e.g., seismic surveys and exploratory drilling) in Federal and state waters of the U.S. Chukchi and Beaufort Seas off Alaska. The Minerals Management Service (MMS) will be a cooperating agency in preparing the EIS. The 2010 Chukchi Marine seismic Survey EED is not a requirement of the permitting agencies, although it may provide some useful information for the EIS.

1.2 Organization of the EED

- Section 1.0 discusses the purpose and need for this document; provides a project description, including vessels and equipment, operations information, and project details.
- Section 2.0 establishes the regulatory framework that applies to the project.
- Section 3.0 describes the resources that could be affected by the proposed project. These include ice and geological conditions, air and water quality, lower trophic organisms, marine mammals such as whales, seal and polar bear, coastal and marine birds, fish, and shellfish, threatened and endangered species, archeological resources, socio-economic resources, subsistence resources, and coastal and marine uses.
- Section 4.0 provides an analysis of the potential effects of the proposed project on the physical environment and biological resources.
- Section 5.0 discusses the potential cumulative effects.
- Section 6.0 defines the mitigation measures to be implemented for the project.
- Section 7.0 incorporates references cited in this document.



Distance to Survey Area in miles:

Barrow	158
Wainwright	114
Point Lay	138
Point Hope	246
Nome	645
Dutch Harbor	1297

Lease Owner
- Statoil
- All Other
- Permit Area
- 3D Seismic Survey Area

- 2D Seismic Lines (Potential Locations)
- Borough
- Polynya Zone

- Village
- Road
- Pipeline

*Notes: The North Slope Borough and Northwest Arctic Borough boundaries extend to the 3 mile State of Alaska jurisdictional boundary.

NAD83, Alaska Albers Equal Area

ASRC Energy Services
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Regulatory and Technical Services

Statoil

PROJECT AREA
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 25 50 100 Miles

FIGURE: 1.0-1

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1.3 2010 Chukchi Marine Seismic Survey Project Description

Statoil's proposed 2010 Chukchi Marine Seismic Survey project in the Chukchi Sea involves using seismic sound-source equipment to gather data on the marine sub-bottom profile in the project area for the assessment of petroleum reserves. This project is specifically a seismic sound-source data acquisition project using a sound-source array towed by a seismic source vessel. This project does not involve exploratory drilling or any other disturbances of the subsurface geology.

The following information details the marine operations of the project, the type and purpose of the equipment to be used, and the logistics involved for conducting project activities during the permitted period.

1.4 Vessels and Equipment

Three vessels, including a seismic source vessel and two support vessels, will mobilize out of Dutch Harbor, Alaska, to the project area in mid-July 2010; the actual departure date is dependent upon ice and weather conditions. It is anticipated that transit time to the project area will be approximately 5 days. Data acquisition is expected to take 60 days. Upon completion of data acquisition, all vessels will demobilize back to Dutch Harbor. Although data acquisition is expected to take 60 days, all permits have been requested for the period from July 15–November 30, 2010, to allow for contingencies and weather delays. The project data acquisition activities will be conducted by Fugro-Geoteam, Inc. (see Figure 1.3-1 for vessel specifications and transit map).

The vessels involved in the seismic survey activities are listed below. (If necessary, similarly equipped vessels may be used for this project in place of those noted here.)

- Marine vessel (M/V) *Geo Celtic:* The seismic source vessel that will tow a 3,000-cubic inch (cu in) sound-source array for data acquisition
- M/V *Tanux I* or similar vessel*:* A support and environmental monitoring vessel for marine mammal monitoring, support, and supply duties
- M/V *Norseman* or similar vessel: A support, environmental monitoring, and crew transfer vessel for marine mammal monitoring, crew transfer, and support and supply duties

Vessel functions will be under the supervision of the Master on the M/V *Geo Celtic.* Changes will be made to adjust to the operational requirements. Either the M/V *Tanux I* or M/V *Norseman* or similar vessels will be available for deployment and retrieval of acoustic recorders for sound-source verification measurements.

1.5 Operations Information

The crew will live aboard the self-contained M/V *Geo Celtic* and two support vessels. Crew changes are planned at least once during the project. The main port for resupply and crew changes during the survey will be Nome, Alaska. A search-and-rescue helicopter stationed in Barrow will be available for emergencies or other unforeseen circumstances. If necessary, personnel and equipment may be transferred through Barrow or Wainwright as alternative ports.

Refueling will take place in Nome, though it is possible that refueling could occur at sea. Helicopter operations are not planned as a part of the seismic survey, although it is possible that individuals could be transported to and from vessels via helicopter, if necessary. In general, helicopter operations are expected to occur only in the case of an emergency.

Marine Mammal Observers (MMOs) will be located on the bridge or weatherdecks of the M/V *Geo Celtic* to watch for marine mammals during the following operations: transit to the survey area; seismic data acquisition; and transit back to Dutch Harbor, the original departure point.

One or more support vessels will be used to protect the streamers from damage, conduct re-supply efforts, and for monitoring activities. All support and environmental monitoring vessels will have MMOs onboard and will be responsible for marine mammal monitoring and mitigation as required by permit stipulations. This includes the establishment of safety radii through sound measurement to determine the decibel (dB) levels and distance required to mitigate disturbances to marine mammals. In the exclusion zone established through this sound-source verification process, mitigation measures will include source shutdown, avoidance, and ramp-up procedures. Support and environmental monitoring vessels will not introduce sounds into the water beyond those associated with normal vessel operations. Measures to reduce effects are demonstrated in Figure 1.4-1.

1.6 Project Details

1.6.1 3D Seismic Survey

The 3D data acquisition process will use a towed sound-source array consisting of 26 active airguns with a maximum discharge volume of 3,000 cu in. The survey area has been reduced to the minimum extent possible and covers 2,368 sq km (915 sq mi).

The M/V *Geo Celtic* has two identical, three-string, sound-source arrays. The arrays will be discharged in an alternating mode, starting with the starboard array. The port array will be discharged 8 seconds later, 18.75 meters (m) (61.52 feet [ft]) along the line; and then the pattern repeats. The array will consist of 26 (plus 10 spare) Soldera G-guns (four 60-cu in, eight 70-cu in, six 100-cu in, four 150-cu in, and four 250-cu in) with a total discharge volume of 3,000 cu in. One of the smallest guns in the array (60-cu in) will be used as the mitigation gun. The airgun array will be towed at 6 m (20 ft) depth and at a distance of roughly 275 m (900 ft) behind the vessel.

The vessel will travel along predetermined lines at between 4–5 knots, while the airgun array discharges at 8-second intervals (shot interval 18.75 m [61.5 ft]). The hydrophone streamer array will consist of twelve streamers of up to 4,050 m (2.5 mi) in length, with a total of 20,000–25,000 hydrophones spaced 2 m (6.5 ft) apart. This large hydrophone streamer receiver array is designed to maximize efficiency, minimize the number of source points, and minimize environmental effects. The hydrophones will receive the reflected signals from the sound-source array and transfer the data to an onboard processing system. Several sensors and steering devices will be used to position the streamer relative to the vessel. The entire 3D seismic survey project will consist of 5,000 km (3,100 mi) of production line, not including transits. Water depth within the survey area is roughly 30–50 m (100–165 ft).

1.6.2 2D Seismic Survey

The 2D data acquisition will be dependent upon weather conditions and ice coverage. Obtaining 2D seismic data is a secondary priority. 2D seismic survey data will be obtained if ice conditions restrict access to the 3D seismic survey area or if 3D seismic survey data acquisition progresses better than anticipated.

A maximum of four 2D survey lines will be collected, and 2D data acquisition will not exceed 675 linear km (420 mi). 2D data acquisition will use the same vessel, sound-source array, and streamer configuration as used for the 3D data acquisition. The sound-source vessel will travel along predetermined lines at 4–5 knots, while the airgun array discharges at 8-second intervals (shot interval 18.75 m [61.5 ft]) (Figure 1.6-1).

Figure 1.3-1 Vessel Transit Map

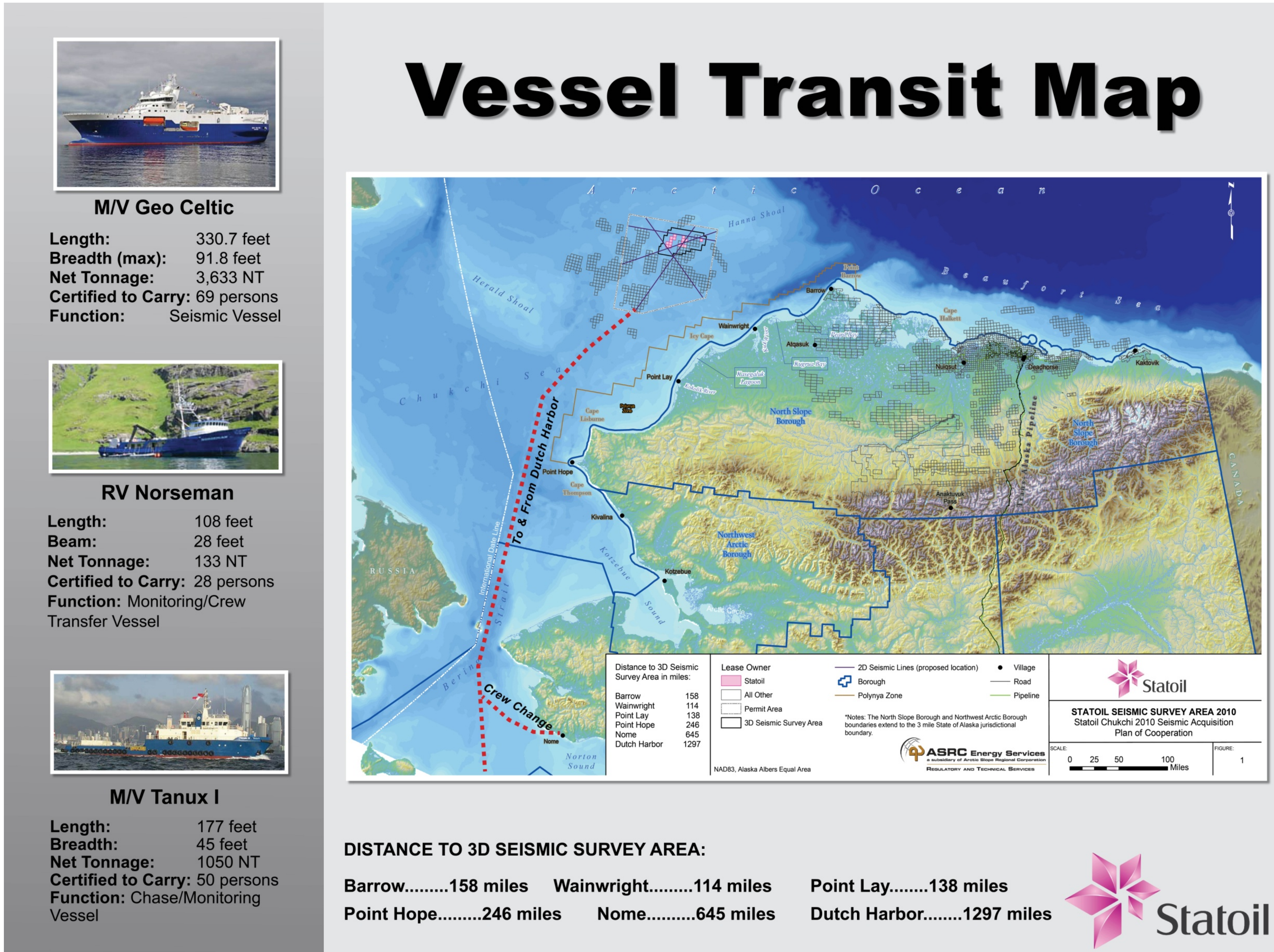

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Figure 1.4-1 Measures to Reduce Effects

Measures to Reduce Impact

Survey & Vessel Design

The seismic vessel and its equipment have been selected to minimize the environmental footprint.

Seismic Vessel

The seismic vessel is new, built in Bergen, Norway in 2007 and equipped with the latest technology and an up-to-date environmentally-friendly design.

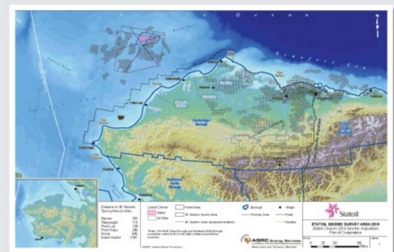
Seismic Receiver Array

The receiver array has doubled in size from previous surveys, to 12 streamers, to reduce the number of shotpoints needed to survey the area.

Solid streamers will be used, rather than kerosene, thereby reducing the risk of pollution into the environment.

Seismic Source Array

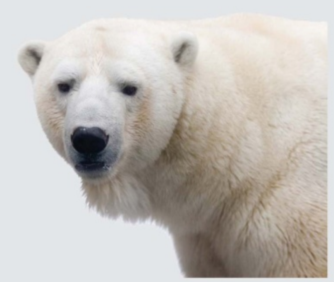
The size has been deliberately kept as small as possible. The focus is directed downward, thus minimizing the sound energy radiated sideways across the area.



Survey Area

The survey area is located far offshore and will not interfere with subsistence activities.

Statoil will prepare a polar bear interaction plan that addresses food and waste management, personnel training, and safety and communication regarding polar bears.



Ice Management

Ice conditions (radar, satellite imagery) in the project area will be monitored during the seismic survey in order to minimize survey time and activity close to the ice edge.

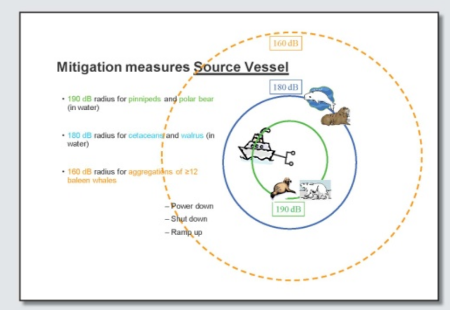
SAR / Communication and Call Centers

Statoil will, together with Shell and ConocoPhillips, operate a Search and Rescue (SAR) helicopter and shore communication and call centers to improve the area's emergency systems.

Marine Mammal Monitoring

Vessels operated by Statoil will take every precaution to avoid harassment of marine mammals, including whales, seals, walruses or polar bears in the water when a vessel is operated near these animals.

- Marine Mammal Observers (MMOs) will be employed on all 3 vessels.
- An additional (third) vessel has been contracted primarily to assist with marine mammal observation.
- Scientific and Inupiat MMOs
  - 5 on source vessel until mid-August, then possibly 3 or 4
  - 2 or 3 on support vessels



Mitigation Procedures

- Establishment of safety radii through sound source verification measurements of airgun array.
- In the established exclusion or safety zone, power down, shut down, and ramp-up procedures will be in place.

Environmental & Baseline Monitoring

Statoil is participating in environmental baseline monitoring with Shell and ConocoPhillips. This includes:

- Seabed and water sampling and analysis over old drill sites
- Fixed seabed acoustic recorders to monitor marine mammal activity in the Chukchi Sea.
- Ecological studies of Chukchi fish populations.

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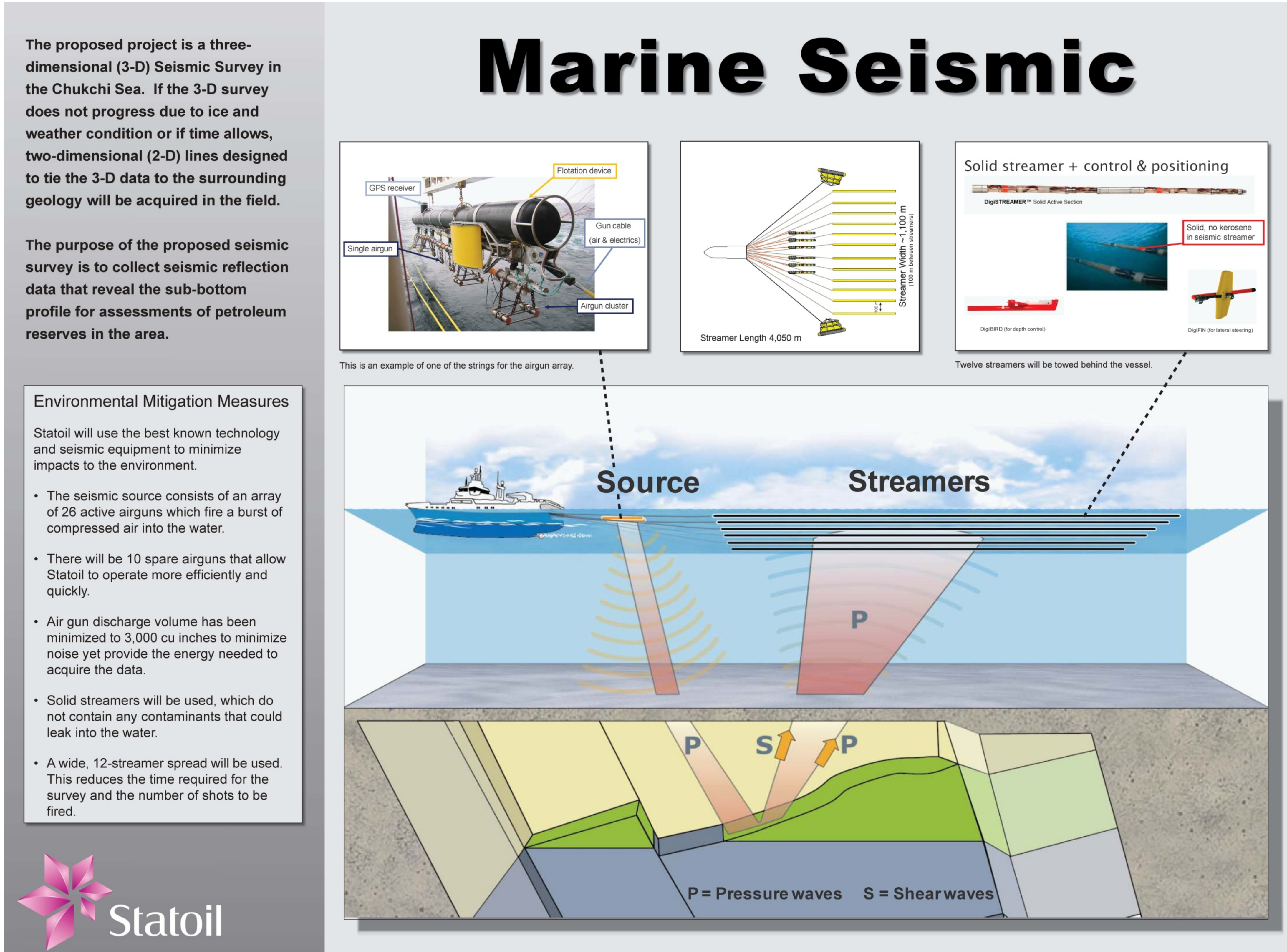
Figure 1.6-1 Martine Seismic Map



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1.7 Project Location

The proposed 3D marine survey will be conducted in the Chukchi Sea in the area of Statoil lease holdings obtained in the U.S. Department of the Interior, MMS Outer OCS Lease Sale 193. The lease areas are located approximately 160 km (100 mi) northwest of Wainwright and 240 km (150 mi) west of Barrow in the Alaskan Chukchi Sea (Figures 1.6-1 and 1.6-2). The 3D marine survey will take place within a 2,368-sq km (915-sq mi) area, minimum of 145 km (90 mi). The water depth in the survey area varies from 30–50 m (100–165 ft). 2D survey activities will take place a minimum of 72 km (45 mi) off the coast.

1.8 Project Timeline

Statoil plans to conduct the survey between July 15 and November 30, 2010, ice and weather permitting. Project vessels, including the sound-source vessel and two support vessels, will arrive in Dutch Harbor by mid-July 2010. The vessels will be supplied, and the crew—including MMOs—will board at this port. Depending on conditions, the vessels will depart Dutch Harbor between mid- to late July and travel to the Chukchi Sea survey area. The anticipated transit time is 5 days, depending on weather conditions.

Upon arrival in the Chukchi Sea, crew aboard the source vessel will deploy the sound-source array and hydrophone streamers and start operation. The source verification measurement will be conducted on the first seismic line to establish a safety zone Data acquisition is expected to continue for 60 days and be completed in the first half of October, depending on weather conditions. This includes seismic data acquisition and anticipated downtime related to mitigation measures. Data acquisition is expected to occur 24 hours per day. Upon completion of data acquisition, project vessels will demobilize to Dutch Harbor.

1.9 Stakeholder Engagement

Statoil intends to maintain an open and transparent process with all stakeholders throughout the life-cycle of activities in the Chukchi Sea. Statoil began the stakeholder engagement process in 2009 through meetings with Chukchi Sea community leaders at the tribal, city, and corporate level. Statoil will continue to engage with leaders, community members, and subsistence groups (as well as local, state, and federal regulatory agencies) throughout the exploration process.

As part of stakeholder engagement, Statoil is developing a Plan of Cooperation (POC) for the proposed 2010 Chukchi Marine Seismic Survey project. The POC identifies the actions Statoil will take to identify important subsistence activities, inform subsistence users of the proposed survey activities, and obtain feedback from subsistence users regarding how to work in cooperation with subsistence activities and the Statoil project.

A POC is required to comply with OCS Lease Sale 193 Stipulation No. 5 and federal regulatory requirements, including the U.S. Code of Federal Regulations (CFR) 50 CFR 216.104(a) (12) (ii). The POC also fulfills the requirements of three major federal permits: the NMFS IHA, the USFWS LOA, and the MMS G&G permit.

Statoil met with leadership from the communities of Barrow, Wainwright, Point Lay, Point Hope, and Kotzebue during the last week of October and the first week of November 2009 in small groups and on a one-on-one basis. These meetings enabled Statoil to introduce the company, the data acquisition project, and specific staff to community leaders, as well as discuss local concerns regarding subsistence activities, timing of operations, and local hire and workforce development. Based upon these meetings, a draft POC document is being developed. Upon completion, the draft POC will be submitted to each leadership member with whom Statoil met during their October and November leadership meetings, as well as other community members. Statoil will also submit the draft POC to NMFS, USFWS, and MMS as part of the permit application process. POC meetings were held in January 2010 in the communities of Barrow, Point Hope, Point Lay, and Wainwright to obtain input from the general public and individual subsistence users within these communities. These community meetings provided input for the scoping process for many of the issues encompassed in this EED.

A final POC documenting all consultations with community leaders, subsistence users groups, individual subsistence users, and community members will be submitted to NMFS, USFWS, and MMS upon completion of consultation. The final POC will include feedback from the leadership meetings and POC meetings. Statoil will continue to document all consultation with communities and subsistence stakeholders.

2.0 REGULATORY FRAMEWORK

2.1 U.S. Regulatory Framework Applicable to Alaskan OCS Geological and Geophysical Exploration

In February 2008, Statoil acquired 16 lease holdings in the MMS OCS Lease Sale 193. The lease areas are located approximately 160 km (100 mi) northwest of Wainwright and 240 km (150 mi) west of Barrow in the Alaskan Chukchi Sea. As part of a project designed to support future oil and gas exploration, Statoil plans to conduct a marine seismic survey in the vicinity of their leases during the 2010 open water season. The purpose of the proposed seismic survey is to collect seismic reflection data to reveal the sub-bottom profile for assessments of petroleum reserves in the area. This project is specifically a seismic sound-source data acquisition project using a sound-source array towed by a seismic source vessel and two support vessels. This project does not involve exploratory drilling or any other disturbances of the seabed and subsurface geology.

The February 2008 MMS lease sale was conducted under the authority of the Outer Continental Shelf Lands Act (OCSLA) and the implementing regulations codified in Title 30—Mineral Resources, Chapter II, MMS, Parts 200–299, CFR. Under the authority found in 30 CFR 250.101, the MMS requires all oil and gas exploration operations to be conducted in accordance with the OCSLA, the regulations of Part 250, and other applicable laws and regulations to make resources available to meet the nation's energy needs, while balancing orderly energy resource development with protection of the human, marine, and coastal environments. The Alaskan Chukchi Sea contains world-class quantities of oil and gas resources, as well as significant biological marine resources, including whales, seals, polar bears, and Pacific walrus. The Alaska Chukchi Sea coastline is home to Alaska Native people who have lived millennia practicing their subsistence lifestyle. Thus, responsible oil and gas exploration activity on the Alaskan Chukchi Sea OCS must balance the competing needs for energy with marine mammal protection and the Alaska Native subsistence lifestyle. In addition to the OCSLA, the Statoil proposed 2010 Chukchi Sea seismic survey project will trigger requirements of NEPA, MMPA, the Endangered Species Act (ESA), and other U.S. statutes and regulations.

2.1.1 Outer Continental Shelf Lands Act

OCSLA established federal jurisdiction over the OCS and granted authority to the Secretary of the Interior to manage OCS resources. The Secretary has delegated the authority to MMS to promulgate regulations, conduct leasing, and issue permits in the OCS. Section 18 of OCSLA directs the MMS to revise its oil and gas leasing programs periodically, which the MMS does on a 5-year basis. These 5-year leasing plans are national in scope and provide a schedule for all lease sales within the 5-year period. The leasing programs are developed through a comprehensive NEPA process that includes resource analyses, public input, and environmental analyses. The Chukchi Sea Lease Sale 193 was conducted under the MMS OCS Oil and Gas Five Year Leasing Program: 2007–2012 (MMS 2007a). Statoil acquired 16 lease holdings in Lease Sale 193 (MMS 2007b).

MMS has issued regulations pertaining to oil and gas exploration, development, and production activity on the OCS in Title 30, CFR, Part 250. MMS has also issued regulations for G&G exploration activity in 30 CFR 251. Statoil's proposed 2010 3D seismic activity must follow the requirements of 30 CFR 251, Lease Sale 193 stipulations (MMS 2007c), and any conditions included in the G&G permit. MMS also issues Notices to Lessees and Operators for specific OCS regions and activities and requires several interagency and government-to-government consultations to demonstrate compliance with applicable federal laws.

2.1.2 National Environmental Policy Act

NEPA mandates federal agencies to conduct an environmental review of their proposed actions or projects that require federal funding, federal authorizations or permits, or that occur on federal lands. NEPA is a coordinated review process between the federal, state, local, and tribal agencies. The federal authorizing agency, or lead agency, works with other agencies that may have a major role in authorizing the proposed action. These other agencies may serve as a co-lead agency or as a cooperating agency. Federal authorizing agencies for seismic survey activity on the Chukchi Sea Lease 193 area include MMS, the National Oceanic and Atmospheric Administration (NOAA)-(NMFS), and USFWS.

NEPA reviews are conducted at various levels of detail and scope, depending on the nature of the proposed action. Some activities with well-known environmental effects may qualify for a Categorical Exclusion from further NEPA analysis, while other activities trigger an Environmental Assessment (EA) or the most rigorous level of review, an Environmental Impact Statement (EIS), depending on the perceived level of impact associated with the project or action. If the proposed action or project is not categorically excluded and the reviewer is unsure of the level of impact, the agency will prepare an EA. At the completion of the EA, the agency will either determine a finding of no significant impact (FONSI) and issue a FONSI to that effect or determine there will be a significant impact and elevate the NEPA review to the EIS level.

There have been several oil and gas-related Alaska OCS NEPA reviews in the past few years. The MMS prepares EISs for their 5-year leasing plans, including the 2007–2012 plan (MMS 2007d) that contained Lease Sale 193. The leasing plan reviews for NEPA were conducted by MMS headquarters. The MMS Alaska OCS Region subsequently prepared a more detailed EIS (MMS 2007b) specifically for the Chukchi Sea Lease Sale 193 for oil and gas lease sales including exploration seismic survey activity. In 2006, the MMS prepared a Final Programmatic Environmental Assessment for oil and gas seismic survey activity on the Beaufort and Chukchi Seas OCS (MMS 2006a) and an accompanying FONSI (MMS 2006b). In 2007, the MMS and NOAA Fisheries/NMFS prepared a Draft Preliminary EIS (DPEIS) for oil and gas seismic survey activity on the Beaufort and Chukchi Seas (MMS and NMFS 2007). Subsequently, on October 28, 2009, NMFS and MMS announced they are withdrawing the 2007 DPEIS and will initiate a new NEPA process (NMFS 2009). And most recently, in October 2009 and December 2009, respectively, the MMS prepared EAs and accompanying FONSIs for Shell's 2010 Exploration Drilling Programs in the Camden Bay OCS (MMS 2009a, MMS 2009b) and in the Chukchi Sea OCS (MMS 2009c, MMS 2009d).

MMS, utilizing their NEPA implementing rules, will prepare an EA specifically evaluating the effects of Statoil's planned seismic survey activity as presented in their G&G permit application. NMFS and USFWS will also prepare EAs for non-lethal, incidental take authorizations of whales and seals; and polar bears and Pacific walrus, respectively, under their authority in implementing the MMPA and the ESA. The federal agencies will evaluate the direct, indirect, and cumulative effects of the Statoil 2010 Chukchi Marine Seismic Survey project as these terms are defined in the implementing NEPA regulations found in 40 CFR Part 1508.

Effects under NEPA, 40 CFR 1508.8, Effects, include "Direct effects, which are caused by the action and occur at the same time and place; and

"Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

"Effects and impacts as used in NEPA regulations are synonymous. Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial."

Cumulative effect, or cumulative impact as listed in NEPA is defined as:

"The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what federal agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7)."

Finally, NEPA defines "significantly" in 40 CFR 1508.27 to consider both context and intensity:

"Context means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant."

"Intensity refers to the severity of impact (effect). Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action."

The environmental analysis presented in this EED tiers off—and incorporates by reference—many of the analyses presented in the MMA NEPA review documents listed above. Statoil anticipates that MMS, NMFS, and USFWS will utilize the environmental information contained in this EED and the previous, recent Chukchi Sea NEPA reviews in preparing their respective EAs and accompanying FONSIs.

2.1.3 Marine Mammal Protection Act

The MMPA established federal authority to conserve marine mammals. Specifically, the MMPA imposes a moratorium on the taking and importation of marine mammals and marine mammal products. The MMPA also preempts all state laws related to taking of marine mammals. A principal goal of this moratorium is to bring marine mammal species and population stocks to and maintain them at "optimum sustainable population" (OSP) levels. Incidental take levels of marine mammals are to be reduced to insignificant levels of injury and mortality approaching zero. In addition, the MMPA specifies as its foremost objective the maintenance of the health and stability of the marine environment. Depending on the species involved, the MMPA is administered by either the USFWS (polar bears, Pacific walrus) or the NMFS (whales and seals, including the bowhead whale, gray whale, fin whale, humpback whale, minke whale, harbor porpoise, beluga whale, bearded seal, ringed seal, and spotted seal cetaceans, pinnipeds).

Under the moratorium and with exceptions noted in the MMPA, it is unlawful to take by harassing, hunting, capturing, or killing any marine mammal, or attempt to do so, or to do so unintentionally. The MMPA defines the term "take" as harassing, hunting, capturing, killing, or collecting; or attempting to harass, capture, kill, or collect marine mammals. Harassment is statutorily defined as "any act of pursuit, torment, or annoyance." Amendments to the MMPA have further divided the term harassment into two levels: Level A Harassment, which has the potential to injure a marine mammal or marine mammal stock in the wild; and Level B Harassment, which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavior patterns. The disruption of behavior patterns includes but is not limited to migration, breathing, nursing, breeding, feeding, or sheltering.

Incidental take of marine mammals in offshore oil and gas activity can be authorized under either a five-year regulation/letter of authorization (LOA) or a one-year incidental harassment authorization (IHA) approach. Under either approach, the take must be by citizens of the United States engaged in a specified activity (other than commercial fishing and take for subsistence by Indians, Aleuts, and Eskimos) within a specified geographical region. With the exception of an authorized intentional take of polar bear to protect human safety (e.g., hazing), the take must be incidental and not intentional for taking of small numbers of a marine mammal species or population stock. An IHA can be used only for takes by harassment.

For an LOA, regulations must prescribe the permissible methods of taking, other means of affecting the least practicable adverse impact on the species and its habitat, and o the availability of the species for subsistence uses, and requirements for monitoring and reporting. The USFWS issued a final incidental take rule in June 2008 (USFWS 2008a). The activity may be for no more than five consecutive years, and it must be found that the take will have a negligible impact on the species and that it will not have an unmitigable adverse impact on the availability of the species for subsistence uses. The LOA approach is being used for incidental take authorization of the USFWS trust species (polar bear and Pacific walrus).

The one-year IHA approach is used for the NMFS trust species (whales and seals). The same findings must be made as for an LOA. Instead of regulations (with LOAs for covered activities), the authorization must be published for 30 days for public review and comment, and the authorization must be issued within 45 days of the close of the comment period if the requisite findings are made. The authorization must include terms and conditions that prescribe methods of taking with the least practicable impact on the species and its habitat, and its availability for subsistence uses, measures necessary to ensure no unmitigable adverse impact on the species for taking for subsistence purposes, and requirements for monitoring and reporting, including peer review of the monitoring plans.

For Statoil’s proposed 2010 Chukchi Sea seismic survey activity, Statoil will need to obtain an IHA from NMFS for incidental, non-lethal takes of ice seals and whales, and an LOA from USFWS for the non-lethal takes of polar bears and Pacific walrus.

2.1.4 Endangered Species Act

The ESA of 1973 established federal responsibility to conserve animal and plant populations that are in jeopardy. The ESA provides a process by which animal or plant populations that are in jeopardy can be listed as threatened or endangered in order to protect the species or its critical habitat. The act defines an endangered species as an animal or plant species that is in danger of extinction throughout all or a significant part of its range. A threatened species is an animal or plant species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The act further requires critical habitat designation at the time of the listing as a threatened or endangered species or within 1 year after the listing.

The purposes of the ESA are to “provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes” of the Act (Section 2, ESA, 16 USC 1531) to the point where the “measures” of the ESA are no longer necessary for their protection. Section 9 of the ESA generally prohibits any action that results in the “take” of a listed species. “Take” means to kill, injure, harass, or cause harm through habitat modification that result in actual death or injury. Section 7 of the ESA prohibits any federal action that is likely to jeopardize a listed species or adversely modify designated critical habitat. Jeopardy and adverse modifications are determined through the consultation process and the issuance of a biological opinion (BO). These prohibitions apply immediately upon the listing of a species or the designation of critical habitat. Federal agencies that issue permits must consult with the agency having jurisdiction over a particular threatened or endangered species (e.g., USFWS – polar bears and birds; and NMFS – whales and seals).

During the past few years, several Alaska arctic species have been listed as either threatened or endangered or are under pending listing decisions from USFWS or NMFS. The federal natural resource agencies have also proposed critical habitat designations. USFWS listed the polar bear as threatened in May 2008 (USFWS 2008b). USFWS published the "polar bear 4(d)" rule in December 2008 (USFWS 2008c). The 4(d) rule was published after the designation of polar bears as a threatened species in order to ensure that the ESA is not misused to regulate global climate change. It states that if an activity is permissible under stricter MMPA standards for polar bears, it is also permissible under the ESA. In October 2009, the USFWS proposed critical habitat designation for the polar bear (USFWS 2009b). USFWS is currently evaluating a petition from the Center for Biological Diversity (CBD) to list the Pacific walrus as a threatened or endangered species (USFWS 2009a; CBD 2008). The CBD has submitted several petitions in recent years to the federal management agencies to list ice seals, etc. (CBD 2010).

Under the ESA, an incidental take may be authorized through an incidental take statement (ITS) included in a BO. In the case of Statoil's proposed 2010 Chukchi Sea seismic survey activity, an ITS would be included for NMFS species in the BOs issued for the NMFS IHA. For the USFWS species, the USFWS previously issued an ITS in their BO included in their 2008 Chukchi Sea LOA regulations. The ESA listed species relevant to the Statoil activities are described in section 3.2.4.

2.1.5 Magnuson-Stevens Fishery Conservation Act

The Magnuson-Stevens Act, also known as the Magnuson-Stevens Fishery Conservation and Management Act, established a set of amendments to the Fishery Conservation and Management Act of 1976. Section 303(a)(7) of the amended act mandated the identification of Essential Fish Habitat (EFH) for each federally managed species of fish by the Regional Fishery Management Councils. Sections 305(b)(2) through (4) list a mandatory process requiring federal agencies to consult with NOAA Fisheries prior to conducting or authorizing projects that could adversely affect EFH. The only EFH in the Chukchi Sea is for salmon. MMS will need to consult with NMFS for possible effects on salmon EFH before issuing the G&G exploration permit.

2.1.6 Coastal Zone Management Act

The federal Coastal Zone Management Act (CZMA) of 1972 authorizes states with approved Coastal Zone Management Plans (CZMPs) to review most federal activities and federally permitted activities within or affecting resources within the state's coastal zone to ensure that the activities will be conducted in a manner consistent with their approved CZMP. The review authority is applicable to any exploration plan or development plan in any area that has been leased under the OCSLA and that affects any land or water use or natural resources within the state's coastal zone. The Alaska Coastal Management Program (ACMP) implements the CZMA and requires OCS plans and projects in Alaska's coastal zone, including potential shorebases, to be reviewed for consistency with statewide standards. Statoil's proposed 2010 Chukchi Sea seismic survey project does not trigger CZMA requirements.

2.1.7 Clean Air Act and MARPOL Annex VI

The Federal Clean Air Act (FCAA), amended 1990, governs air pollutant emissions and requires the U.S. Environmental Protection Agency (EPA) and states to carry out programs to ensure compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant (PSD) Increments. The FCAA delegates authority for promulgation of regulations and administration of air quality programs in the OCS to the EPA, with the exception of portions of the Gulf of Mexico where MMS is the lead permitting authority. In 1992, EPA promulgated 40 CFR 55, Outer Continental Shelf Air Regulations. Emissions from stationary sources like production platforms located on the OCS (OCS sources) are regulated under Part 55. They are subject to some but not all of the requirements that would apply to similar onshore sources. Emissions from vessels in motion are not regulated under Part 55, except to a limited extent when those vessels are supporting an OCS source. However, emissions from vessels attached to the seabed or to an OCS source are regulated. Part 55 is not applicable to seismic survey activities on the OCS, including Statoil's proposed 2010 Chukchi Sea seismic survey project. Title II of the FCAA governs emission standards for moving sources, including non-road engines and vessels. In 2003, EPA promulgated emission standards for non-road engines on U.S. flagged vessels (EPA 2003).

The International Maritime Organization (IMO), a United Nations (U.N.) agency, developed emission standards from engines that power ships for non-U.S. flagged vessels. The international air pollution standards are found in Annex VI to the International Convention on the Prevention of Pollution from Ships (MARPOL). The Maritime Pollution Protection Act of 2008 allowed the U.S. to become a party of the Protocol of 1997 to amend MARPOL and incorporated the amended provisions of that international instrument into U.S. law. The Protocol of 1997 contains amendments to prevent and control air pollution from ships (MARPOL Annex VI). Under MARPOL Annex VI, large diesel-powered, oceangoing vessels must limit their emissions of nitrogen oxides (NO_x) and use cleaner-burning fuels to reduce their sulfur dioxide (SO_2) emissions. Globally, the current MARPOL Annex VI NO_x limits were effective January 1, 2000. Annex VI began enforcement in the U.S. in January 2009. In December 2009, EPA subsequently adopted stringent emission standards for all ships that affect U.S. air quality (EPA 2009). In October 2008, the IMO adopted new international standards for marine diesel engines and their fuels (2008 Amendments to MARPOL Annex VI) that will apply globally following ratification of the amended treaty.

The MARPOL Annex VI parties may also designate Emission Control Areas (ECAs) that would require more stringent fuel standards. On July 17, 2009, IMO approved in principle a joint U.S.-Canada proposal to amend MARPOL Annex VI to designate an ECA for specific areas of U.S. and Canadian coastal waters. The U.S.–Canada proposal, however, did not include the Aleutian Islands, western Alaska, and the U.S. and Canadian Arctic waters, but did include the waters adjacent to the Pacific coast, the Atlantic/Gulf of Mexico coast, and the main Hawaiian Islands. The Annex VI parties will vote in March 2010 to adopt the North American ECA. The ECA designation would ensure that ships that affect U.S. air quality meet stringent NO_x and fuel sulfur requirements while operating within the designated area up to 370 km (200 nautical miles [nm]) off the U.S. coast.

2.1.8 Clean Water Act

The Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), has several programs that are applicable to proposed activities in offshore waters, including the OCS. Most CWA programs are administered by the EPA or states. The Section 401, Water Quality Certification program; and Section 402, National Pollutant Discharge Elimination System (NPDES) permitting system, extend into the OCS. Section 403, Ocean Discharge Criteria, is also applicable to the OCS. Section 404, Permits for Dredged or Fill Material—administered by the U.S. Army Corps of Engineers (USACE)—does not extend out into the OCS. Ocean dumping and dredged material management are subject to the requirements of the Marine Protection, Research, and Sanctuaries Act. Section 402 requires point sources to obtain either an NPDES individual permit or general permit to discharge any pollutant into navigable waters of the U.S. The EPA and the states implement the provisions of the NPDES permit program. In 2006, EPA issued the Arctic Oil and Gas General Permit for oil and gas exploration drilling activity on the Alaskan Arctic OCS (Permit No. AKG280000). The Arctic Oil and Gas General Permit is not applicable for seismic survey activities. In February 2009, EPA finalized the Vessel General Permit (VGP) for Alaskan waters. The VGP is generally applicable for all vessels greater than 79 ft in length or vessels that discharge ballast water on inland U.S. waters and waters within 6 km (3 nm) of the shoreline. Applicants of General Permits are required to submit a Notice of Intent to EPA prior to receiving coverage under the General Permit. The Statoil proposed 2010 Chukchi Sea seismic survey project will not trigger NPDES General Permit No. AKG280000 eligibility but may trigger the requirements of the NPDES VGP.

2.1.9 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act authorizes USACE to implement and manage a permit program to prevent effects on harbors and navigation. Under this program, the proponent of projects in navigable waters that would require construction activities or installation of a facility on the OCS seafloor would require a permit. The Statoil proposed 2010 Chukchi Sea seismic survey project will not place any facilities on the seafloor and thus is not subject to the Rivers and Harbors Act.

2.1.10 Oil Pollution Act of 1990

Section 4202 of the Oil Pollution Act of 1990 (OPA 90), and as amended by the Coast Guard and Maritime Transportation Acts of 2004 and 2006 and codified in Section 311 of the CWA, established a statutory mandate requiring tank and nontank vessel owners and operators to prepare and submit oil or hazardous substance discharge response plans for vessels operating on navigable waters of the U.S. Section 311 of the CWA defines *nontank vessel* as greater than 400 gross tons, is not a tank vessel, carries oil of any kind as fuel for main propulsion, and operates on the navigable waters of the U.S. The U.S. Coast Guard (USCG) retains primary authority to manage oil spill prevention and response planning for U.S. navigable waters. The USCG will accept plans meeting State of Alaska Oil Discharge Prevention and Contingency Plan requirements to also fulfill OPA 90 spill plan requirements. In 2006, the USCG issued Navigation and Vessel Inspection Circular (NVIC) No. 01-05, Change 1 that provided Interim Guidance for the Development and Review of Response Plans for Nontank Vessels. On August 31, 2009, the USCG proposed Nontank Vessel Response Plan rulemaking to codify the guidance listed in NVIC No. 01-05, Change 1. The nontank vessel response plan requirements will be codified in 33 CFR 155. Final rulemaking is expected to be completed in 2010.

2.1.11 National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended, is federal legislation enacted to ensure that the nation's historical properties and archaeological resources are not lost through neglect or inadvertently destroyed by activities permitted or funded by federal agencies. Section 106 of the NHPA requires federal agencies to review projects for potential effects to historic resources and to seek ways to avoid, minimize, or mitigate any adverse effects on such resources prior to issuing federal permits and authorizations.

According to the MMS 30 CFR Part 251 regulations, "archaeological resources" means any material remains of human life or activities that are at least 50 years of age and are of archaeological interest. The MMS further defines a significant archaeological resource as those meeting the criteria of significance for eligibility to the National Register of Historic Places as defined in 36 CFR Part 60.

Archaeological sites on the Alaska OCS are most likely either prehistoric Native American sites, dating from the end of the last Ice Age when sea levels were lower than present day, or historic shipwrecks.

MMS 30 CFR Part 251 regulations also require the permit holder of a G&G exploration permit not to disturb archaeological resources and for the permit holder to allow MMS representatives to inspect G&G exploration activities. The Statoil proposed 2010 Chukchi Sea seismic survey project will not physically disturb the OCS seabed and hence will not disturb archaeological resources.

2.1.12 Executive Order 12898—Environmental Justice

Executive Order (EO) 12898, issued February 11, 1994, and entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (EO 1994), directs federal agencies, including MMS, NOAA Fisheries, and USFWS—to the extent practicable and permitted by law—to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of regulatory programs, policies, and activities on minority populations or low-income populations (EO 12898 §1-101). Each federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons from participation in or subjecting persons to discrimination under such programs, policies, and activities (EO 12898 §2-2). In addition, each federal agency shall work to ensure that public documents, notices, and hearings related to human health or the environment are concise, understandable, and readily accessible to the public (EO 12898 §5-5). EPA determined that the proposed Shell Chukchi Sea Exploration Oil and Gas Drilling Program Prevention of Significant Deterioration (PSD)/OCS air permitting action potentially affects a number of communities on the North Slope, many of which participate in subsistence harvests of marine mammals in the region. EPA further determined that its review of demographic characteristics indicated that many of the potentially affected communities have a large percentage of Alaskan Natives, who are considered a minority under EO 12898 (EPA 2010).

2.1.13 Executive Order 13366—Committee on Ocean Policy

EO 13366, issued on December 17, 2004, and entitled *Committee on Ocean Policy* (EO 2004), established the policy of the United States to coordinate the activities of federal agencies regarding ocean-related matters in an integrated and effective manner to advance the environmental, economic, and security interests of present and future generations of Americans (EO 13366 §1(a)). EO 13366 also established policy to facilitate the coordination and consultation regarding ocean-related matters among federal, state, tribal, and local governments, the private sector, foreign governments, and international organizations (EO 13366 §1(b)). Section 2 of EO 13366 defined "ocean-related matters" to include matters involving the oceans, the Great Lakes, the coasts of the U.S., and related seabed, subsoil, and natural resources.

2.1.14 Obama Ocean Policy Directive

On June 12, 2009, President Obama issued a memorandum to the heads of executive departments and federal agencies establishing an Interagency Ocean Policy Task Force, charged with developing a recommendation for a national ocean policy ensuring the protection, maintenance, and restoration of oceans, coasts, and the Great Lakes. The Task Force has also been tasked with recommending a framework for improved stewardship, and effective coastal and marine spatial planning (CMSP). On September 10, 2009, the Task Force released an Interim Report, which contained recommendations and a brief overview of the suggested national ocean policy, policy coordination framework, and implementation strategy. On December 14, 2009, the Task Force released its Interim Framework for Effective Coastal and Marine Spatial Planning. The Interim Framework recommends consideration of a new approach to planning and managing uses and activities in the coastal and marine environment. Under the Interim Framework, CMSP is envisioned as a regional process, developed cooperatively among federal, state, tribal, and local authorities, regional governance structures, and with significant stakeholder and public input. The recommendations included in the Interim Framework have not been finalized, and no CMSP procedures currently exist for the Alaska region.

2.2 International Environmental Treaties and Agreements

In addition to U.S. statutes, regulations, and EOs, there are a number of international conventions to which the United States is a signatory and that would apply to the Statoil 2010 Chukchi Marine Seismic Survey project. The IMO has developed several conventions to govern pollution from ships to the marine environment from operational or accidental causes (IMO 2010).

2.2.1 International Convention for the Prevention of Pollution from Ships

MARPOL 73/78 is the principal international legislation governing pollution of the marine environment by ships from operational or accidental causes. MARPOL 73/78 is the combination of two treaties adopted in 1973 and 1978 and has been updated by amendments during the past 30 years.

The MARPOL 73/78 consists of six technical annexes:

- Annex I: Regulations for the Prevention of Pollution by Oil
- Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
- Annex II: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
- Annex IV: Prevention of Pollution by Sewage from Ships
- Annex V: Prevention of Pollution by Garbage from Ships
- Annex VI: Prevention of Air Pollution from Ships

2.2.2 International Convention on Oil Pollution Preparedness, Response, and Cooperation

In November 1990, the IMO adopted additional measures to prevent oil pollution from ships. The International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC) requires ships to carry aboard an oil pollution emergency plan. The OPRC also requires vessels to report incidents of pollution to coastal authorities, carry onboard equipment to combat potential oil spills, and conduct periodic training exercises for dealing with oil pollution. The OPRC furthers the actions required in Annex I of MARPOL 73/78.

2.2.3 Protocol on Preparedness, Response, and Cooperation to Pollution Incidents by Hazardous and Noxious Substances

The IMO adopted the Protocol on Preparedness, Response ,and Cooperation to Pollution Incidents by Hazardous and Noxious Substances (HNS) in March 2000. The protocol follows the principles of the OPRC to pollution incidents by hazardous and noxious substances. The IMO, for purposes of the HNS protocol, defined any substance other than oil that, if introduced into the marine environment, is likely to create hazards to human health, to harm living resources and marine life, to damage amenities, or to interfere with other legitimate uses of the sea. Vessels are required to carry a shipboard pollution emergency plan to deal with HNS incidents. The HNS protocol ensures that ships carrying HNS are covered by preparedness and response regimes similar to those for oil pollution.

2.2.4 International Convention for the Control and Management of Ships' Ballast Water, and Sediments

The IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments in February 2004. This convention includes technical standards and requirements for the control and management of ships' ballast water and sediments. The purpose of the convention is to minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. The convention required ports and terminals to have ballast management standards to remove ballast water and sediments safely. For vessels, the convention requires ships to have a Ballast Water Record Book to record when ballast water is taken on board, circulated or treated, discharged into the sea or at a reception facility, and accidental or exceptional discharges.

2.2.5 International Convention on the Control of Harmful Anti-fouling Systems on Ships

In October 2001, the IMO adopted the International Convention on the Control of Harmful Anti-fouling Systems on Ships. This convention prohibited the use of harmful organotins in anti-fouling paints used on ships and established a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems.

2.2.6 Agreement of Conservation of Polar Bears (1973)

The United States is one of five countries (Canada, Denmark, Norway, Russia, and the U.S.) party to the 1973 treaty for the conservation of polar bears. The Agreement is implemented in the United States by the MMPA. The Agreement prohibits the "taking" (hunting, killing, capturing) of polar bears, except in limited circumstances. The Agreement calls for appropriate action to protect the ecosystem of which polar bears are a part, special attention to habitat components such as denning, feeding, and migration areas, and management under sound conservation practices based on best available scientific data. The Agreement also imposes trade restrictions and promotes cooperative international research.

2.2.7 Agreement between the Government of the United States and the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population (2005)

The United States and Russia are parties to the 2005 treaty that specifically concerns the Chukchi Sea polar bear population stock. Implemented under a 2007 amendment to the MMPA, the Agreement limits consumptive use to Native people, provides for establishing annual take levels, calls for joint scientific research efforts, and adopts habitat and other goals from the 1973 Agreement.

3.0 AFFECTED ENVIRONMENT

This section describes the affected environment relative to physical, biological, and sociocultural resources found in the Statoil project area potentially affected by the 2010 seismic project. The Chukchi Sea environment is covered by the arctic ice pack 7–10 months each year, but supports a diverse biological ecosystem driven primarily by the seasonal presence of sea ice. The ice pack shapes the habitat for many of the biological organisms, from the primary productivity of the plankton communities to the migration patterns of the bowhead whale. The Chukchi Sea ice conditions are influenced by weather, wind, ocean currents, and extreme daylight conditions. The sociocultural settings of the Chukchi Sea communities are closely intertwined with the biological resources and the ice conditions of the Chukchi Sea.

The Statoil seismic project area is located approximately 242 km (150 mi) west of Barrow, Alaska. The water depth within the project area ranges from 30–50 m (100–165 ft). The project area is one of the most remote locations where oil and gas exploratory work is being conducted. Because of its remoteness, there is a limited amount of baseline data. Statoil has collaborated with other leaseholders to conduct baseline surveys to characterize the biological resources of the project area.

3.1 Physical Environment

3.1.1 Geology and Geomorphology

The project area is situated in a relatively shallow, U.S. portion of the Chukchi Shelf, a broad, low-relief continental shelf that slopes gently to the north and transitions into the Amerasian Basin (MMS 2007). Historically, the Chukchi Shelf has been subaerially exposed during various times of low sea level. Approximately 20,000 years ago, during a period of low sea level, the Bering Land Bridge connecting Alaska and Russia was formed and exposed (MMS 2009).

More specifically, the Statoil lease blocks are situated on the Hanna Shoal and the Hanna Trough; the Hanna Trough is surrounded by the Chukchi Shelf, Arctic Platform, and uplifted sediment sources and runs through the center of the seismic permit area (Sherwood et al. 2002). The southwestern boundaries of the seismic permit area are bordered by the Herald Thrust and the Herald Shoal. The Chukchi Platform comprises the western seismic permit area boundary and beyond. Southeast of the seismic permit area is the Barrow Canyon, which separates the Chukchi Shelf from the Beaufort Sea continental shelf. To the east and northeast lies the Barrow Arch. North and northeast of the project area is the Arctic Platform. The Arctic Platform advances west off the Alaskan coast and meets the Hanna Trough (Sherwood et al. 2002). Figure 3.1.1-1 shows the Statoil lease blocks relative to surrounding geologic structures.

3.1.1.1 Stratigraphy

Nonexistent to thick Tertiary age clastic strata overlay thick Devonian to Cretaceous age clastic strata on the near-surface sea floor of the Chukchi Sea (the upper 1,000 m [3,300 ft]) (MMS 2009 and Sherwood et al. 2002). These strata are overlain with thin accumulations of veneer Pleistocene and/or Holocene Quaternary clastic sediment. The youngest units may be only several feet thick, but can reach a thickness of 61 m (200 ft) in locally specific areas (MMS 2009). Paleozoic age subsurface strata have been examined only through seismic, gravity, or magnetic data; and areas such as the Northeast Chukchi Basin appear to have a carbonate to clastic stratigraphic thickness ranging up to 9,140 m (29,987 ft) (Sherwood et al. 2002).

3.1.1.2 Seafloor Sediments and Geology

At the seismic permit area's boundaries, the Herald Arch is an overthrust zone, characterized with Cretaceous and Tertiary rocks containing shale diapers, and is exposed onshore on the Cape Lisburne Peninsula, extending offshore in a northwesterly trend toward the Russian Chukchi (MMS 2009 and Wilson 1982). The Barrow Arch is an extension of the Beaufort Sea continental shelf, trends northeast to southeast, and was formed during a period of low sea level (MMS 2009). The Chukchi and Arctic Platforms are relatively shallow shelves and flank the Hanna Trough. The Hanna Trough trends generally north to south and is a branch of the east to west trending Colville Basin of northern Alaska (MMS 2009).

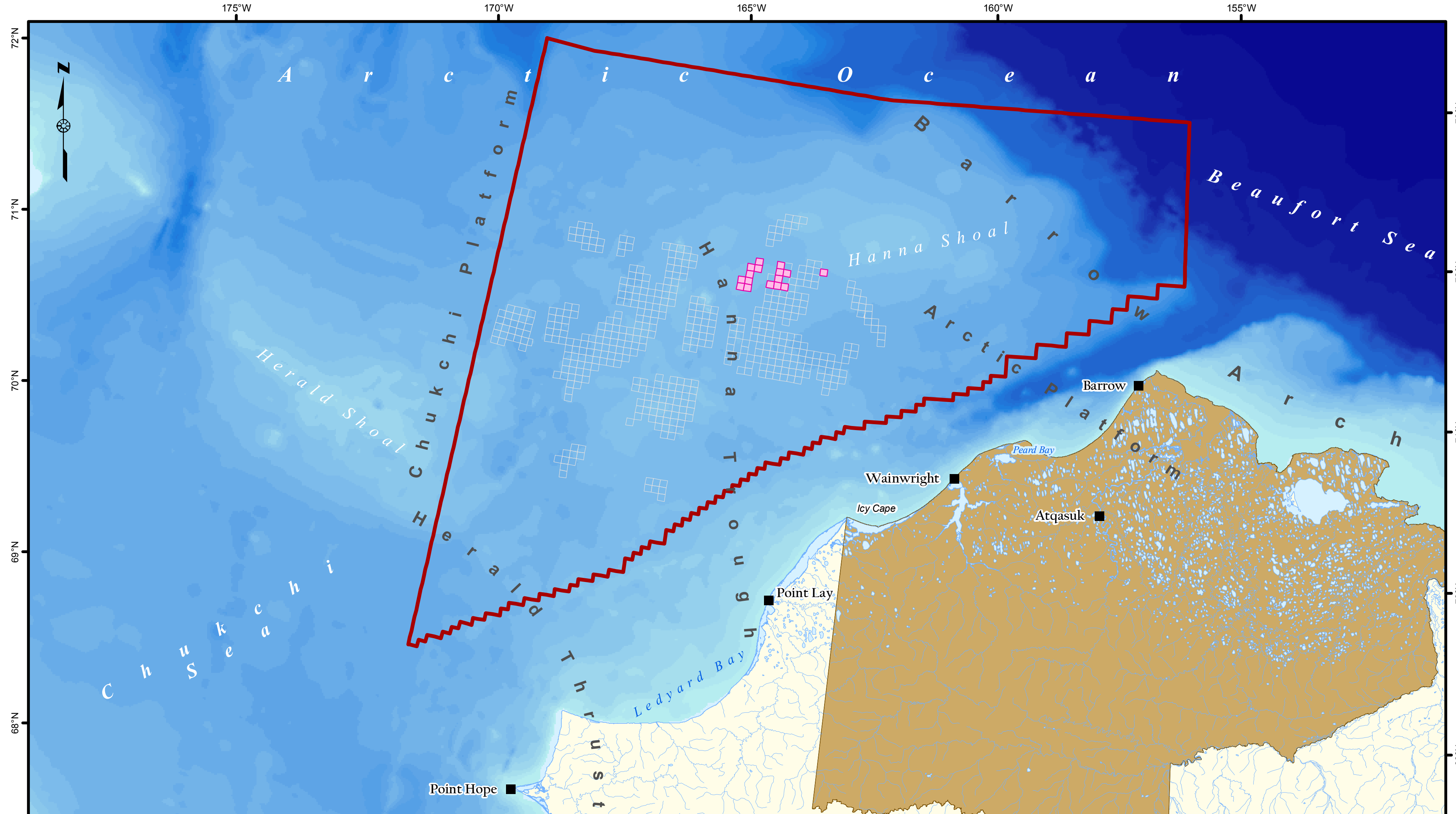
Annually, the seismic permit area can expect 0.15–0.25 centimeters (cm) (0.06–0.10 inches) of modern sedimentation, as opposed to the nearshore areas, which have little to no modern sedimentation (MMS 2009). Modern deposition is composed primarily of sediment from the Yukon and other rivers that is carried by the Alaska Coastal Current. Bioturbation creates largely unsorted, homogeneous, poorly layered sedimentation. This silt and clay are found over much of the Chukchi Shelf; higher concentrations are found west of Cape Lisburne and in the central Chukchi Shelf area (MMS 2007).

Sand deposition is sparser than silt and clay in the Chukchi Sea and can be found primarily along the course of the Alaska Coastal Current, flowing to the northeast, and over the Herald and Hanna Shoals. Additionally, modern sand depositions from surrounding sea cliffs can be found near Point Lay. While most of the sand on the shoals is considered modern sedimentation, portions may be residual or relict (MMS 2007).

Gravels are found on the Herald and Hanna Shoals as well as nearshore, whereas mud predominantly covers the shallow, surficial sediments over most of the rest of the Chukchi Shelf (MMS 2009). The high gravel content on these shoals and nearer to shore is considered relict or residual, having been deposited after being resuspended by ice gouging of the seafloor or having been winnowed and submerged (MMS 2007). Gravel can also be found in the northern part of the Chukchi Shelf, where paleochannel fill is experienced more often than in the rest of the shelf; the fill is typically thicker and consists of mud, muddy sand, and gravel and was deposited during periods of sea level rise (MMS 2009).

In general, the thickness of Pleistocene sediments will be greater closer to and in the Hanna Trough and nearer to shore than on the Hanna or Herald Shoal. Holocene deposits of soft, silty clay may be found on top of thicker Pleistocene deposits in previously exposed lagoons, stream channels, and recent ice gouges. These deposits are generally thin (less than 5 m [16 ft]) and may grade into sands and gravels locally. Quaternary sediments may reach a thickness of 42 m (140 ft) in the Hanna Trough, but will be nearer to 1.8 m (6 feet) on the Hanna Shoal (Sherwood et al. 2002 and MMS 2009).

Ice gouging causes the largest disturbance on the seafloor, as the project area is covered by ice 7–10 months of each year. As an ice keel drags along the seabed, it will leave linear to curvilinear gouges that can be many miles in length, 1–4 m (3–13 ft) deep, and tens of feet wide (MMS 2007. The morphology of ice gouging is influenced by "the shape of the ice keel, the type and thickness of the seafloor sediment, the type of driving force on the ice, and the relative age of the feature" (MMS 2007). Ice packs with multiple ice keels will produce parallel ice gouges as the ice pack moves. Gouges in compact sediment will be flatter and shallower than those in soft, unconsolidated sediment; they will also appear more rough and irregular on sidescan sonar recordings (MMS 2007).



Lease Owner

Statoil

All Other

Village

Lease Sale 193 Area

National Petroleum Reserve - Alaska

NAD83, Alaska Albers Equal Area.

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

GEOLOGIC FEATURES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.1.1-1

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Latitude and seafloor angle appear to amplify ice gouging density, while increasing water depth decreases its density. The eastern flank of the Barrow Sea Valley and the northeast flank of the Hanna Shoal experience relatively substantial ice gouging densities. Ice gouging on the Hanna Shoal has modified the sedimentary substrate. Finer fraction is disturbed and resuspended, while the coarser fraction is winnowed and left as a lag deposit. Similar ice gouging patterns and results are found on the Herald Shoal (MMS 2007).

Ice gouging occurrence can be relatively scattered from year to year because of the Chukchi Shelf's variable wind and complex current influences. Generally, ice gouging tends to become more erratic with increasing distance from shore, but in areas of steep slope, including shoal edges, ice gouging tends to parallel bathymetric contours (MMS 2007).

3.1.1.3 Subseafloor Geology

Below the seafloor there is a high potential for trapped oil and gas because strata under the Chukchi Sea have been folded and faulted on numerous occasions. Subseafloor oil and gas prospects include anticline, fault trap, and stratigraphic wedge-out formations (Bailey 2008).

Exploration wells previously drilled in the Chukchi Sea have encountered thermal hydrocarbons in the Ellesmerian, Beaufortian, and Lower Brookian Sequences. The Arctic Platform and Chukchi Shelf that flank the Hanna Trough are basement highs cored by the lower Paleozoic Franklinian sequence (MMS 2009). The Franklinian Basement lies under any well that has been drilled. This stratigraphic sequence was formed more than 400 million years ago. The relatively undeformed Franklinian sequence found under the Chukchi Sea is similar to that found under the eastern edge of the North Slope, which has proven oil shows (Bailey 2008).

Above the Franklinian sequence is the Ellesmerian stratigraphic sequence, aged from late Devonian to early or mid-Jurassic times. The same rock sequence can be found under other North Slope oil and gas fields such as Prudhoe Bay, Northstar, Lisburne, and Endicott (Bailey 2008). The Hanna Trough contains a thick sequence of Ellesmerian rock and appears to be an extension of the Beaufort Sea continental shelf, swinging around under the Chukchi Shelf to the north from the east-to-west aligned marine basin (Bailey 2008). Ellesmerian deposition was initially rift- or fault-driven during Late Devonian to Permian times, forming the Lower Ellesmerian sequence (Sherwood et al. 2002). Secondarily, between Permian and Late Jurassic times, sediment washed from ancient landmasses north of the present-day Beaufort Sea coastline, largely unaccompanied by faulting, forming the Upper Ellesmerian sequence (Sherwood et al. 2002; Bailey 2008).

The Barrow Arch, found south and southwest of the seismic permit area within 60 km (37 mi) of the coast, also extends from the Beaufort Sea under the Chukchi Shelf and is part of another stratigraphic sequence, the Beaufortian sequence (Sherwood et al. 2002; Bailey 2008). The Beaufortian sequence is a result of the Canada Basin rifting during the Jurassic and early Cretaceous times, which formed both the North Chukchi Basin and uneven fault blocks. Grabens and flexural downwarps sag between higher rocks and, over time, collected depositions of thick sequences of clastic sediments that, in turn, became reservoir-quality sandstone (Sherwood et al. 2002; Bailey 2008). The Kuparuk River, Alpine, and Milne Point fields are located on a Beaufortian sequence. The northern Chukchi Sea has a number of identified sags similar to these, though the variation in rock types may differ greatly from those in the Beaufort Sea (Bailey 2008).

Lastly, the Brookian sequence is also present in the seismic permit area. The Brookian stratigraphic sequence was formed as the Brooks Range emerged during the Cretaceous and Tertiary times. Sediments flowed north, mostly into the Colville Basin under the North Slope, but also over time onto the Beaufort Sea continental shelf and then into the North Chukchi Basin (Bailey 2008). As deformation folded rocks in the Colville Basin, the Hanna Trough north-trending faults were reactivated and helped to facilitate the Brookian strata structure on the Chukchi Platform (Sherwood et al. 2002).

In 1989–1990, Shell drilled the Burger well just south of the current day location of Statoil's leases, finding a major gas pool in sandstones similar to those under Kuparuk of the Beaufortian sequence. MMS estimated a possibility of greater than approximately 396,000,000 cubic m (14 trillion cubic ft) of gas in the 40-km (25-mi) diameter dome. At a depth of 2,500 m (8,202 ft), the Burger well did not penetrate rocks below the Beaufortian sequence. The Brookian sequence sandstone above the Beaufortian also showed signs of gas storage (Bailey 2008).

Lease blocks on the eastern side of the Hanna Trough are in an area with gas potential in all of the major rock sequences. A thick sequence of Ellesmerian and Brookian rocks can be found in the Hanna Trough. The Hanna Trough is a large, sunken area of Franklinian basement, with a substantial Ellesmerian strata overlay, passing up the middle of the Chukchi Shelf (Bailey 2008).

3.1.2 Climate and Meteorology

The study of climate change involves both instrumental records (e.g., meteorological stations, ship observations) and paleo proxies (e.g., tree rings, ice cores, corals, mollusk shells, pollen counts, lake and ocean sediment analysis) to provide a continuous timeline. Proxy records are extremely useful in analyzing past climate patterns since instrumental records are spatially and historically limited.

Global climate observation stations have been operational for the last two centuries, and there are more stations on land and in the Northern Hemisphere. However, since instrumentation evolves with new technology, data quality issues such as instrument calibration, station relocation, and data continuity prohibit combining some of these available historical records to create a continuous, homogenous climatological dataset.

Climate information and statistics provided in this section have been derived from instrumental records and are limited by availability (e.g., the period of record for data that are continuous and homogenous usually begins mid-20th century).

3.1.2.1 General Description

The Chukchi Sea is located in the Arctic Climatic Zone, which is characterized by freezing temperatures, sustained winds, and low precipitation. The area is subject to intense winds due to the absence of natural wind barriers. Precipitation, fog, and low visibility are common throughout the summer. Wind speeds increase from July–October, and gale-force (greater than 34 knots (39 miles per hour [mph]) winds are often present. Increased storm frequency and the onset of freezing usually occur in October. High-wind events and blizzards are also common from December–March. Climate and weather patterns play an important role in sea ice conditions, especially ice extent, concentration, and thickness. The movement of sea ice is also greatly influenced by pressure systems and wind patterns.

The open water season in the Chukchi occurs between July and October, and the amount of open water increases into September, when the minimum ice extent is attained. The sea ice typically begins to clear in late May, melting from south to north. The sea ice tends to clear out of the area each melt season and is replaced with new ice that thickens into first-year ice during the winter. Freezeup usually begins in October, when the pack ice advances southward and fast ice forms along the shore. Refer to Section 3.1.4 Sea Ice for additional information regarding sea ice.

Climate and sea ice conditions can be highly variable and are subject to change from natural and anthropogenic (human-caused) forcings. Scientists have identified natural climate mechanisms that occur in cycles, and climatologists and meteorologists are able to apply this knowledge to strengthen the accuracy of their short- and long-term predictions or forecasts. The climate mechanisms influencing Alaska's climate include the Arctic Oscillation (AO), the Pacific Decadal Oscillation (PDO) and the El Niño-Southern Oscillation (ENSO). These mechanisms facilitate atmosphere-ocean processes or feedback loops that can amplify warming or cooling trends (e.g., the warm phase of the AO tends to reduce sea ice cover and initiate a feedback loop that results in surface warming and further reduction in sea ice cover).

3.1.2.2 Factors Affecting Climate

The difficulty of determining climate trends and measuring global climate change lies in the complexity of gauging what changes are due to the various interactions and cycles that naturally occur between the ocean, land, and atmosphere and which are due to anthropogenic processes. While there is general agreement that human activity can have an effect on climate change, the earth's climate is naturally ever-changing and will continue to change due to its cyclical variations and processes. Climate variability is influenced by natural forcings such as changes in the earth's orbital cycle, sunspot activity, continental drift, and volcanic eruptions. It is also affected by anthropogenic forcings, such as fossil-fuel burning that produces gases and aerosols, and land use or land cover change (e.g., deforestation, urbanization).

Distinguishing the magnitude of these two causes remains a challenge for scientists today as the earth has not experienced many of these cycles during the period of reliable observations—about 50–100 years (Bond et al 2010).

Paleoclimatology studies the larger time scales (centennial–millennial) of climate change, including the occurrence and duration of ice ages, which are attributed to variations in the earth's orbital parameters. Variations that occur with each cycle of the earth's orbital parameters include precession—the direction of the earth's axis at closet and farthest approaches (23,000 year cycle); obliquity—the tilt of the earth's axis (41,000 year cycle); and eccentricity—the shape of the earth's orbit around the sun (100,000 year cycle) (Shulsky and Wendler 2007). These variations affect the amount of solar radiation received at the earth's surface and in turn affect the surface temperatures and climate regimes.

Climate change in Alaska due to regional climate mechanisms tends to occur in cycles, which range from annual (seasonal changes), interannual–decadal (El Niño), multi-decadal–centennial (AO and PDO). In addition to these climate mechanisms, Alaska's climate is subject to change from processes that occur on the scale of thousands of years.

El Niño/La Niña Effects on Alaska's Climate

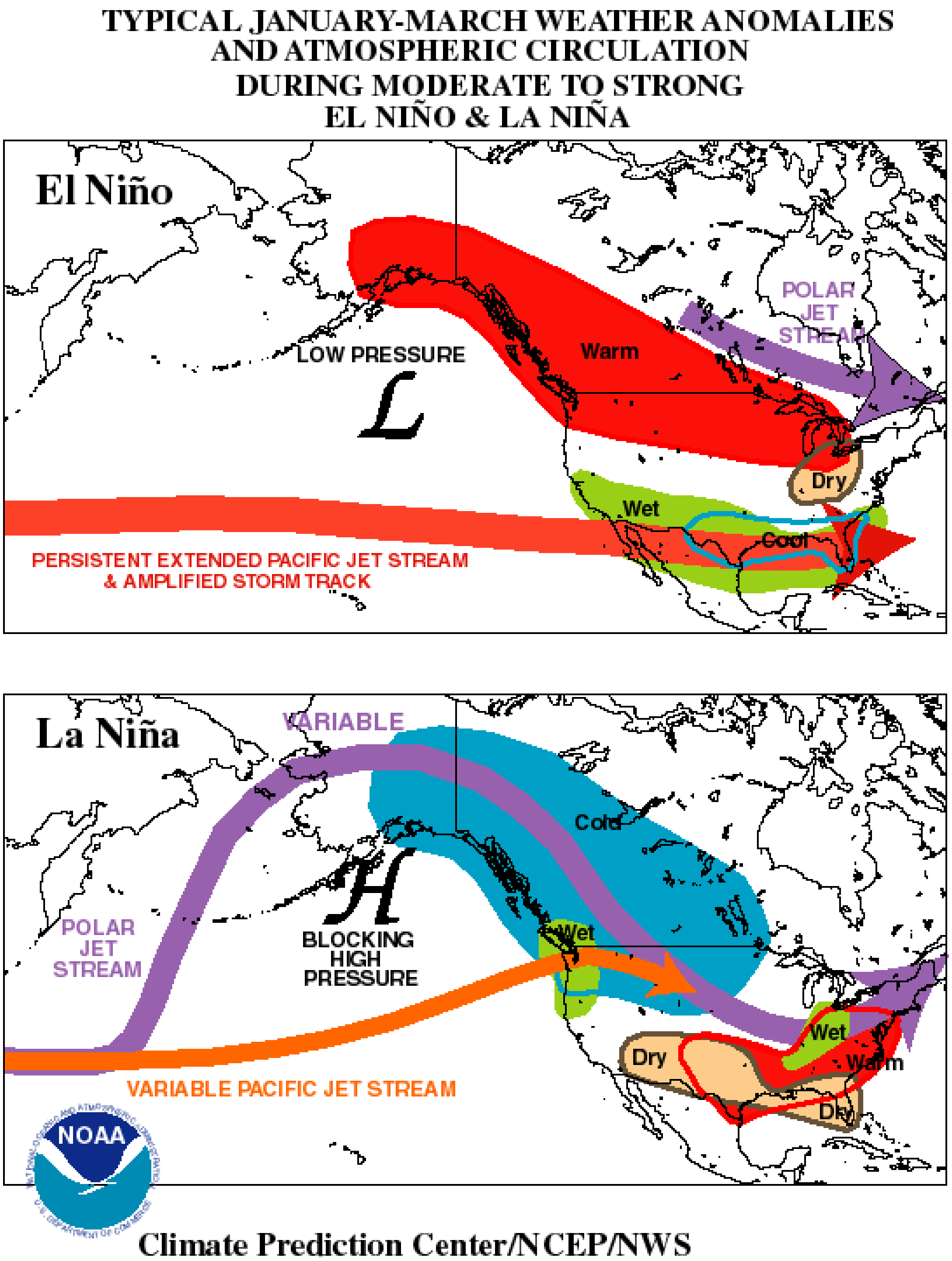
ENSO is a coupled ocean-atmosphere process with warm (El Niño) and cool (La Niña) phases that typically occur at irregular intervals every 2–7 years. The intensity of an El Niño event is indexed by the Southern Oscillation Index, which is the pressure gradient between Tahiti and Darwin, Australia (Bond et al. 2009). El Niño is characterized by warmer Equatorial Pacific waters, and La Niña is indicated by cooler ocean temperatures in this region.

El Niño events affect temperature and precipitation patterns across the globe (mostly warming), and there is a resulting strong, positive temperature anomaly for the eastern two-thirds of Alaska, most prominent during the winter (Figure 3.1.2-1). The effects of El Niño events on Alaska are quite variable, and comparison of each event shows strong similarities as well as significant differences regionally and statewide and at different timescales (i.e., strong El Niños have shown both minor and major effects on temperature and precipitation at different locations across Alaska) (Papineau 2005).

Although there are differing opinions on defining an El Niño event, a 0.5 degrees Celsius (°C) (33° Fahrenheit [°F]) temperature anomaly is often used as the threshold for *moderate,* and a 1.0°C

(34 F) anomaly for *strong*. Using these definitions, there were approximately 17 warm events (eight strong, nine moderate) in Alaska between 1955 and 2006. There were approximately 11 cold events (five strong, six moderate) in Alaska during the same time period (Redmond 2010).

Figure 3.1.2-1 El Niño and La Niña Effects on Alaska



Source: National Weather Service

In western Alaska and along the Arctic coast, the effects of El Niño tend to be less prominent. This is due to the tendency for a higher frequency of atmospheric pressure ridges to form over the eastern Gulf of Alaska and western Canada during the winter (Figure 3.1.2-1). As a result, more storms progress up the west side of the ridge into Southcentral Alaska, bringing warmer temperatures and, often, increased cloud cover and precipitation. The strength of the El Niño events affects how these ridges and the Aleutian Low shift (usually to the east). The Aleutian Low is a semi-permanent low-pressure center located near the Aleutian Islands during the winter. The stability of the ridge location tends to influence temperature variability (low stability—warmer temperatures; high stability—near normal or cooler temperatures west of 145° west [W]) (Papineau 2005).

La Niña tends to produce the opposite effects of El Niño, bringing strong negative temperature anomalies across Alaska (Shulsky and Wendler 2007). La Niña events cause increased winter ridging between the eastern Bering Sea to the western Gulf of Alaska (170°W and 150°W). Similar to El Niño, the position and stability of the ridge affects the statewide distribution of warmer or cooler temperature anomalies (i.e., a ridge centered near 160°W tends to produce warmer temperatures with cloud-free conditions west of the ridge and cooler temperatures east of the ridge) (NOAA 2009).

The Influence of the AO and PDO on Alaska

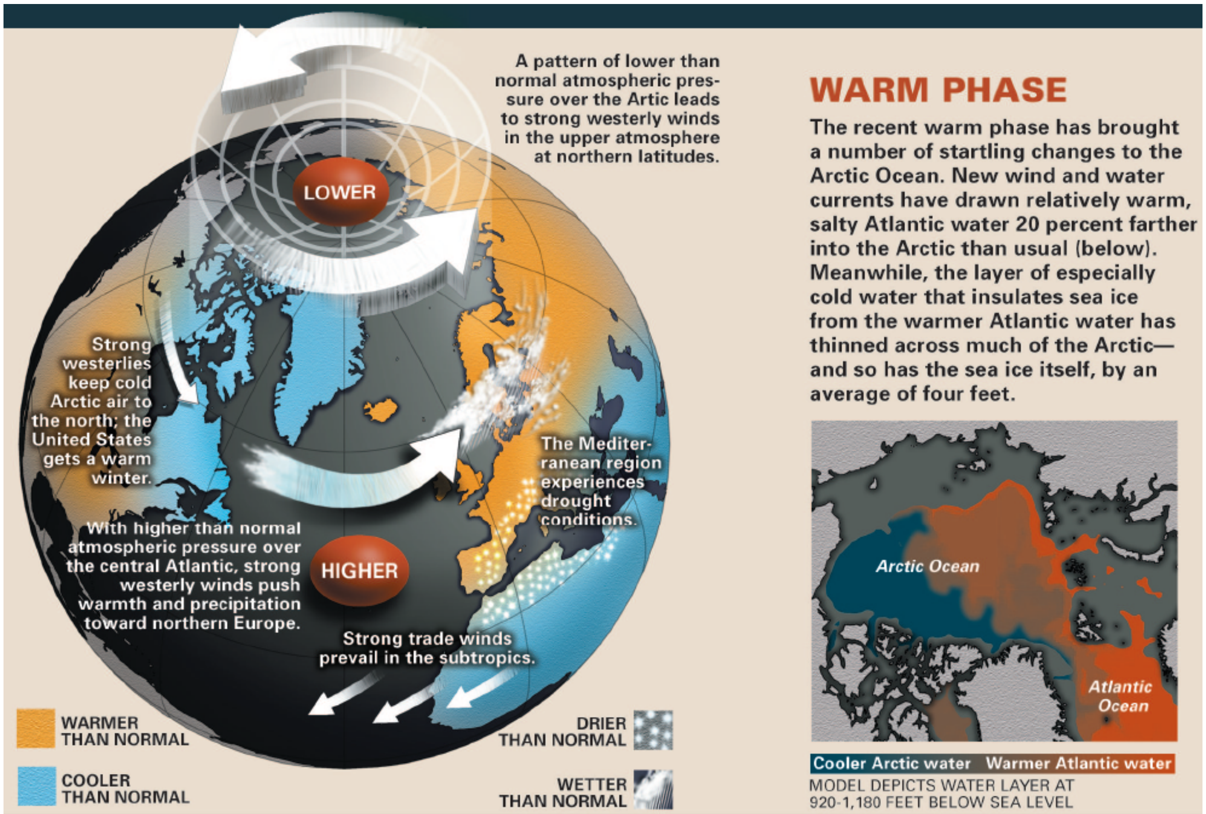
Arctic Oscillation

The AO refers to the net feature exhibiting a fluctuation of the atmospheric pressure at polar and mid-latitudes, between positive and negative phases, which in turn affects the winter atmospheric circulation, air surface temperature, and surface precipitation over the Northern Hemisphere (Lohmann et al. 2005). The low index or negative (cold) phase is characterized by higher than normal polar sea-level pressure, weaker westerlies and trade winds, and colder winters in North America and Europe.

The high index, or positive (warm), phase is characterized by below-normal polar sea-level pressure, enhanced surface westerlies in the north Atlantic, warmer and wetter than normal conditions in northern Europe, and stronger trade winds at lower latitudes. Higher mid-latitude pressures force ocean storms farther north and bring wetter weather into Alaska, Scotland, and Scandinavia and drier weather into the western United States and the Mediterranean.

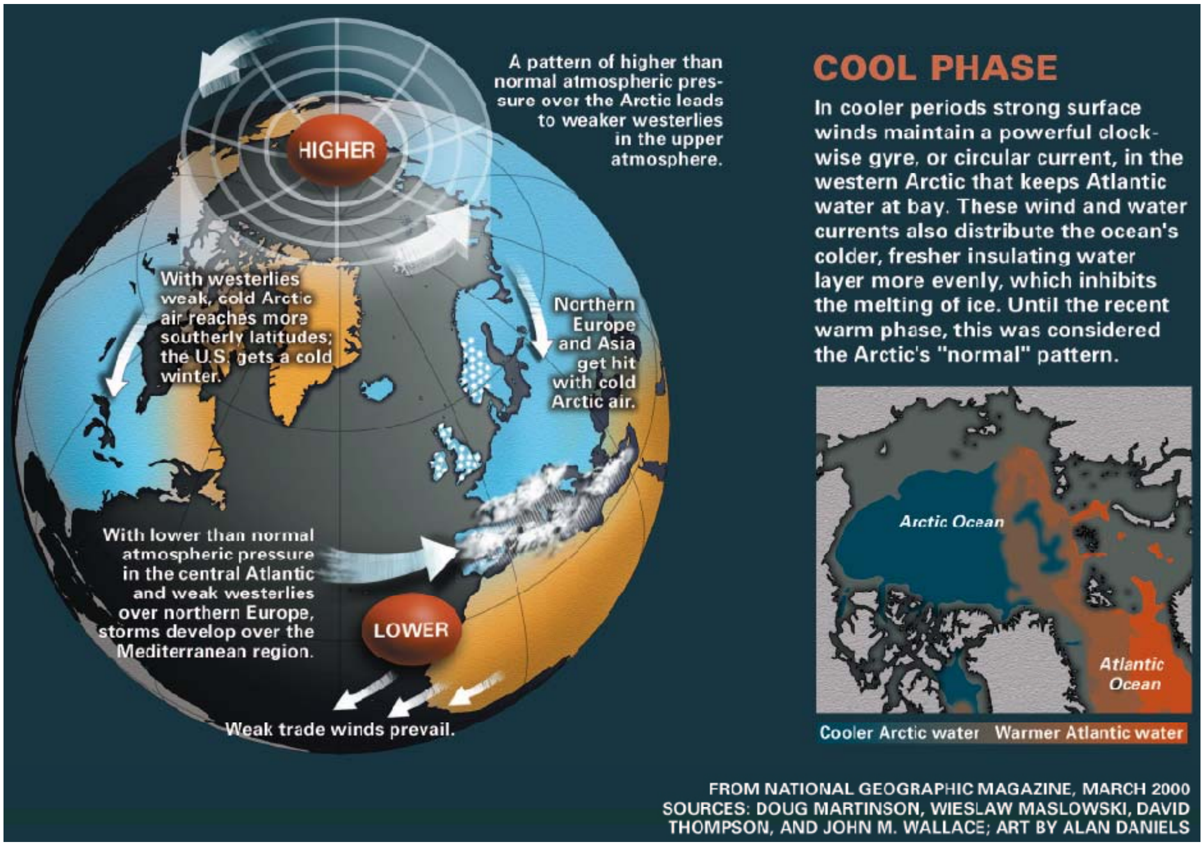
See Figures 3.1.2-2 and 3.1.2-3 for graphical depictions of the positive and negative phases, which tend to create opposing weather patterns (Stewart 2005).

Figure 3.1.2-2 Positive (warm) Phase of the Arctic Oscillation



Courtesy of Todd Mitchell, Joint Institute for the Study of the Atmosphere and Ocean (JISAO), 2004

Figure 3.1.2-3 Negative (cool) Phase of the Arctic Oscillation



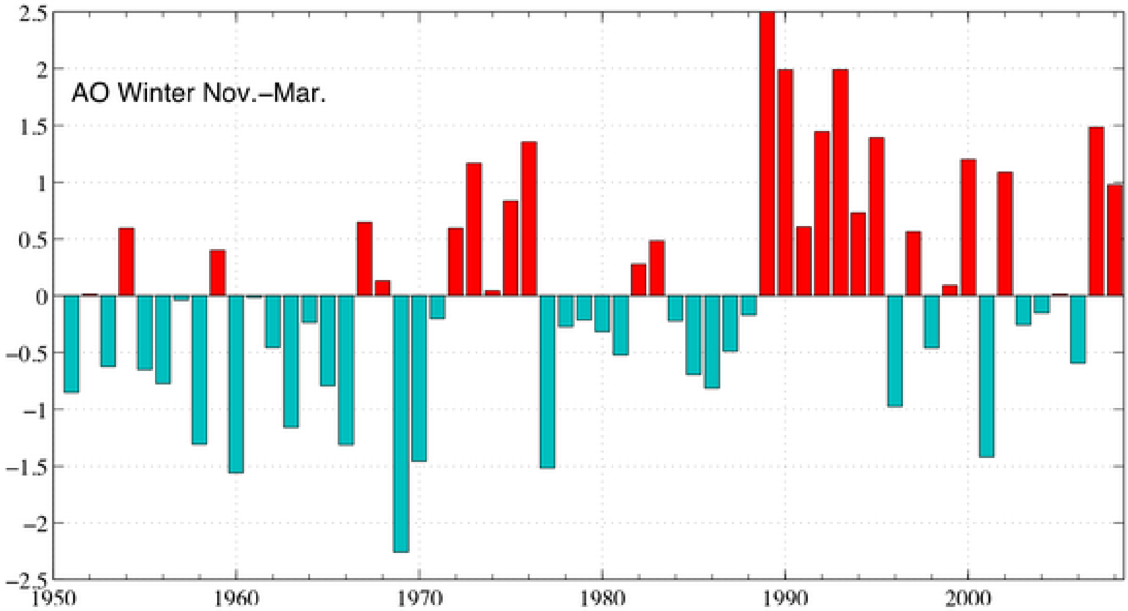
Courtesy of Todd Mitchell, JISAO, 2004

Although the AO does influence climate patterns in northern Alaska, the correlation between the AO index and North Slope temperatures is weak, and the AO index is not as solid of a numerical measure of climate forcing in the western Arctic as it is in the eastern Arctic. The AO does, however, indicate conditions that promote either an increase or decrease in Arctic Ocean ice extent (i.e., an influx of warmer Atlantic water during a positive phase promotes sea ice loss). Since the polar region acts as a global heat sink, the warm phase tends to trigger natural feedback loops that can amplify the regional warming trends. The snow and ice cover is reduced and the increase in open water, which has a lower albedo, amplifies solar energy absorption, which in turn adds to surface warming and additional sea ice loss. This cycle continues, furthering reduction in sea ice cover.

Figure 3.1.2-4 depicts the tendency for the AO to remain in one phase for a period of time with relatively short interruptions. The AO tends to alternate between phases, but there are notable episodes of distinct prolonged warm periods (late 1970s and 1989–1994) and cool periods (1950–early 1970s and 1977–1988) . Since 2000, the AO has been quite variable, rapidly alternating between positive and negative phases (Arctic Change 2010).

The PDO index strongly correlates with temperatures across Alaska and is a useful tool for climate predictions in the region (Papineau, NWS 2009). It is also useful in explaining Alaska's changing sea ice conditions due to the increased influx of Pacific waters through the Bering Strait.

Figure 3.1.2-4 The Arctic Oscillation in Winter (November–March)



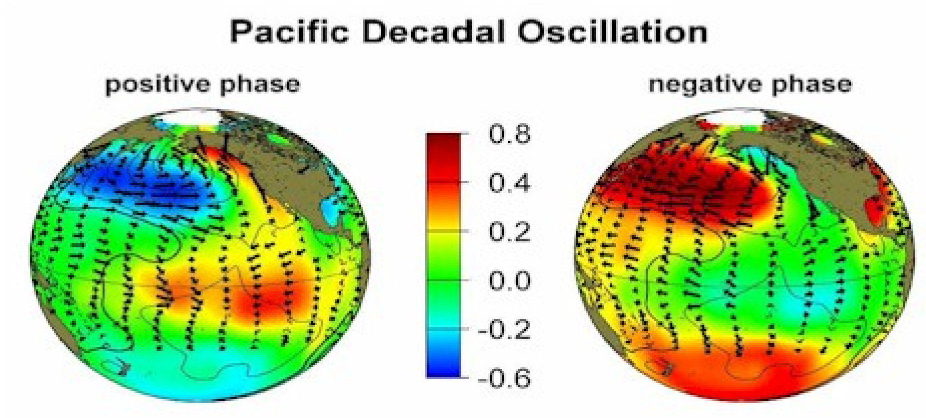
Courtesy of Arctic Change
Values are averaged over the months of May through September. Red bars Indicate positive (warm) years; blue bars negative (cool) years. Note that 2008 was the most negative since 1956

PDO

The PDO is a statistical measure of sea surface temperature (SST) anomalies in the North Pacific and was discovered because of its effects on the marine ecosystem, namely salmon fisheries. Positive (warm) PDO indices correlate with cold anomalies in the central North Pacific and warm anomalies in the Gulf of Alaska and the Pacific Northwest. Warm phases contribute to high salmon production in Alaska and low salmon production along the west coast of the continental United States. The ocean circulation patterns in the Gulf of Alaska during these periods transport warm Pacific waters through the Bering Strait into the Arctic Ocean, where the increased temperatures contribute to sea ice loss.

This pattern is reversed during negative PDO phases, presenting warm anomalies in the central North Pacific and cold anomalies in the Gulf of Alaska and along the North American coast (Papineau 2005). Additionally, low salmon production is noticed in the Gulf of Alaska, and high salmon production occurs along the west coast of the contiguous U.S. Figure 3.1.2-5 depicts the opposing patterns of SSTs, sea level pressure, and surface winds during the positive and negative phases.

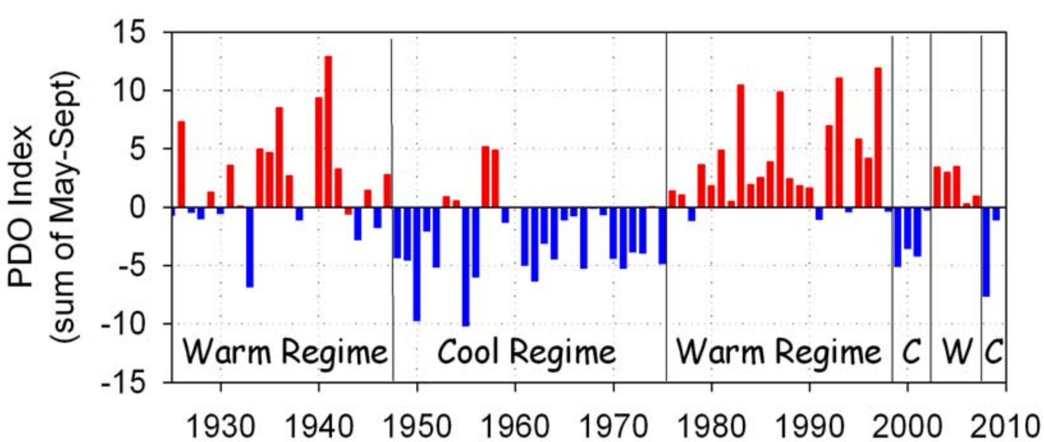
Figure 3.1.2-5 SST Opposing Patterns



Typical wintertime SSTs (colors), sea level pressure (contours), and surface windstress (arrows) anomaly patterns during warm and cool phases of PDO (JISAO 2005)

There is also some correlation between the strength of El Niños and which phase the PDO is in at the time of occurrence. Although there is great variability, El Niños that occur during negative PDOs generally tend to produce slightly cooler than normal temperatures, and those that occur during positive PDOs tend to be warmer than normal, relative to other El Niños. On the other hand, it appears La Niñas that occur during negative PDOs tend to cause cooler temperature anomalies that rarely occur during a positive PDO (Papineau, NWS 2009).

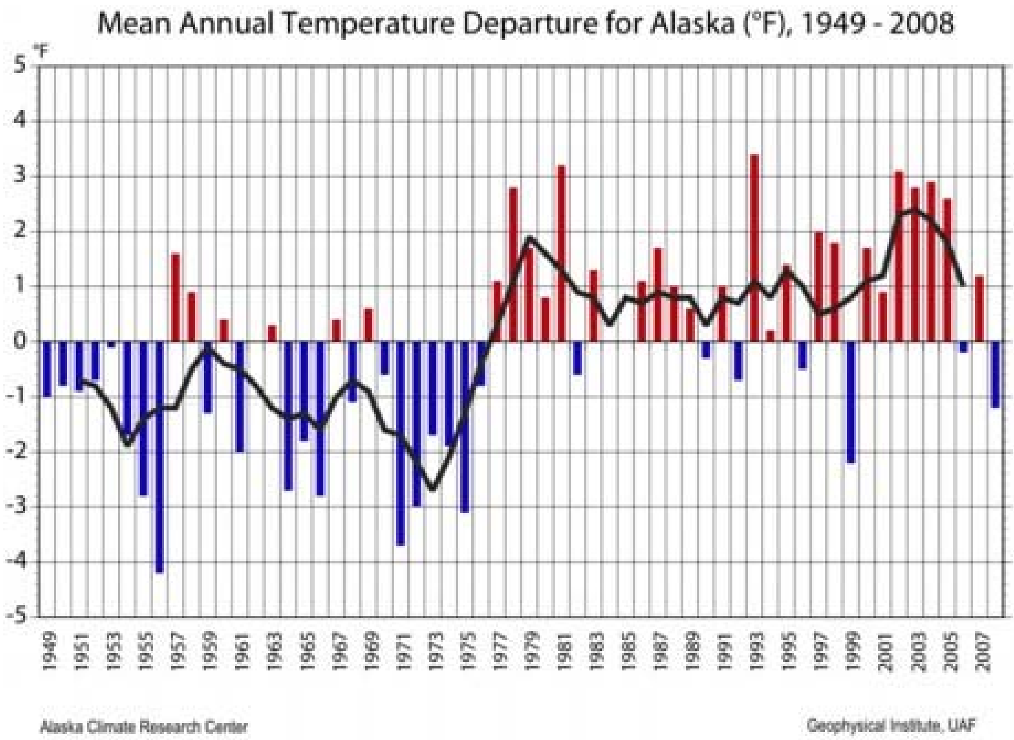
Figure 3.1.2-6 Shifts in Phase of the PDO, 1925–2008



(Northwest Fisheries Science Center)
Values are averaged over the months of May through September. Red bars Indicate positive (warm) years; blue bars negative (cool) years. Note that 2008 was the most negative since 1956

Given the high variability of El Niños' effects on temperature and precipitation, it is very difficult to predict future conditions since similar patterns have produced opposite effects in the past. On the other hand, La Niñas' effects on temperature and precipitation are relatively predictable, and exceptions have been rare.

Figure 3.1.2-7 Temperature Anomalies in Alaska



(Alaska Climate Research Center)
Note how the positive anomalies (red) tend to coincide with the positive phases of the PDO (in red, Figure 3.1.2-5).

The PDO experienced a significant shift from a negative phase to a positive phase in 1976, causing a rapid transition to warmer winters in western North America compared to primarily cold winters from 1947–1976, as shown in Figures 3.1.2-6 and 3.1.2-7 (Papineau 2001, Hartman and Wendler, 2005). Indications are that the PDO may be reversing phases again as the index values have been negative for the past several years, with a distinct switch in 2007.

Although the causes of the PDO are not fully understood, information derived from its multi-season and multi-year presence improves climate forecasts. The PDO index measures the strength of the SST anomalies and is a good indicator of the magnitude of the expected temperature anomalies (i.e., a large positive PDO index will result in greater temperature increases). Climatologists are able to recognize climate patterns and predict their influence on regional and global scales. Meteorologists can likewise apply this information for greater accuracy in long-range and short-range forecasting.

3.1.2.3 Air Temperatures

The project area is dominated by subfreezing temperatures most of the year. Winter mean air temperatures range from -18°C to -27°C (0°F to -16°F), with extremes of -46°C (-50°F) and colder. Summer air temps average 2–9°C (35–47°F), with highs that can get up to the mid-20s°C (mid-70s°F). Table 3.1.2-1 shows the minimum, mean, and maximum air temperatures for Barrow (Alaska Climate Research Center, 2008 and MMS 2007).

Summer ice melt patterns are influenced primarily by an influx of warmer water from the Bering Sea, which initiates in the eastern portion of the Chukchi Sea and then progresses westward. Freezeup is delayed until October because of the warmer inflow (MMS 2007). Ice growth in open water and in leads is heavily influenced by surface air temperature, while the heat balance of multi-year ice is predominately controlled by the radiation balance (Rigor et al. 2000).

TABLE 3.1.2-1 Barrow Mean, Maximum, and Minimum Temperatures (°F) (1901–Present)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean Temp °F	-13.7	-15.9	-13.7	-0.5	20.1	35.0	40.4	38.7	31.2	14.6	-0.9	-10.6	10.4
Max Temp °F	-7.7	-9.8	-7.4	6.3	24.9	39.5	46.5	43.6	34.8	19.3	4.6	-4.7	15.8
Min Temp °F	-19.6	-22.0	-20.0	-7.3	15.3	30.4	34.3	33.8	27.5	9.8	-6.4	-16.4	5.0

Source: Alaska Climate Research Center, 2008
°F = degrees Fahrenheit

3.1.2.4 Sea Surface Temperatures

AO is responsible for 74 percent of the summer warming over the eastern Arctic Ocean and 14 percent of the cooling during the winter in the western Arctic. In general, it is responsible for more than half of the sea surface temperature trends over the Arctic (Rigor et al. 2000 and Cavalieri et al. 2003)

In recent years, the increase in ice-free water as the sea ice melts in the summer has facilitated sea surface warming. Throughout the Bering Strait and Chukchi Sea, surface temperatures rose from -16 to -15°C (3–5°F) based on the 100-year average (University of Washington 2007). Sea ice acts as sea surface insulation from air temperature, winds, and most importantly ultraviolet rays from the sun.

Warming sea surface temperatures have a spiraling effect—not only does the surface get warmer in the summer, but sea ice takes longer in the fall and winter to redevelop and will generally not come back as thick (University of Washington 2007).

3.1.2.5 Pressure, Precipitation, Obstructions to Visibility and Fog

Sea level pressure in the Arctic is primarily influenced by AO (Thompson and Wallace 1998). Table 3.1.2-2 shows average sea level pressures near Barrow. Air circulation in the Arctic is dominated by a region of high pressure generally located over the Beaufort Sea. The Siberian High is south and west of the Beaufort High. Low-pressure systems, with strong southeast (SE) winds, occasionally move northeast (NE) through the Bering and Chukchi seas into the Arctic basin, bringing unseasonably warm air and moisture to the region. These eastern-moving, western-Pacific storms generally stay south of the Bering Sea, but occasionally a low pressure system will travel north (MMS 2007).

TABLE 3.1.2-2 Barrow Monthly Mean, Maximum, and Minimum Sea Level Pressure (Inches) (1971–2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	30.07	30.12	30.14	30.10	30.06	29.96	29.95	29.89	29.90	29.92	29.97	30.04
Max	30.66	30.71	30.66	30.56	30.43	30.28	30.27	30.26	30.32	30.40	30.51	30.68
Min	29.44	29.56	29.63	29.65	29.67	29.57	29.59	29.48	29.44	29.39	29.40	29.41

Source: Alaska Climate Research Center 2008

Western-Pacific low-pressure systems, though not common, occur more often in the summer. These systems come up through the Bering Sea and follow the northwestern Alaskan coast, bringing cloudy skies, frequent precipitation, and southwesterly winds. During the winter, a ridge of high pressure is more commonly present, linking the Siberian High and high pressure over the Canadian Yukon (MMS 2007).

Measurable precipitation falls 200–300 days each year in the Chukchi Sea; however, the amounts are typically light. July, August, and September have the heaviest precipitation, totaling an average of 2–4 inches per month (U.S. Department of Commerce et al. 2008). The *Climatic Atlas* shows some type of precipitation or obstruction to visibility occurring 44–64 percent of the time from June–November (NOAA and NCDC 2008). Forms of precipitation range from rain to freezing rain or blowing snow. Table 3.1.2-3 shows Barrow mean monthly precipitation.

Freezing rain and fog can lead to superstructure icing, primarily when air temperatures are less than 0°C (32°F) and wind speeds are greater than 10 knots. Snow can fall at any time of the year, beginning regularly in September and occurring 26 percent of the time (U.S. Department of Commerce et al. 2008).

Fog is the main restriction on visibility during the summer months, primarily June through September. During the winter months, poor visibility is due to a high frequency of snowstorms. Low visibility during the winter is evident 10–15 percent of the time, a significantly smaller rate than during the summer because snowstorms do not occur as often in the winter as fog does in the summer (MMS 2007).

In July and August, visibilities drop below 2 mi 10–25 percent of the time, and below 0.5 mi 5–20 percent of the time (U.S. Department of Commerce et al. 2008). However, fog tends to decrease with proximity to the coastline (MMS 2007). Fog is present about 26 percent of the time from June through August and drops to 18 percent in September and 11 percent in November (U.S. Department of Commerce et al. 2008). Table 3.1.2-4 shows visibility of less than 2 nm off Barrow.

Visibility less than 4 km (2 nm) occurs 20 percent of the time in June and 30 percent in July. Visibility is less than 9 km (0.5 nm) 10 percent of the time in June and 18 percent in July. Visibility less than 4 km (2 nm) occurs 16–18 percent of the time in August and September and is less than 0.9 km (0.5 nm) 8–10 percent of the time (U.S. Department of Commerce et al. 2008). Table 3.1.2-5 shows visibility of less than 2 nm off Cape Lisburne.

TABLE 3.1.2-3 Barrow Mean Rain, Mean Snowfall, and Mean Snow Depth (Inches) (1901–Present)

Measured in Inches	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean Precip.	0.12	0.12	0.09	0.12	0.12	0.32	0.87	1.04	0.69	0.39	0.16	0.12	4.16
Mean Snowfall	2.0	1.9	1.7	2.1	1.7	0.8	0.2	0.9	5.0	7.4	3.2	2.2	29.1
Mean Snow Depth	9	10	11	11	6	1	0	0	1	4	7	8	6

(Source: Alaska Climate Research Center, 2008)

TABLE 3.1.2-4 Visibility of Less than 2 Nautical Miles Percent Frequency in Coastal Area off Barrow

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Visibility < 2 Nautical Miles	16.7	12.6	7.6	12.2	9.4	18.5	29.1	21.7	19.5	17.1	9.7	10.0	21.4

(Source: U.S. Department of Commerce et al. 2008)

TABLE 3.1.2-5 Visibility of Less than 2 Nautical Miles Percent Frequency in Coastal Area off Cape Lisburne

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Visibility < 2 Nautical Miles	33.3	33.3	25.0	33.3	18.2	25.6	24.1	22.5	9.8	16.7	16.7	0.0	19.9

(Source: U.S. Department of Commerce et al. 2008)

3.1.2.6 Winds—Nearshore, Offshore

The average wind speed in the Chukchi Sea is 14–18 knots. High winds, 20 knots and above, tend to occur during the winter months near the coast. Gale winds have generally been recorded up to 1 percent of the time in the project area from July through October. Strong gale winds, with speeds greater than 48 knots, have also been present up to 1 percent of the time in June, August, and September (U.S. Department of Commerce et al. 2008). Hurricane strength winds greater than 64 knots (74 mph) have also been recorded in this region.

Prevailing northerly winds are found during the winter (November –March), ranging from northwest to northeast across the Chukchi Sea. In the summertime (June – September), winds may alternate between north and south. Coastal surface winds between Barrow and Point Lay most commonly blow from the northeast. Further south, at Cape Lisburne, winds generally blow from the east and southeast (MMS 2007). Table 3.1.2-6 shows the wind direction in three villages along the Chukchi Sea coast: Barrow, Wainwright, and Point Hope. Table 3.1.2-7 shows the average wind direction offshore of Barrow and Cape Lisburne.

Periods of high wind may occur at open sea, but most often occur closer to the shore. Coastal winds generally range from 8–16 knots, but may be sustained for periods of time at much greater speeds, with gusts recorded at up to 56 knots. Table 3.1.2-8 shows the average wind speed for Barrow, Wainwright, and Point Hope. During the October 1963 storm in Barrow, winds gusted at 65–74 knots, with sustained winds reaching 48 knots. The storm surge reached 10 ft. Wave-induced erosion occurs along the coast and can result in rapid shifts in open water ice packs (MMS 2009).

TABLE 3.1.2-6 Average Coastal Village Wind Directions along the Chukchi Sea (1996–2002)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Barrow	ENE	E	E	E	E	E	E	E	E	E	E	ENE	E
Wainwright	E	E	E	E	E	E	W	E	E	E	E	E	E
Point Hope	N	N	N	N	N	N	S	N	N	E	NNE	N	N

(Source: Alaska Climate Research Center, 2008)
E = east
ENE = east-northeast
N = north
NNE = north-northeast
W = west

TABLE 3.1.2-7 Average Wind Directions in Coastal Areas off Barrow and Cape Lisburne

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Coastal Area off Barrow	W	N	NE	E	E	N	E	E	E	NE	E	E	E
Coastal Area off Cape Lisburne	SE	N	W	W	N	SE	SE	N	NW	N	NE	N	NW

(Source: U.S. Department of Commerce et al. 2008)
E = east
N = north
NE = northeast
NW = northwest
SE = southeast

TABLE 3.1.2-8 Average Coastal Village Wind Speeds (Knots) along the Chukchi Sea (1996–2002)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Barrow	10.9	11.4	11.0	11.2	10.4	9.9	11.0	11.6	10.6	11.6	12.3	11.3	11.1
Wainwright	8.9	9.9	10.6	10.9	9.8	9.6	10.3	10.9	9.6	10.6	9.9	8.7	10.0
Point Hope	14.3	13.4	12.3	10.9	10.3	10.8	11.6	13.4	14.0	14.3	15.2	14.1	12.9

(Source: Alaska Climate Research Center, 2008)

3.1.2.7 Wave Heights

Waves in the Chukchi Sea are generally less than 2 m (6 ft) in height. Wave heights between 3–4 m (10–12 ft) have been observed only 1 percent of the time between July and October; the same is true for wave heights between 4–6 m (13–19 ft) (NOAA and NCDC 2008).

Wave height is directly affected by ice cover and wind speed. The presence of sea ice cover drastically reduces or eliminates waves. After freezeup, waves will be found only in localized leads and will be much smaller than waves occurring with similar wind speeds in open water.

Wave height has a direct positive correlation with wind speed, especially in open water; Table 3.1.2-9 shows probable wave heights based on wind speed, demonstrating the relationship between high wind speeds and increased wave height during periods of open water. Tables 3.1.2-10 and 3.1.2-11 show the percentage of time wind speeds are calculated at greater than 33 knots and wave heights are observed to be greater than 3 m (9 ft). It is important to mention that these data are submitted by vessels in transit, and as ships tend to avoid bad weather if possible, the results are biased toward good weather samples (U.S. Department of Commerce et al. 2008).

TABLE 3.1.2-9 Probable Wave Heights Based on Wind Speed

Miles Per Hour	Knots	Wind Force (Beaufort)	Probable Wave Height (ft)
0–1	0–1	0	-
1–3	1–3	1	¼
4–7	4–6	2	½
8–12	7–10	3	2
13–18	11–16	4	4
19–24	17–21	5	6
25–31	22–27	6	10
32–38	28–33	7	14
39–46	34–40	8	18
47–54	41–47	9	23
55–63	48–55	10	29
64–72	56–63	11	37
73+	64+	12	45

(Source: U.S. Department of Commerce et al. 2008)

TABLE 3.1.2-10 Wind Speed and Wave Height Percent Frequency in Coastal Area off Barrow

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Wind >33 knots	0.8	0.0	0.0	2.9	0.4	0.5	0.5	0.5	1.2	1.8	3.5	1.7	1.0
Wave height >9 ft	0.0	0.0	0.8	2.6	0.0	0.0	0.6	0.3	1.9	0.8	7.1	0.0	1.0

(Source: U.S. Department of Commerce et al. 2008)

TABLE 3.1.2-11 Wind Speed and Wave Height Percent Frequency in Coastal Area off Cape Lisburne

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Wind >33 knots	0.0	0.0	0.0	0.0	0.0	0.7	0.4	0.7	1.7	5.8	3.4	27.3	1.4
Wave Height >9 ft	25.0	0.0	50.0	0.0	0.0	0.0	1.2	3.0	8.4	11.4	28.6	44.4	4.5

(Source: U.S. Department of Commerce et al. 2008)

3.1.2.8 Superstructure Icing

The accretion of sea ice on vessels or structures depends on sea conditions, atmospheric conditions, and the ship's size and behavior. Icing can also be caused by heavy sea spray, freezing rain, or fog. Significant ice accumulation can greatly increase a vessel's weight and elevate the center of gravity, making it top-heavy and difficult to control with regard to speed and direction.

The likelihood of superstructure icing increases when low air and sea surface temperatures are combined with sustained high winds. These conditions are common in the Chukchi Sea region, especially in September and October, when icing is expected to occur at least half the time. Icing potential increases when the air temperature falls below 0ºC (32°F), wind speed is greater than 10 knots, and the sea surface temperature is equal to or less than 5ºC (41°F). Severe (very heavy) icing can occur when air temperatures are less than or equal to -9ºC (16°F) and wind speeds are equal to or greater than 34 knots.

A superstructure icing nomograph is used to forecast spray ice accumulation using air temperature, surface wind, and sea temperature. The National Weather Service issues superstructure icing forecasts in Alaska. There are three categories:

- Light—0.1 to 0.8 inches of ice accretion/3 hours
- Moderate—0.8 to 2.4 inches/3 hours
- Heavy—greater than 2.4 inches/3 hours

3.1.2.9 Storms

Wind events, periods of sustained moderate to high wind speeds, are frequent in the Chukchi Sea due to the development and movement of pressure systems in the Arctic, which are referred to as Arctic storms. On average, the Chukchi Sea will experience 6–10 storm days per month during the summer, and about 80 percent of each storm will average 6–24 hours in duration. Individual storms, however, may last 8–14 days (MMS, 2007-FEIS).

A few studies have evaluated the wind events in the region, using Barrow as the representative meteorological station (Lynch et al 2004; Papineau). Although Barrow defines the eastern limit of the Chukchi Sea, the systems that produce the wind events affect the entire Chukchi/Beaufort region.

Wind events were defined as wind speeds greater than or equal to 10 m/s (20 kts) sustained for at least 12 continuous hours, based on data from 1973–2003. The ten highest west wind events at Barrow occurred between July and October. The following conclusions were developed during the study:

1. The majority of east winds are a result of high pressure over the Arctic, and the majority of west winds resulted from low pressure systems. Easterlies occur twice as often as westerlies and increase in frequency throughout the open water period.
2. Storms tend to occur in series, with short periods between events. Consecutive systems following the same trajectory generally result in large storm surges or waves along the coast.
3. High pressure over Alaska, East Siberia, and the Chukchi Sea tends to occur between September and October.
4. Low-pressure systems develop or track over three geographical regions: Siberia and the offshore arctic islands of Eurasia; the Arctic Ocean north of 75°north (N); and the area extending from the Bering Strait across Alaska into western Canada.

3.1.3 Physical Oceanography

The Chukchi Sea is a relatively shallow (approximately 50 m [164 ft]) shelf sea that carries nutrient-rich Pacific waters through the Bering Straight into the Arctic Ocean. Factors affecting the physical oceanography of the Chukchi Sea include incoming watermasses, particularly the Bering Strait influx and the Siberian Coastal Current; atmospheric-pressure systems; surface-water runoff; density differences between watermasses; and seasonal and perennial sea ice.

Figure 3.1.3-1 depicts the circulation patterns of the Chukchi Sea, which include:

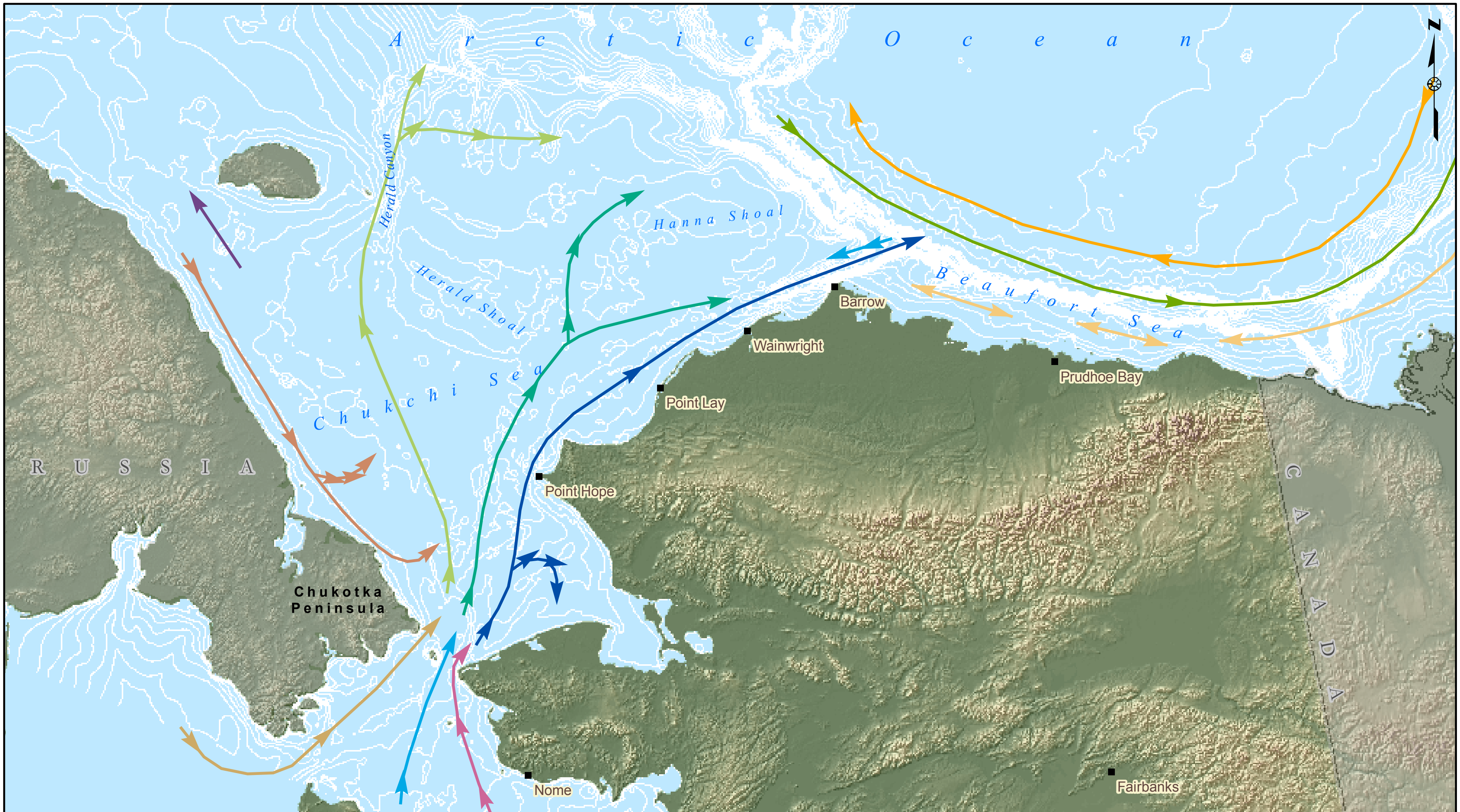
- Incoming watermasses:
  - Anadyr Water, Bering Shelf Water, and Alaska Coastal Water from the south through the Bering Strait
  - The seasonal Siberian Coastal Current from the northwest, flowing south along the Chukotka Peninsula
- Outflows: Long Strait, Herald Canyon, the Central Channel, and the Alaska Coastal Current (via Barrow Canyon), which transport the incoming watermasses northward across the Chukchi Shelf.
- Northern continental slope features:
  - The Beaufort Gyre, a wind-driven circular current that circulates near-surface water in the Arctic Ocean basin in a clockwise motion
  - The Beaufort Shelf Jet, an eastward moving shelf-break jet between the Beaufort Gyre above and the Atlantic Water below
  - The Atlantic Water (Intermediate) circulates water at depth in a counterclockwise motion

3.1.3.1 Major Topographical Features

The easterly limit of the Chukchi Sea falls around Point Barrow, Alaska, and the westerly limit coincides with the Russian Chukotka shoreline. Wrangel Island lies at the northwestern edge, with the Bering Strait to the south. The area of the Chukchi is approximately 500 km (311 mi) east to west and 800 km (497 mi) north to south. The offshore region is characterized by a broad, low-relief continental shelf, sloping slightly to the north and significantly to the northeast. Complex ridges and troughs are common nearshore where depths drop below 40 m (131 ft). The underlying bedrock and sedimentation define the bathymetry, which was further shaped by the lower sea levels during the Pleistocene and Holocene epochs. The Bering Land Bridge, a vast plain linking northeast Russia and Alaska, was formed in the Bering Strait because of recurring episodes of exposure of the continental shelf.

Topographic features within or contiguous to the lease area that influence the oceanographic circulation patterns include (Figure 3.1.3-1):

- Peaks
  - Hanna Shoal's west edge, rising to about the 20 m (66 ft) isobath
  - Herald Shoal, rising to about the 20 m (66 ft) isobath
  - Blossom Shoals, just offshore of Wainwright
  - Northwest of Point Hope, a spit-like shoal is formed along the 30 m (98 ft) isobath
- Valleys
  - One unnamed sea valley near the northwestern corner of the project area with the lowest depth in the lease area around 70 m (230 ft)
  - One unnamed sea valley in the northeastern corner of the project area with the lowest depth in the lease area around 3,000 m (9800 ft)
  - Herald Canyon, runs north between Wrangel Island and Herald Shoal
  - Barrow Canyon, follows a linear northeastern direction, offset from the coast at Point Hope, deepening toward Barrow
  - Hope Valley, a wide depression, runs in a northerly direction from the Bering Strait to Herald Canyon



Ocean Current

- Alaska Coastal
- Alaska Coastal Water
- Anadyr Water
- Beaufort Gyre
- Beaufort Shelf
- Beaufort Shelf Jet
- Bering Shelf Water
- Central Channel
- Herald Valley
- Long Strait Flow
- Siberian Coastal
- Bathymetric Contours

NAD83, Alaska Albers

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

GENERALIZED CIRCULATION OVER CHUKCHI AND BEAUFORT SEAS
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 50 100 200 Miles

FIGURE: 3.1.3-1

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3.1.3.2 Mean Flow Characteristics

Watermasses flow to the Chukchi Sea through several pathways in the Bering Strait, propelled by a northward slope in the mean sea level between the Pacific and Arctic Oceans of around 0.5 m (1.6 ft). Occasionally, strong northern winds create a southerly flow. The mean annual transport is highly variable and is often interrupted by significant wind events. The mean annual transport has been approximated at $8.0 \pm 0.2 \times 10^5$ m³/s ($2.8 \pm 0.07 \times 10^7$ ft³/s), peaking in the summer to about three times that of the winter transport (Coachman and Aagaard 1988; Roach et al. 1995; Cherniawsy et al. 2005). Rough estimates (± 20 percent) of the mean velocities in January and June are approximately 10 cm per second (cm/s) and 30 cm/s (4 and 12 inches per second [in/s]), respectively (Woodgate, Aagaard, and Weingartner 2005).

The mean flow through the Bering Strait splits into three major outflows, and each has comparable throughput, approximately between 1.0-3.0 x 10^5 m³/s (3.5-10.6 x 10^6 ft³/s). Herald Canyon, Central Channel, and Barrow Canyon form exits for the watermasses as they traverse the Chukchi Shelf. Long Strait also provides an exit, but at a much smaller scale. The residence times of watermasses on the Chukchi shelf range from 1–6 months, in accordance with the highly variable flows (Woodgate, Aaagard, and Weingartner 2005).

The freshwater budgets of the Chukchi Sea and the larger Arctic Ocean are directly influenced by the freshwater input through the Bering Strait (Woodgate and Aagaard 2005; Shimada et al. 2001). There are large annual variances in temperature and salinity due to seasonal winds and freshwater input along the Alaskan Coast. The general cycle of the watermasses is cooling in the fall, increasing salinity in winter, and freshening and warming starting in spring and continuing into summer. The greatest variances occur along the Chukchi coast, especially in the polynya zone.

During the winter and spring each year, a large system of polynyas develops along the coast from Point Hope to Barrow and remains open about half the time (Stringer 1991). From February to April, the widths of the polynyas are typically less than 1 km (0.6 mi) but can reach 75–80 km (47–50 mi) during extreme events. As sea ice forms in the polynyas, salt rejection occurs, creating cold, dense, supersaline watermasses that flow seaward (Cavalieri and Martin 1994; Winsor and Bjork 2000).

3.1.3.3 Major Circulation Patterns

Three watermasses flow through the Bering Strait's eastern and western channels (Figure 3.1.3-1):

1. Anadyr Water—nutrient-rich, deep Bering Sea water that flows upward onto the shelf from the Gulf of Anadyr and through the Russian Exclusive Economic Zone in the western channel. South of the Bering Strait, it flows west to east and eventually mixes with the Bering Shelf Waters in the Chukchi Sea to form the Bering Sea Water.
2. Bering Shelf Water is more saline, relatively nutrient- and carbon-rich, and forms in the northern-central Bering Sea, paralleling the bathymetry as it moves northward through the western side of the eastern channel.
3. Alaska Coastal Water (ACW) is warmer, less saline, nutrient- and carbon-poor water that is separated from the Bering Shelf Water by a front created by the horizontal gradient between the inner and outer shelf watermasses (Feder et al. 1990).

Anadyr Water typically flows through Hope Sea Valley into Herald Valley, where it branches into a northeastward flow over the central shelf and an eastward flow along the north flank of Herald Shoal. The mean annual transport has been estimated at 3.0 x 10^5 m³/s (1.1 x 10^7 ft³/s). There is an anticyclonic circulation around the north flank due to the shoal itself that traps waters and slows the exchange with other shelf waters. The eastward flow eventually joins with the northeastward branch of flow through the Central Channel (Weingartner 1998).

The Central Channel carries the Bering Shelf Waters northward at approximately 8 cm/s (3 in/s) and diverges at Hanna Shoal into two branches: one northeastward toward the slope and one eastward along the southern edge of the shoal. The mean annual transport has been estimated at 2.0 x 10^5 m^3/s (7.1 x 10^6 ft^3/s), about one quarter of the total transport through Bering Strait. Along Hanna Shoal's southern edge, the incoming shelf waters slowly mix with these waters before converging with the Alaskan Coastal Current (ACC) at the head of Barrow Canyon (Weingartner 1998).

The ACW enters the Bering Strait and either joins the ACC along the Chukchi coast and exits through Barrow Canyon or flows northward through Hope Valley and exits through Herald Canyon. The mean velocity of the ACC has been approximated at 5 cm/s (2 in/s), but the flow is variable, largely due to wind (Weingartner et al. 1998). Flow reversals or diversions can occur for several weeks at a time, which has prevented the ACW from entering the Chukchi coastal area in the past (Wilson et al. 1982; Aagaard 1984; Weingartner et al. 1998).

Both ACW and Bering Waters are carried northward by the strong, persistent flow that has been observed in Barrow Canyon (Woodgate and Aagaard 2005). The ACW is pushed above the Bering Water as it flows from the head of the canyon to the mouth (Pickart et al. 2005). Barrow Canyon's mean velocities range from 14–23 cm/s (6–9 in/s), with maximum velocities of approximately 100 cm/s (39 in/s) (Weingartner et al. 1998). The annual mean transport through Barrow Canyon is roughly estimated to be 3.0 x 10^5 m^3/s (1.1 x 10^7 ft^3/s) (Pickart et al. 2005). Atlantic water flows upward into Barrow Canyon, causing the flow to reverse at times due to the pressure gradient of the variable longshore current (Johnson 1989; Aagaard and Roach 1990).

The Siberian Coastal Current (SCC) runs from the northwest along the Chukotka Peninsula and is present in the summer but weak in fall and winter. Winds, ice melt, and Siberian river outflow contribute to the strength and presence of the SCC, which can be highly variable. The SCC was absent in 1995, and the Long Strait Flow pushed water northwest into the Siberian Sea (Weingartner et al. 1999; Munchow, Weingartner, and Cooper 1999). At the Bering Strait, the SCC mixes with the Bering Strait influx and is pushed southward when the Bering Strait flow reverses at times. An offshore front near Chukotka Peninsula divides the cold, less saline SCC from the warmer, highly saline Bering Sea Water. The annual mean transport of the SCC is approximately 1.0 x 10^5 m^3/s (3.5 x 10^6 ft^3/s), similar to other regional currents (Weingartner et al. 1999).

3.1.3.4 Bathymetry

The offshore Chukchi seabed is relatively flat with complex ridges and troughs nearshore and toward the foot of the slope. Water depths in the lease areas range from approximately 30–3,000 m (95–9,800 ft). Most of the isobaths in the lease area fall in the 30–60 m (95–200 ft) range, with the northeastern area sharply dropping to a depth of 3,000 m (9,800 ft) in an unnamed valley north of the Barrow Canyon.

The most current comprehensive bathymetric data set available for the Arctic Ocean is the International Bathymetric Chart of the Arctic Ocean. Version 1.0 was introduced in 2001 with 2.5 km x 2.5 km (1.6 mi x 1.6 mi) grid cell spacing. Version 2.0 was improved with 2 km x 2 km (1.2 mi x 1.2 mi) grid cell spacing and updated with recent multi-beam data sets and a collection of Navy submarine, Scientific Exploration Expedition (SCICEX), and USCG Cutter *Polar Star* data (Jakobsson et al. 2008). Although Version 2.0 has been enhanced, the grid cell spacing is too large for small scale analysis.

The Alaska Ocean Observing System (AOOS) provides a bathymetric data set with 1 km x 1 km (0.6 mi x 0.6 mi) grid cell spacing for the coastal waters of Alaska, including the offshore Chukchi Sea region. These data are currently available in a geographic information system (GIS) format for map creation from the AOOS website.

Additionally, Shell conducted shallow hazards surveys at the five planned drill sites to satisfy the requirements of 30 CFR 250.214 and MMS Alaska OCS Region NTL 05-A01. Shell conducted surveys at two sites in 1989–1990 and three sites in 2008 using sub-bottom profilers and side scan sonar methods to collect detailed bathymetric data and identify seafloor features (MMS 2009 EIA). The reports containing this information are located at MMS OCS Alaska Region and were completed by Fugro-McClelland Marine Geoscience, Inc., in 1989–90 and by Fugro Geoconsulting, Inc., in 2009 (Fugro 1989a-c; Fugro 1990a-d; Fugro 2009).

Table 3.1.3-1 provides a summary of the bathymetric data collected within each of the identified lease blocks and at each proposed drill site.

TABLE 3.1.3-1 Water Depths at Exploration Blocks and Planned Drill Sites

			Water Depth Range within Block		Water Depth at Proposed Drill Site	
Prospect	Drill Site	OCS Block	Meters	Feet	Meters	Feet
Burger	C	Posey 6764	45.1–46.3	148–151	45.4	149
Burger	F	Posey 6714	43.9–46.3	142–152	45.1	148
Burger	J	Posey 6912	43.5–44.5	142–146	43.9	144
Crackerjack	C	Karo 6864	43.0–43.9	141–144	43.3	142
SW Shoebill	C	Karo 7007	44.8–45.6	147–150	45.4	149

Source: Shell Gulf of Mexico Inc. 2009

3.1.3.5 Current Bathymetric Data Collection

The Arctic lacks bathymetric and tidal data. This deficiency was recognized during the Arctic Research and Monitoring Workshop and concurrent 2009 Alaska Marine Science Symposium. With increased activity and interest in the Arctic, it is important for the United States, primarily the U.S. Navy and Coast Guard, to develop updated nautical charts for the maritime transport industry, search and rescue operators, oil spill responders, and the scientific community to safely conduct their operations.

The U.S. Navy conducted six submarine-based collaborative SCICEX cruises in the Arctic between 1993 and 2000 to support collection of physical and biological oceanographic data and bathymetry for public scientific purposes.

The United States conducted four Arctic cruises (2003, 2004, 2007, and 2008) to collect quality bathymetric and geophysical data to support the submission for an Extended Continental Shelf under Article 76 of the U.N. Convention on the Law of the Sea. The primary focus of data collection was the foot of the continental slope and 2,500 m (1.55 mi) isobath, which are used to define the continental shelf claim.

The lack of updated nautical charts presents difficult situations in which vessels must rely on local traditional knowledge to safely navigate the Chukchi and Beaufort Seas, especially near the coastline.

The *United States Coast Pilot*® provides the most detailed supplemental information to the nautical charts and often warns against transiting in this area without the aid of local guides.

3.1.4 Sea Ice

Sea ice in the Arctic Ocean Basin, and certainly in the Chukchi Sea itself, can perhaps best be described as in a state of flux at present. Heavy depletion of multi-year ice, as seen in prior years (reflected in record seasonal minimums set during the summer meltout of 2007 and near minimums in 2008), appears to be stabilizing and moving toward a recovery. Over the last 2 years, the Arctic Ocean has experienced, for the first time in several seasons, a large amount of first-year ice survival and transition into second-year ice. Upward trends in sea ice extent show progress toward a net gain in total ice coverage. Whether these trends continue, or there is a return to those leading up to the record minimums in 2007, remains to be seen. Ongoing monitoring and detailed analysis of current ice conditions will be the best course to understand, safeguard, and mitigate potential effects on sea ice coverage.

Sea ice serves multiple environmental purposes, including insulating the ocean, reflecting shortwaves, collecting and transporting particles and snow, and providing a biological habitat. Sea ice influences the exchange of energy and matter between the atmosphere and ocean and, in combination with snow cover, determines light penetration into the sea. During formation and consolidation, sea ice rejects salt, resulting in a highly saline, dense upper ocean that, in turn, affects circulation and behavior of the regional watermasses. Sea ice formation and extent differ extensively from one area to another and are analyzed and monitored by a number of organizations, typically for scientific or military purposes.

The Chukchi Sea is characterized by uniformly shallow depths and an influx of relatively warm water entering by way of the Bering Straits. Consequently, the Chukchi Sea ice regime can be characterized as composed of a large percentage of first-year ice, greater winter sea ice movement, and less fast ice formation nearshore in comparison to the Beaufort Sea. The ice thickness, multi-year ice presence, and open water season vary with latitude and distance from the coast. In the Chukchi Sea, the pack ice edge usually retreats north of 73°N in the summer but occasionally remains in the lease area. South of 71°N, first-year ice is dominant. Areas of new and young ice scattered with thicker floes and low multi-year ice concentrations are commonly found nearshore by Cape Lisburne. A recurring lead system forms between Point Hope and Point Barrow, widening between Cape Lisburne and Point Lay. The characteristics of the sea ice types and zones found in the Chukchi Sea are explained below.

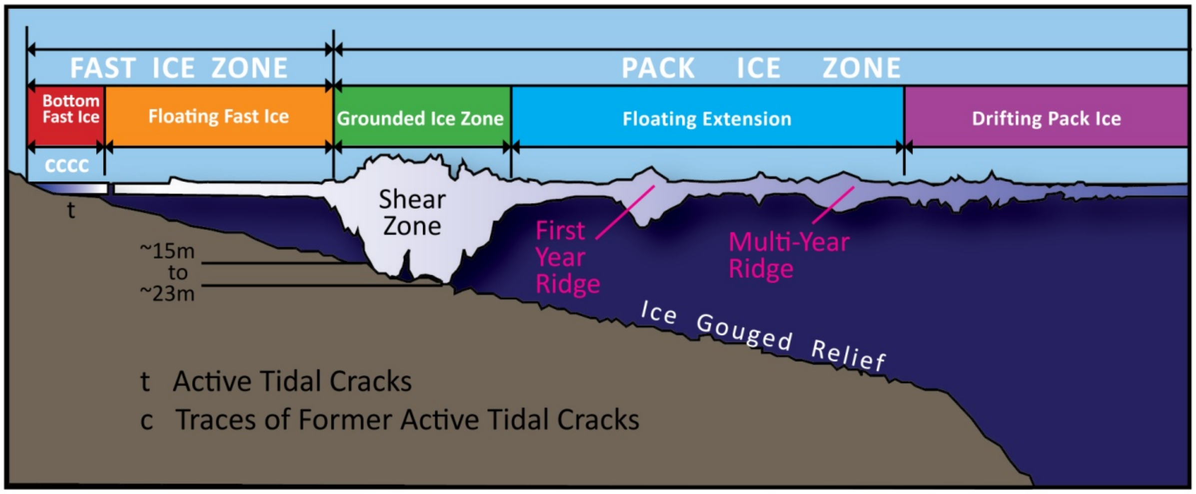
3.1.4.1 Sea Ice Zones

Sea ice forms into three primary zones, as depicted in Figure 3.1.4-1:

- *Fast ice zone,* composed of bottomfast ice extending into a floating sheet
- *Shear zone,* which includes partially grounded ice and ridges, varying in height and severity
- *Pack ice zone,* consisting of first-year ice and multi-year ice that drifts with the winds and currents, with ridging, leads, and refrozen leads developing between floes

The extent and structure of these zones vary along the coast and are influenced by bathymetry and offshore shoals. Movement of the pack ice affects the location of the zones in proximity to the shore as it causes ridging and creates water openings. There are several factors that affect the movement of the pack ice, including oceanic circulation and current patterns and wind speed and direction.

Figure 3.1.4-1 Schematic Representation of Fast Ice (landfast), Grounded Ice, and Pack Ice Zones



Source: Brower et al. 1988.
Note: The Pack Ice Zone includes the grounded Ice Zone.

Note: The Pack Ice Zone includes the grounded Ice Zone.

3.1.4.2 Fast Ice

Fast ice is characterized as first-year thick to medium ice that is relatively stable and affixed to the coast. The fast ice zone develops as bottomfast ice along the coast forms seaward and couples with floating fast ice, bounded by the grounded ice zone. Bottomfast ice is frozen to the seabed and typically extends to the 2 m (7 ft) isobath. The floating fast ice usually extends out to the 20–30 m (66–98 ft) isobath, at which point it is anchored and relatively immobilized by the grounded ice ridges in the shear zone (Eicken 2006). Multi-year pack ice may be integrated during freeze/thaw episodes when pack ice or ice floes driven into the fast ice zone refreeze within the areas of fast ice. Ice-shove (*ivu* in the Inupiaq language), which is the movement of fast ice, is variable, occurring more frequently during freezeup and breakup. Events such as compaction of offshore sea ice, closure of lead systems, strong or prolonged winds, and warming of the landfast ice can cause ice-shove.

Pileups and rideups along the coast and on offshore islands also result from the forces of the wind and currents. Onshore pileups commonly occur 20 m (66 ft) inland from the coastline and present enough force to ascend steep coastal bluffs. Wind and ice rideup, in which the whole ice sheet slides relatively unbroken over the ground surface for more than 50 m (164 ft), does not happen often and rideups beyond 100 m (328 ft) are rare (MMS 2007).

The fast ice mean annual growth cycle typically starts with the gradual formation of ice in October, continuing with slow growth until the greatest monthly mean extent is reached in March or April (Eicken 2006). Melting of fast ice typically begins mid-May, with open water conditions usually attained by July. Table 3.1.4-1 compares mean occurrence dates of fast ice events in the Chukchi Sea as determined by Barry (1979) and Eicken (2006).

TABLE 3.1.4-1 Mean Occurrence Dates (1996–2004) for Landfast Ice Conditions

Event	Description		Eicken 2006 Zone 1[2]	Barry et al., 1979 Central Chukchi Sea[3]
First Ice*	First continuous fast ice	**Mean**	1-Dec	Early November
		σ'[1]	31.8	
Stable Ice	Stable ice inside of 15-m isobath	**Mean**	23-Feb	February
		σ'	41.9	
Breakup	First openings and movement	**Mean**	4-Jun	10-Jun
		σ'	13.9	
Ice Free	Nearshore largely free of fast ice	**Mean**	18-Jun	5-Jul
		σ'	12.7	

Source: (Eicken 2006), (Barry 1979)
Notes:
[1] σ' = the mean standard deviation due to interannual variability at each coast point for each zone (days).
[2] Zone 1 =the coastal area from around Point Barrow west to Peard Bay (~156–160 °W).
[3] Central Chukchi Sea is approximately the same area as Zone 1.

3.1.4.3 Shear Zone

The shear zone, also referred to as the stamukhi zone, is recognizable by its dynamic nature and often highly deformed ice features. It anchors the fast ice zone and is characterized by movement between differing ice types, resulting in large ridges, rubble fields, and openings. Along the seaward side of the shear zone, openings in the sea ice form (leads or polynyas), allowing open water to freeze and form new ice, which deforms under pressure or shear from the drifting pack ice (Eicken 2006). Leads and polynyas are described in more detail under "Leads, Polynyas, and Flaw Zone," below.

Ridges form when the pack ice buckles, fractures, or shears due to current or wind forces. The most intense ridges form in water depths between 15–40 m (49–131 ft), and moderate ridges develop in both the fast ice and pack ice zones (MMS 2007). Perpendicular interaction creates pressure ridges, typically with thicknesses two–four times the sheet thickness. Parallel interaction creates shear ridges, which are straighter and have thicknesses comparable to the sheet thickness.

3.1.4.4 Pack-Ice Zone

Pack ice is typically formed by the cementing of multi-year ice by seasonal and first-year ice. The pack-ice zone includes the shear zone and comprises several ice types:

- *First-year ice*—ice that has grown to at least 30 cm (12 in) in thickness during the initial stages of development. Historically, 1.2–1.5 m (3.9–4.9 ft) thick ice floes have been recorded in the Chukchi Sea
- *Multi-year ice*—ice that has survived one or more melt seasons. Ice is considered to have reached the multi-year stage of development if it survives into the new ice growth cycle, typically in October. Thick multi-year floes of 3–5 m (10–16 ft) have been recorded in the Chukchi Sea
- *Ridges*—areas of upward deformation created by pressure or shear forces. Multi-year ridges are stronger than first-year ridges due to refreezing
- *Floebergs*—consolidated hummock or rubble fields

- *Ice islands*—large, table-like icebergs with areas up to 1,000 sq km (621 sq mi) and thicknesses up to 60 m (197 ft)

The dynamics of the pack ice drift in the Chukchi Sea are mainly attributed to the dominant atmospheric systems and the Beaufort Gyre, a strong clockwise oceanic circulation pattern that generates westerly currents along the coastline and north/northwesterly currents offshore. Transient low- and high-atmospheric-pressure systems in the region can cause a change in drift as well, as can the many other oceanic currents present in the region. See Figure 3.1.3-1.

The structure and appearance of the pack ice edge change with seasons as well as from weather events or currents. As the pack ice melts, thaw and freeze episodes form a conglomerate of smaller floes and worn blocks that have broken off. Warm water influx creates various-sized embayments, or conformations resembling bays, along the ice edge, with some larger ones reappearing annually in the same locations. The shapes of the embayments strongly resemble local bathymetric features and substantiate the theory that warm water influx is dependent on bathymetry. Three embayments regularly appear at the following locations: between 170° and 175°W; centered on 168°W; and northwest to west of Point Barrow.

Fragments of ice islands or floebergs with drafts greater than 25 m (82 ft) have been known to accumulate at Hanna Shoal (Toimil 1976; Eicken 2006). This Hanna Shoal area is subject to greater seasonal growth due to repeated groundings of ice islands or floebergs and the potential for this ice to remain in the area even during meltout.

3.1.4.5 Leads, Polynyas, and Flaw Zone

A number of open water zones develop each winter in the Chukchi Sea. Factors such as currents, winds, and influx from rivers form large, open-water features in the sea ice that are designated as leads (linear) and polynyas (non-linear). Typically, these openings result when the wind or current forces drive the pack ice away from the fast ice zone and close when the winds or currents reverse and drive the pack ice back toward the fast ice zone. New ice can form in these openings, creating cold, dense, high-salinity watermasses that tend to flow seaward.

The lead fraction, the percentage of area covered by leads, typically ranges between 0.01–0.62 from Icy Cape to Point Barrow and increases dramatically in the spring to at least 0.10 (Eicken 2006). The lead fraction continues to increase until June, when the polynyas reach their maximum extent and the pack ice edge begins to retreat. Occasionally, the Chukchi prospects are located in the polynyas and the seaward boundary extends more than 100 km (62 mi) from the coast.

Leads tend to lose their linear shape as winter progresses into spring and the lead-density increases, forming polynyas (Eicken 2006). During the winter and spring, a system of polynyas develops along the coast from Point Hope to Barrow and remains open about half the time (Stringer 1991). This zone has been described as a 50–100 km (31–62 mi) wide area beyond the landfast ice (Norton 2004). From February to April, the widths of polynyas are typically less than 1 km (0.6 mi) but can reach 75–80 km (47–50 mi) during extreme events. Figure 3.1.4-2 shows several of the recurring polynyas in the Chukchi Sea.

3.1.4.6 Annual Sea Ice Cycle Timing

There is great interannual variability in the sea ice growth and decay patterns in the Chukchi Sea. Freezing occurs in the northern Chukchi around late September to late October and in the southern Chukchi around mid- to late October (Belchansky 2004). Melting usually begins in early May in the southern Chukchi and early to mid-June in the northern Chukchi.

The Chukchi Sea reaches its minimum sea ice extent in early fall and generally exhibits these characteristics throughout the decay cycle:

1. The ice melts from south to north, with a much larger opening forming in the southern region (approximately 100 km [62 mi]) than in the northern region, which is typically approximately 4 km (2.5 mi). These dimensions, however, can vary greatly due to yearly fluctuations in climatic inputs.
2. The opening expands considerably from July through September, reaching widths up to several hundred kilometers. At times, the Beaufort Gyre or other forces push ice into the Chukchi Sea and consequently close the open water areas near Point Barrow and Wainwright.
3. The minimum extent of sea ice typically occurs in September.
4. Southern advance of the pack ice edge and freezing usually begins in October.

■ Town

Polynya

Bathymetric Contours

NAD83, Alaska Albers

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

GENERALIZED LOCATION OF CHUKCHI POLYNYAS

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 25 50 100 Miles

FIGURE: 3.1.4-2

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3.1.4.7 Factors Affecting Annual Sea Ice Cycle

The annual cycle of ice growth and decay plays an important role in ice conditions and is dependent on factors such as meteorology, bathymetry, currents, and type and concentrations of ice present during freezeup. The thickness of the ice is determined by the weather conditions in the area (e.g., colder temperatures produce thicker ice), as well as the mixing of the water column, which is affected by dynamics such as circulation patterns, bathymetry, and atmospheric-pressure systems. There are a number of dominant currents and seafloor topographical features in the Chukchi that produce relatively predictable ice conditions in some areas.

Along with offshore winds, warm water flowing north into the Chukchi Sea from the Bering Sea and Yukon River discharge initiates ice decay in the summer and ice motion in the winter. The ACC plays a major role in the Chukchi ice conditions. Originating from the main current near Point Hope, it generally follows the 37 m (121 ft) isobath north of Cape Lisburne and then branches into two main streams: one flows north, and the other increases in velocity as the water is channeled into the narrow Barrow Canyon (Belchansky 2004).

Local meteorological factors and variability can help determine the actual thickness sea ice will achieve during the ice growth cycle. For instance, snow cover can be a deterrent to ice growth since it acts as an insulator and retards heat exchange needed to allow for continued cooling of the water beneath the ice. The comparison of cumulative snowfall with ice thickness records shows that years of heavy snowfall result in poor ice development. Timing of snowfall events may also be critical in ice growth, with later events perhaps insulating the ice from increased solar radiation and thus delaying the meltout process.

Additionally, the high-latitude arctic location of the Chukchi Sea affects the freezeup and meltout cycle of sea ice by regionally specific factors such as the seasonal increase and decrease in sunlight hours, the transition in orientation of earth’s axis with relationship to the sun, and the angle of incidence of incoming solar radiation during daylight hours. Periodic fluctuations in these factors due to orbital wobble or variations in climate inputs such as cloud cover, shifts in the AO or PDO, and El Niño/La Niña events can result in great yearly variability in ice extent.

3.1.4.8 Ice Extent

The location of the pack ice edge is highly variable. Maximum and minimum extents are generally reached in March and September, respectively. The pack ice edge typically retreats northward by July, but ice can be present at any point. To estimate the variability in the location of the pack ice edge relative to several proposed Chukchi Sea drill sites, MMS analyzed data from the National Ice Center (NIC) for the period July 1–4 from 2000–2009. A summary of those findings is presented in Table 3.1.4-2.

TABLE 3.1.4-2 Location of Pack Ice Edge Relative to Proposed Prospects

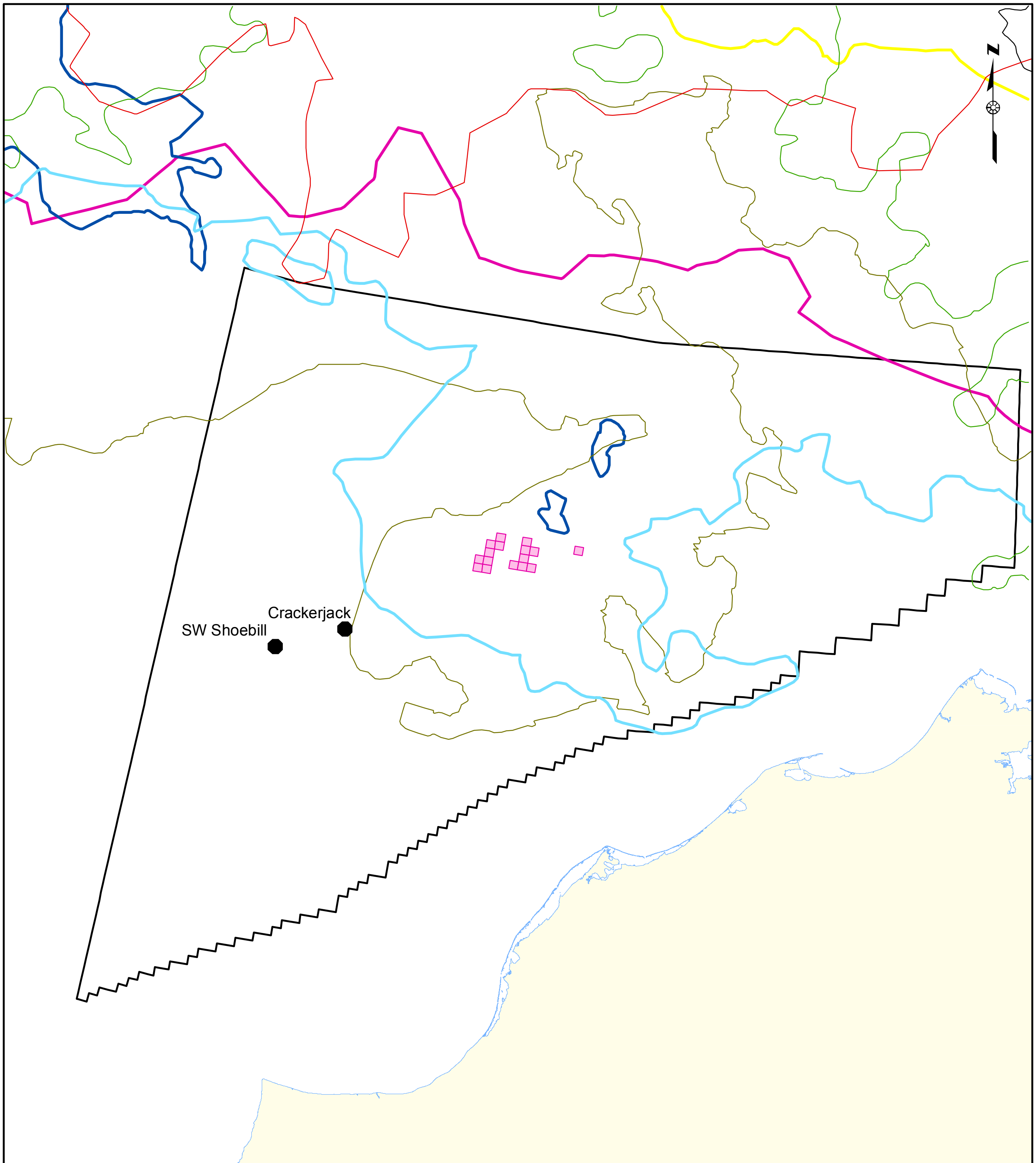
Proposed Drill Site[1]	Latitude NAD 83 UTM Zone 3	Longitude	Year[2]	Distance Pack Ice Edge is from Site[3] (km)	Notes
SW Shoebill	N71° 04' 24.4163"	W167° 13' 38.0886"	2009	-51	Ice Covered
			2005	100	Open Water
Crackerjack	N71° 13' 58.9211"	W166° 14' 10.7889"	2009	-50	Ice Covered
			2005	87	Open Water
Burger J	N71° 10' 24.0292"	W163° 28' 18.5219"	2000	-64	Ice Covered
			2005	72	Open Water
Burger F	N71° 20' 13.9640"	W163° 12' 21.7460"	2000	-87	Ice Covered
			2005	53	Open Water
Burger C	N71° 18' 17.2739"	W163° 12' 45.9891"	2000	-84	Ice Covered
			2005	55	Open Water

Notes:
1. More information on drill sites can be found in Shell's MMS approved *OCS EIS/EA MMS 2009-061 Environmental Assessment—Shell Gulf of Mexico, Inc., 2010 Exploration Drilling Program, Burger, Crackerjack, and SW Shoebill Prospects, Chukchi Sea Outer Continental Shelf, Alaska.*
2. Year for which the National Ice Center (NIC) sea ice edge data (July 1-4) was analyzed.
3. Negative distances indicate the pack ice edge is south of the site. Positive distances indicate the pack ice edge is north of the site.

The MMS also concluded the duration of open water, which is defined as less than 10 percent ice concentration, has increased in the central Chukchi Sea by about 4 weeks over the past 30 years, with an average of around 17 weeks (MMS 2007). However, the open water period in the immediate vicinity of the leases can be limited or extended by a number of factors as discussed under "Factors Affecting Annual Sea Ice Cycle," above.

High concentrations of ice have been observed several times in the project area well into July and beyond. 2000 and 2009 were years in which the proposed drill sites were still ice-covered in early July. Also, the proposed drill sites were ice-covered well into July 2008, and transit between the proposed drill sites and Barrow was not possible. Large amounts of ice that extended from the Chukchi coastline to the proposed drill sites did not begin to clear until the middle of August.

Figure 3.1.4-3 depicts the wide variation in the location of the pack ice edge in the Chukchi Sea for the period 1996 through 2004, as estimated from NIC data.



Ice Free 9/10/1996
Ice Free 9/22/1997
Ice Free 10/2/1998
Ice Free 9/24/1999
Ice Free 9/15/2000
Ice Free 9/24/2001
Ice Free 10/6/2003
Ice Free 10/1/2004
Lease Sale 193 Area
Statoil
Prospect

Source: USDOC, NOAA, National Ice Center 1996-2004.
Figure taken from MMS report *Chukchi Sea Planning Area: Oil and Gas Lease Sale 193 and Seismic Surveying Activites in the Chukchi Sea. OCS EIS/EA MMS 2007-026.*

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
REGULATORY AND TECHNICAL SERVICES

Statoil

GENERALIZED MAXIMUM RETREAT OF SEA ICE (YEARS)
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 15 30 60 Miles

FIGURE: 3.1.4-3

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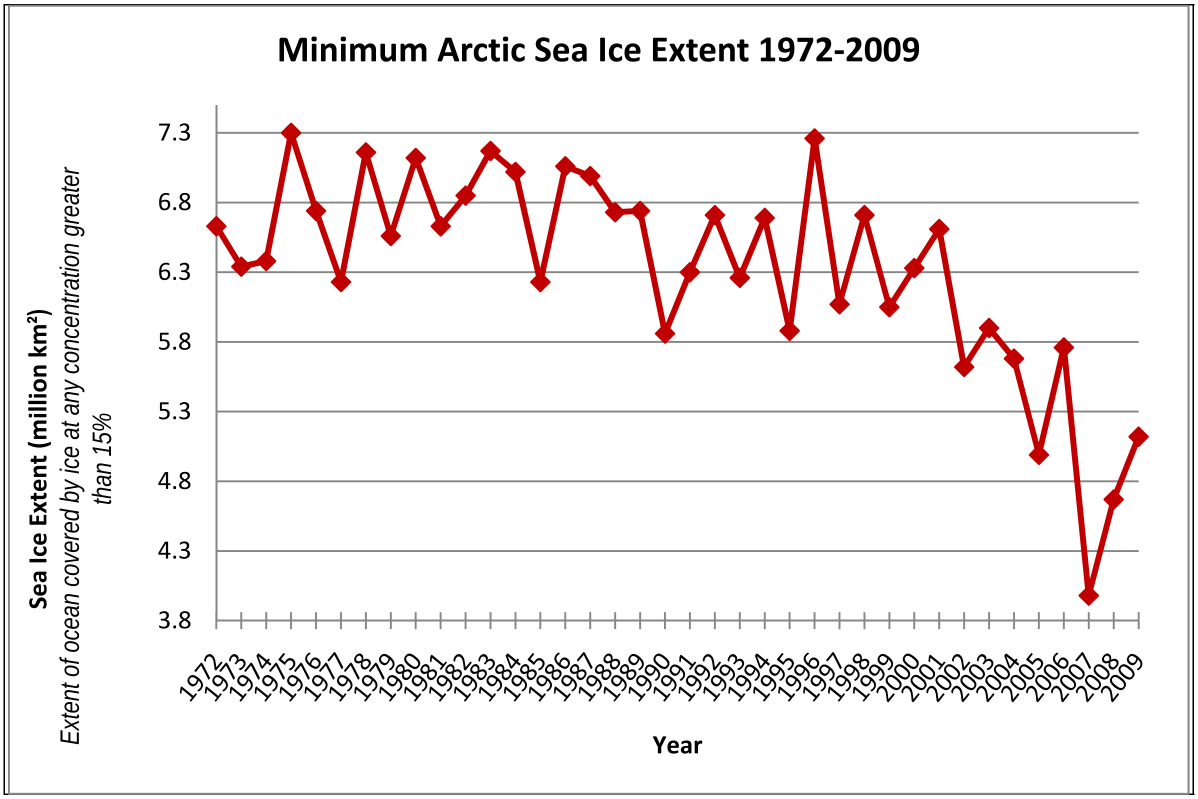
Many methods have been developed to monitor and analyze the extent of sea ice. Most methods involve the use of active or passive sensors, typically from satellite platforms but occasionally from shore-based systems, to catalog and assess ice characterization and extent. The most reliable sources of ice data come from those processes in which sensor inputs are coupled with evaluation by experts trained in sea ice analysis in order to properly describe the geographic extent of ice types and to attribute these areas with codes or descriptions of ice concentration, form, floe size, and stage of development. The NIC performs this type of analysis utilizing RadarSat and Advanced Very High Resolution Radar imagery and has also created many resultant datasets useful in the estimation of expected ice conditions. Among these are periodic (daily and weekly) charts of various polar regions, tabular data containing the minimum and maximum extents of sea ice, and long-range climatological datasets.

For this document, maximum and minimum ice extents for arctic sea ice were acquired from NIC and compiled and plotted to display the overall trend in both the minimum and maximum sea ice extents for the years 1972–2009. Climatological datasets were also acquired in GIS format for use in displaying and describing sea ice trends during the periods of 1972–2007 and 2003–2007. Finally, median locations for the sea ice extent were received from the National Snow and Ice Data Center (NSIDC) to depict recent ice trends from 2007–2009.

3.1.4.9 Minimum Ice Extent

As shown in Figure 3.1.4-4, minimum arctic sea ice extent experienced annual variations but remained generally stable until 2001, followed by a recent decline, particularly distinct from 2001–2007. Since 2007 there has been a steady recovery from the low experienced that year. The length of the dataset (less than 40 years), along with recent climatic changes in other variables that affect ice extent, make it difficult to determine whether the recent events were in themselves anomalies or if they reflect longer-range trends. It does seem likely that the recent extreme events may be stabilizing as the minimum ice extent has increased substantially since the record low in 2007.

Figure 3.1.4-4 Minimum Arctic Sea Ice Extent 1972–2009

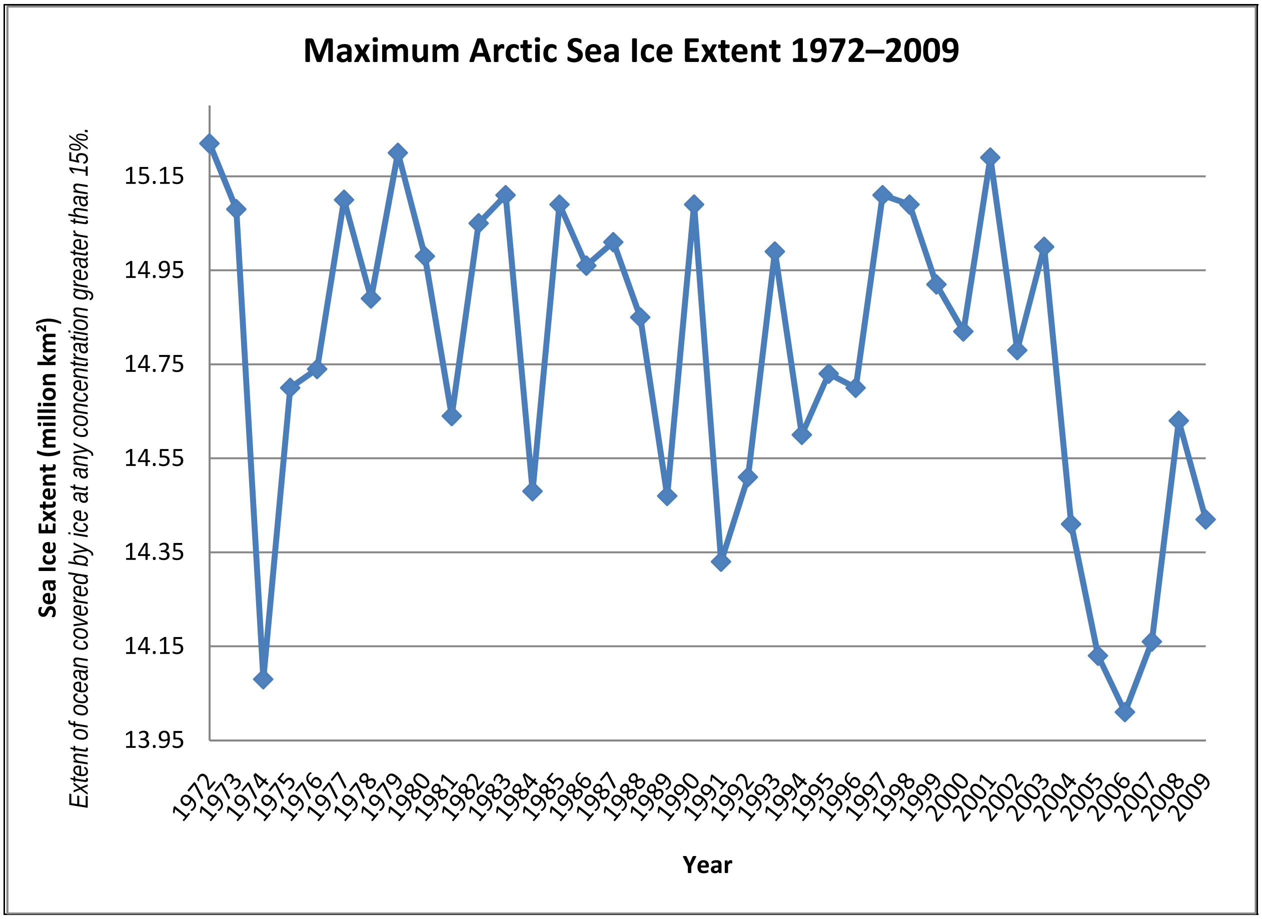


Note: Data for ice extents was compiled from the National Ice Center (NIC) Arctic Ice Extent data (National/Naval Ice Center n.d.).

3.1.4.10 Maximum Sea Ice Extent

The maximum extent of ice indicates the amount of net gain or loss from one cycle to the next. The data presented in Figure 3.1.4-5 indicate much greater variability in maximum sea ice extent over time. However, the trend has generally paralleled that of the minimum sea ice extent data. There was a recent decline in extent, most notable from 2003–2006, then a significant increase from 2006–2008, followed by a slight decrease between 2008 and 2009. It is likely that there is a move toward a more steady state as the recent ice growth cycles have shown retainment of first-year ice that transitions into multi-year ice in the following years. Recently, the NSIDC reported an increase by 658,222 sq km (409,000 sq mi) (26 percent) of arctic sea ice extent since the low in 2007.

Figure 3.1.4-5 Maximum Arctic Sea Ice Extent 1972–2009



Note: Data for ice extents was compiled from the National Ice Center (NIC) Arctic Ice Extent data(National/Naval Ice Center n.d.).

3.1.4.11 Climatological Data

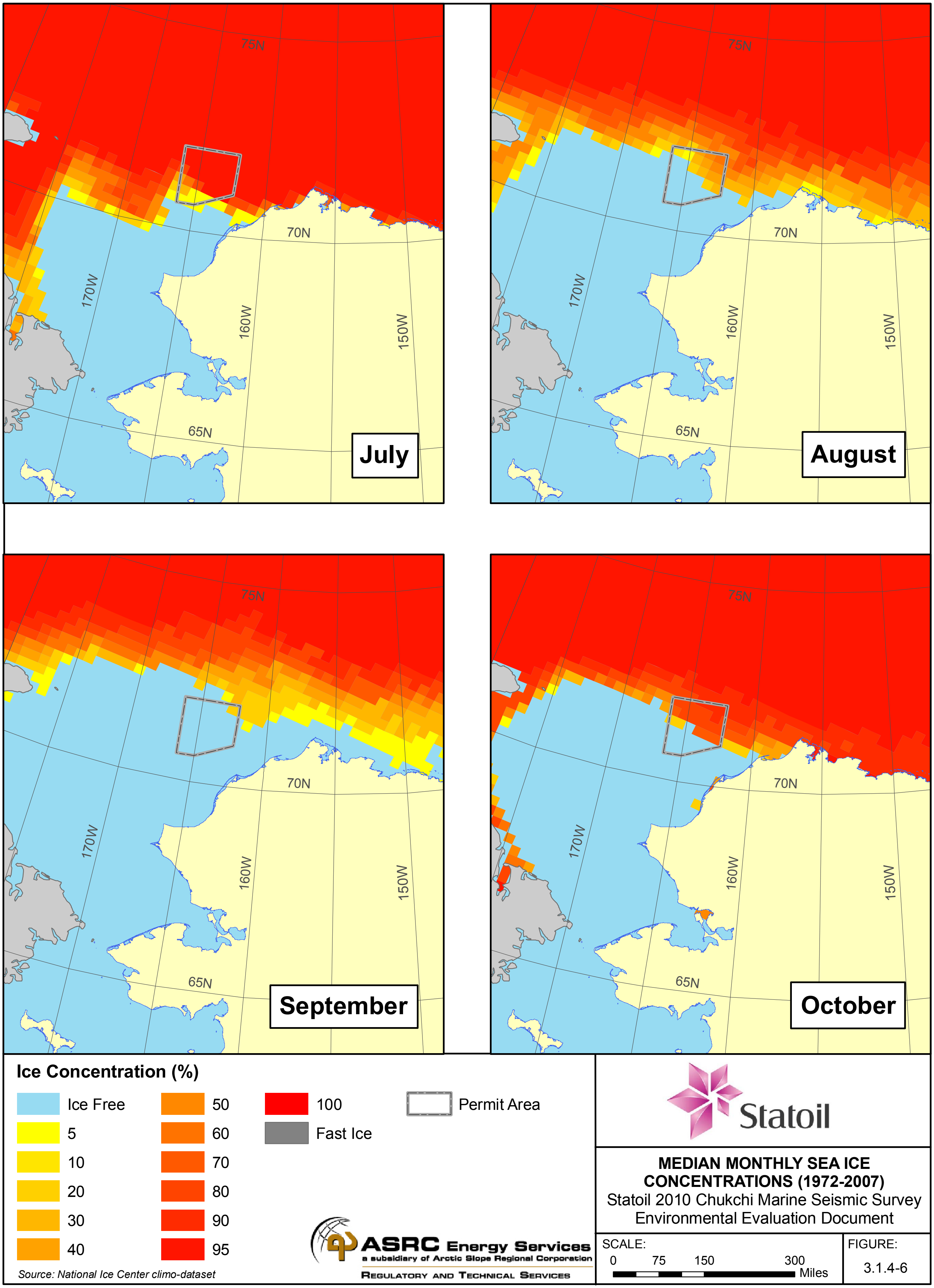
NIC climatological data consist of gridded (25 km [15.5 mi]) and vector products that depict sea ice concentration and are further processed to depict monthly median, maximum, and minimum values for given time intervals of 36-year, 10-year, and 5-year periods. These data thus provide a coarse estimation of the frequency of occurrence of ice at any concentration. Sea ice extent may also be derived using the sum of ice concentration values.

Figure 3.1.4-6 displays the climatological data for the Chukchi Sea from 1972–2007. It can be seen that, during this period, high concentrations of sea ice were found across the lease area in July, with a steady retreat of ice clearing the area by September. By October, high concentrations of ice were beginning to again cover the area.

Figure 3.1.4-7 shows similar data for 2003–2007. Lesser concentration can be seen for July, followed by a much greater retreat well north of the lease area, with the area relatively ice-free in August. No ice is seen back in the area by October. It is extremely likely that the 2003–2007 dataset is heavily influenced by the record minimums of 2007.

3.1.4.12 Recent Ice Trends

As noted previously, the recent trend in sea ice data has indicated an increase in both extent and age of ice (i.e., an increase in the amount of multi-year ice). Figure 3.1.4-8 shows both the median minimum (September) and median maximum (March) extent of ice coverage, as represented by data provided by the NSIDC. It can be seen that, since 2007, the position of the ice edge during these months has been drifting steadily southward. The maximum is increasingly extending beyond the value for 1979–2007, and the minimum is approaching this location as well. It remains to be seen if these are trends toward increased ice growth or simply an anomaly in long-term ice depletion.



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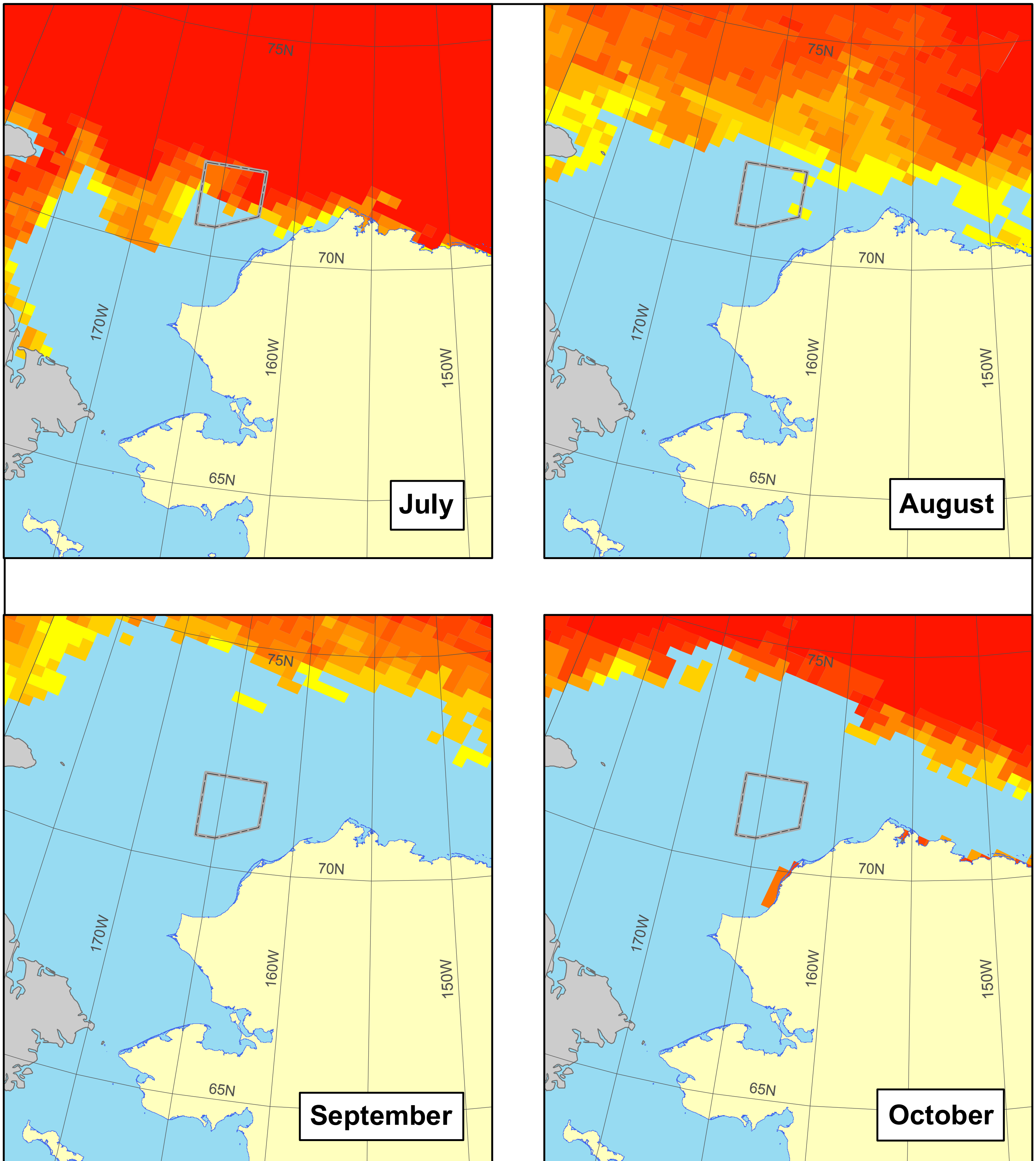

Ice Concentration (%)

- Ice Free
- 5
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 95
- 100
- Fast Ice
- Permit Area

Source: National Ice Center climo-dataset

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

MEDIAN MONTHLY SEA ICE CONCENTRATIONS (2003-2007)
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 75 150 300 Miles

FIGURE: 3.1.4-7

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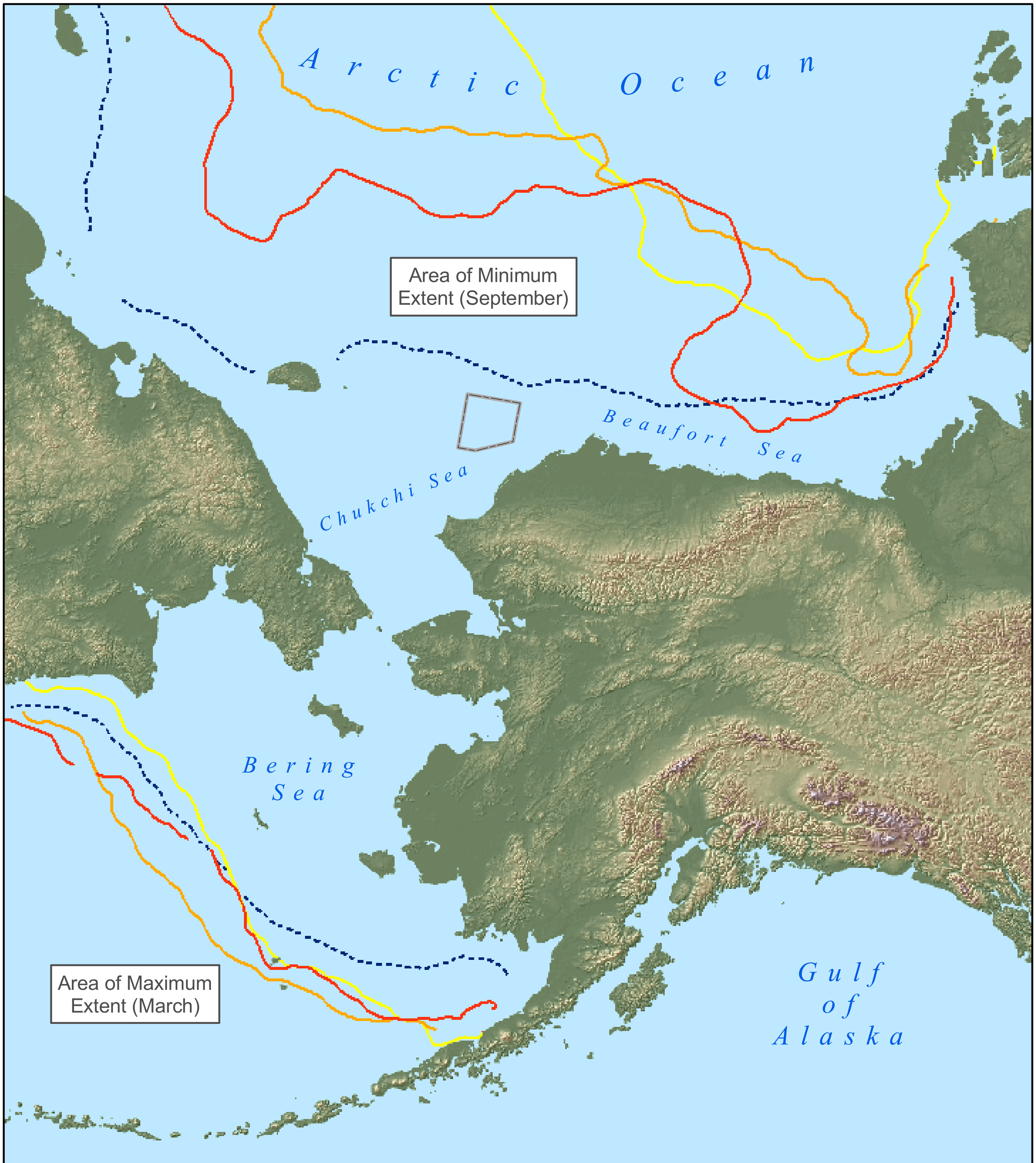

Sea Ice Extents:

- 2009
- 2008
- 2007
- 1979-2000 Median
- Permit Area

Source: National Snow and Ice Data Center

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

SEA ICE EXTENTS (2007-2009)
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 100 200 400 Miles

FIGURE: 3.1.4-8

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3.1.5 Water Quality

Water quality is a term that describes the quantitative and qualitative chemical, physical, and biological attributes of water. The common quantitative measurements used to assess water quality are temperature, acidity (pH), density, oxygen content, electrical conductance, and turbidity. These characteristics can vary naturally due to seasonal or biological effects, but can also be influenced by human activity. A water body is considered to be in its natural state when it is not influenced by negative stressors like human pollution or habitat loss (MMS 2007). Current information on some of the baseline levels of the water quality characteristics is discussed below.

The water quality in the northeastern Chukchi Sea is considered to be largely uninfluenced by human activity. Small and local changes to water quality in the area are mostly due to naturally occurring processes like seasonal plankton blooms, water column changes, natural hydrocarbon seeps, and turbidity caused by runoff from the terrestrial environment (MMS 2007). The Alaska Department of Environmental Conservation (ADEC) has not identified any waterbodies in the Arctic Subregion as impaired under Section 303 of the CWA (ADEC 2006).

3.1.5.1 Temperature and Salinity

The temperature and salinity conditions of the Chukchi Sea are largely influenced by oceanographic currents and sea ice. Bering Sea Shelf and the ACC bring relatively warm water north from the Bering Sea. The Bering Sea Shelf water is also saltier than the Chukchi Sea water (MMS 2007).

Sea ice cover in the Chukchi Sea and currents from the Bering Sea together have a profound effect on the temperature and salinity of water in the project area. As ice forms in marine water, the relative saline concentration increases in the water column. The density of water increases commensurate with increased salinity from freezing and Bering Sea inputs over the winter months. In spring, freshwater from melting ice begins to circulate, lowering the salinity (MMS 2007b).

3.1.5.2 Turbidity and Dissolved Oxygen

Turbidity is related to the amount of suspended solids that are present in a given body of water. High suspended sediments will cause the water to appear “muddy.” Turbidity and dissolved oxygen are inversely related, such that a higher amount of suspended solids leads to a lower amount of dissolved oxygen in a given body of water. Particles such as clay, silt, and plankton reflect light, which creates relatively warmer water that cannot contain as much dissolved oxygen.

Turbidity in the Chukchi Sea can be caused by wind, ocean currents, coastal erosion, and inputs from rivers and streams. However, observations of the effect of these inputs in the Chukchi Sea are limited to waters less than 5 m (16 ft) deep. Ice cover in the Chukchi Sea also reduces suspended solids due to the formation of ice crystals around solids suspended in the water column (MMS 2007b).

3.1.5.3 Trace Metals

Trace metal concentrations in the Chukchi Sea are well below ranges that disrupt basic biological functions of marine life (Boehm et al. 1987; Crecelius et al. 1991). Concentrations of trace metals in the Chukchi Sea are relatively higher than in other areas of the Arctic Ocean, but this is considered to be caused by inputs from the Bering Sea and not a local source (Moore 1981; Yeats 1988 in MMS 2007b).

3.1.5.4 Hydrocarbons

Hydrocarbon concentrations in the Chukchi Sea are considered to be of natural origin and only approximately 1 part per billion (MMS 2007b).

3.1.5.5 Persistent Organic Pollutants

Persistent organic pollutants (POPs) are carbon-based compounds that are typically found in pesticides, solvents, and industrial processes (Ritter et al. 1995). These compounds are of concern due to their natural ability to cycle between the atmosphere and waterbodies. Water currents and air movements that flow toward the Arctic are known to carry POPs, where they can bioaccumulate through trophic levels in the environment. Concentrations of these compounds are similar to those of the Great Lakes, though their presence in the waters of the Chukchi Sea is of concern due to the lack of any direct POP sources in the region (Strachan et al. 2001).

3.1.6 Air Quality

Specific air quality data in the Chukchi Sea Lease Sale Area 193 are unknown due to the significant distance to shore, inclement weather, long periods of darkness, extreme temperatures, and remoteness. There are no islands, platforms, or infrastructure in the Chukchi Sea on which to install, operate, and maintain ambient air quality monitoring equipment (EPA 2009a). The nearest onshore location from the Statoil lease blocks for background air quality monitoring data is Wainwright, Alaska, approximately 115 miles (185 km) distant. Wainwright is one of the few locations on the coast of the Chukchi Sea that has even limited infrastructure (EPA 2009a). Wainwright is a rural community with a population of around 500. It has a relative lack of pollution sources and has similar meteorology to the Chukchi Sea Lease Sale Area 193.

In November 2008, to support exploration oil and gas permitting efforts, ConocoPhillips Alaska, Inc. (CPAI), and Shell, with EPA concurrence, jointly began operating an ambient air quality monitoring station in Wainwright, Alaska. In January 2010, as part of the Shell Chukchi Sea OCS/PSD permitting effort, EPA determined that the monitoring data collected at the Wainwright monitoring site are, in general, conservatively representative of air quality in the Chukchi Sea Lease Sale Area 193 (EPA 2009a). EPA further determined that small-diameter particulate matter measurements at the Wainwright station during high-wind days with no precipitation or snow cover are not representative of air quality in the Chukchi Sea Lease Sale Area 193. In January 2010, EPA determined that the Lease Sale Area 193 air quality met all NAAQS criteria for healthy air quality (EPA 2009a).

Since Statoil’s leases in Lease Sale Area 193 are generally further away from shore than Shell’s leases, EPA would presumably concur that the Wainwright air quality monitoring data will also be conservatively representative at the Statoil lease blocks.

Air quality monitoring has also been conducted at several North Slope locations during the past 10 years, principally near Nuiqsut at the CPAI Alpine and Kuparuk oil fields and near Deadhorse at the BP Exploration (Alaska) Inc. Prudhoe Bay, Liberty, and Badami oil fields. Although ambient air quality monitoring stations are sited to minimize the effect of localized combustion emission sources and windblown dust, the effect of windblown dust and local combustion emission sources cannot always be eliminated from measured onshore locations. Thus, offshore locations, including the Chukchi Sea Lease Area 193, without localized combustion sources and windblown dust sources should have lower concentrations of pollutants than the measured values at Wainwright or the North Slope oil fields.

3.1.6.1 Federal Clean Air Act and Implementing Air Quality Agencies

Air quality in the United States for the non-OCS is managed by the combination of federal, state, and local air pollution control agencies. Air quality in most states is managed by the applicable state air pollution control agency, with oversight from the EPA. Air quality in Alaska is managed primarily by ADEC, with oversight EPA. Local air pollution control agencies, with state and EPA approval, may manage specific geographic areas within a state. The FCAA and its implementing regulations are the governing authority for air quality management in the United States. States and local air pollution control agencies may also manage air quality with state air quality protection laws, regulations, and ordinances that are consistent with federal law and regulations.

Air quality in the United States OCS is managed by the EPA, state or local air quality agencies, or the MMS, depending on the distance to shore and the geographical location within the United States OCS. For example, the MMS generally regulates air quality in the Gulf of Mexico (GOM) OCS, whereas EPA regulates air quality in the non-GOM OCS pursuant to Section 328 of the FCAA. EPA may share non-GOM OCS regulatory authority with delegated state or local air quality agencies for OCS waters within 40 km (25 mi) of the seaward boundary of that state. EPA, however, retains sole regulatory authority for OCS waters beyond 40 km (25 mi) of the seaward boundary of that state. In the case of the Alaska OCS, EPA has retained authority for the nearshore OCS (within 40 km [25 mi] of the Alaska seaward boundary) and sole authority for the outer OCS (beyond 40 km [25 mi] of the Alaska seaward boundary). ADEC regulates nearshore waters in Alaska or within 5 km (3 mi) of the Alaska shore. Thus, where the prospective OCS offshore activity occurs will dictate which agency (EPA or ADEC) will be the lead regulatory agency and whether federal (EPA) or state (ADEC) air quality regulations will apply. In addition, the nature of the specific oil and gas exploration activity dictates whether the FCAA and its implementing regulations apply. For example, exploratory drilling, development, and production activity trigger air permitting requirements, but seismic activity—such as the proposed Statoil 3D seismic acquisition—does not.

3.1.6.2 NAAQS and Air Quality Control Regions

The EPA established NAAQS for six criteria pollutants to protect against adverse effects on human health and public welfare. The six criteria pollutants include:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Small-diameter particulate matter ($PM_{2.5}$, PM_{10})
- Sulfur dioxide (SO_2)
- Ozone (O_3)
- Lead (Pb)

In early December 2009, EPA received a petition from the CBD to add carbon dioxide (CO_2) and other greenhouse gases (GHGs) as criteria pollutants (CBD 2009). As of mid-January 2010, EPA had not yet responded to the CBD petition.

The FCAA established two types of national air quality standards. Primary standards set limits to protect human health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (EPA 2010). The primary and secondary NAAQS are identical for three of the six criteria pollutants ($PM_{2.5}$, PM_{10}, O_3, and Pb). The SO_2 secondary NAAQS is less strict than its primary standard, and there is no secondary NAAQS for CO. The 24-hour NO_2 primary and secondary NAAQS are identical, however, EPA recently promulgated a more stringent 1-hour NO_2 primary NAAQS in February 2010.

The NAAQS set a limit to the concentration of the criteria pollutants in the ambient air. When an area does not meet the air quality standard for one or more of the criteria pollutants, the EPA designates the area as a nonattainment area. The FCAA sets forth the regulatory process to be applied to an area in order to comply with the standards by a designated date. This date varies by the type of pollutant and the severity of the nonattainment air quality problem. The State of Alaska adopted the federal NAAQS as Alaska Ambient Air Quality Standards (AAAQS) for the six criteria pollutants and established state ambient standards for two other air pollutants, reduced sulfur compounds and ammonia (ADEC 2009). The NAAQS and AAAQS are summarized in Table 3.1.6-1.

TABLE 3.1.6-1 National and Alaska Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS[a]	AAAQS[b]
Nitrogen Dioxide (NO_2)	1-hour (k) Annual (arithmetic mean)	0.100 ppm 100 μg/m^3 (0.053 ppm [c])	– 100 μg/m^3
Particulate Matter ($PM_{2.5}$)	24-hour (e) Annual (Arithmetic Mean)	35 μg/m^3 [c] 15 μg/m^3 [c]	– –
Particulate Matter (PM_{10})	24-hour (f) Annual (arithmetic mean)	150 μg/m^3 [c]	150 μg/m^3 50 μg/m^3
Sulfur Dioxide (SO_2)	3-hour (g) 24-hour (g) Annual (arithmetic mean)	1,300 μg/m^3 (0.5 ppm [d]) 365 μg/m^3 (0.14 ppm) 80 μg/m^3 0.03 ppm	1,300 μg/m^3 [d] 365 μg/m^3 80 μg/m^3
Carbon monoxide (CO)	1-hour (g) 8-hour (g)	40,000 μg/m^3 (35 ppm) 10,000 μg/m^3 (9 ppm)	40 mg/m^3 10 mg/m^3
Lead (Pb)	Rolling 3-month Quarterly (arithmetic mean)	0.15 μg/m^3 [c] 1.5 μg/m^3 [c]	– 1.5 μg/m^3
Ozone (O_3)	1-hour (h) 8-hour 2008 std (i) 8-hour 1997 std (j)	0.12 ppm [c] (235 μg/m^3) 0.075 ppm [c] (147 ug/m^3) 0.08 ppm [c]	235 μg/m^3 – –
Reduced sulfur compounds measured as SO_2	30-minute (g)	–	50 μg/m^3
Ammonia (NH_3)	8-hour (g)	–	2.1 mg/m^3

a = National Primary and Secondary Ambient Air Quality Standards, 40 CFR Part 50, July 1, 2009
b = State of Alaska Ambient Air Quality Standards, Alaska Administrative Code, 18 AAC 50.010, November 4, 2009
c = primary standard is the same as secondary standard
d = secondary standard
e = To obtain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 μg/m^3.
f = Not to be exceeded more than once per year on average over 3 years
g = Not to be exceeded more than once per year
h = EPA revoked the 1-hour O_3 standard in all areas, although some areas have continuing obligations under that standard (“anti-backsliding”).
i = To obtain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.
j = To obtain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
k = Effective April 12, 2010 as published in the February 9, 2010 *Federal Register*.
mg/m^3 = milligrams per cubic meter
ppm = parts per million
std = standard
μg/m^3 = micrograms per cubic meter

The onshore area adjacent to the Chukchi Sea is the Northern Alaska Intrastate AQCR 9. The EPA designated this region as Class II and in attainment or unclassifiable for all criteria air contaminants pursuant to 40 CFR 81.302.

The Chukchi Sea OCS airshed extends beyond the Northern Alaska Intrastate AQCR 9. During the Shell outer Chukchi Sea PSD permitting effort, EPA asserted, "the atmosphere over United States territorial waters is ambient air and United States law, including 40 CFR Part 50 in which the NAAQS are promulgated, applies within the boundaries of United States and its territorial waters. Nothing in the FCAA or EPA's implementing regulations limits the applicability of the NAAQS to ambient air over land or to only ambient air within the jurisdiction of states or tribes" (EPA 2009a).

EPA, for permitting purposes, further asserted that the outer Chukchi Sea OCS and the outer Beaufort Sea OCS should be regulated and managed as if they were one new, single baseline area and as a Class II area that was in attainment or unclassifiable for all criteria pollutants (EPA 2009a). EPA made this determination by agency memorandum and as part of the Shell Chukchi Sea OCS PSD permitting process. In August 2009, EPA, during the initial Shell PSD permit public notice period, determined that the outer OCS airshed should be regulated and managed as if it were part of the Northern Alaska Intrastate AQCR 9. Shell and CPAI disputed the August 2009 EPA determination and asserted that air quality effects from prospective oil and gas exploration activity on the Chukchi Sea Lease Area 193 should be demonstrated at the nearest affected onshore location, e.g., Wainwright, Point Lay, and not beyond the boundary of the nearest defined intrastate AQCR (the Northern Alaska Intrastate AQCR 9). As of mid-January 2010, the AQCR applicability disagreement between EPA and Shell and CPAI is still unresolved. On March 31, 2010, EPA issued the Shell Chukchi Sea OCS/PSD permit holding to their August 2009 AQCR determination.

The closest existing nonattainment area to the Lease Sale Area 193 is a portion of the Fairbanks North Star Borough designated nonattainment for particulate matter (PM) $PM_{2.5}$ and located approximately 1,014 km (630 mi) south, southeast of the project area. The next closest existing nonattainment area to Lease Sale 193 area is the Eagle River area of Anchorage, designated nonattainment for PM_{10} and located approximately 1,320 km (820 mi) south, southeast of the project area. The nearest PSD Class I area is Denali National Park, including the Denali Wilderness but excluding the Denali National Preserve (ADEC 2009). Denali National Park is located approximately 1,102 km (685 mi) south, southeast of the project area. The U.S. National Park Service (NPS) identified two Class II national monuments, Cape Krusenstern National Monument and the Bering Land Bridge National Monument, as areas of concern with respect to potential visibility effects (EPA 2009a). The distance from the Lease Sale 193 area to the Cape Krusenstern National Monument and the Bering Land Bridge National Monument is greater than 483 km (300 mi) and 636 km (395 mi), respectively.

3.1.6.3 Lease Sale Area 193, Alaska North Slope, and Chukchi Sea Air Quality

The existing air quality along the Chukchi Sea coastline and in Lease Sale Area 193 is considered to be good because of the lack of onshore pollutant emission sources. The concentrations of all criteria air pollutants are much lower on the Alaska North Slope and western Alaska coastline than the maximum allowed by the NAAQS and AAAQS. The background ambient concentrations for onshore (Wainwright) and offshore (Lease Sale Area 193) locations, along with the corresponding NAAQS/AAAQS, are presented in Table 3.1.6-2.

Emissions in the area come primarily from electrical power generating facilities in small villages such as Barrow, Wainwright, Point Lay, and Point Hope. Small amounts of pollutants are also emitted from vehicles such as cars, trucks, and all-terrain vehicles (ATVs) and heavy construction equipment such as bulldozers and graders. Industrial sources exist within the oil fields near Prudhoe Bay located to the east and at the Red Dog Mine well south of the Lease Sale Area 193, but both have little effect on ambient air standards in western Alaska onshore areas. The latest preliminary data from the

Western Regional Air Partnership (WRAP) Emissions Data Management System (EDMS) indicate North Slope Borough (NSB) annual emissions in 2005 from all sources (point, area, on-road mobile, and non-road mobile) of approximately 41,800 tons NO_x; 6,700 tons volatile organic compounds (VOCs); 19,700 tons CO; 3,500 tons $PM_{10;}$ and 1,070 tons SO_2. The large majority of the NO_x and SO_2 emissions and about 55 percent of CO emissions were attributed to the North Slope oil and gas industry. Area and non-road mobile emission sources contributed the majority of VOC and PM_{10} emissions and the remaining 45 percent of CO emissions (WRAP 2005). The 2005 preliminary emission estimate for the Northwest Arctic Borough (NWAB) indicates approximately 3,800 tons NO_x, 6,000 tons VOCs, 9,100 tons CO, 2,500 tons PM_{10}, and 185 tons SO_2. The majority of NO_x and SO_2 emissions were attributed to industrial sources, whereas the majority of VOC, CO, and PM_{10} emissions were attributed to area emission sources (WRAP 2005).

Ozone

O_3 is a regional pollutant formed as the result of chemical reactions between emissions from many sources over a period of several hours or days and over a large area. O_3 is formed in the atmosphere through a chemical reaction of NO_x, VOCs, and CO in the presence of sunlight. The estimated emissions of O_3 precursors from point, area, and mobile sources in the NSB and NWAB are listed in the preceding paragraph. The North Slope oil and gas industry has measured O_3 and O_3 precursors for the past 10 years. CPAI and Shell began collecting ambient O_3 measurements at their Wainwright monitoring station in late 2008. EPA reviewed the North Slope oil and gas industry station data and determined the maximum 1-hour and 8-hour O_3 concentrations were 61 percent and 67 percent of the applicable O_3 NAAQS. Similarly, EPA determined the maximum 1-hour and 8-hour O_3 concentrations from the Wainwright monitoring station were 49 percent and 63 percent of the applicable NAAQS (EPA 2009a).

Localized Dust

Air quality on the Alaska North Slope is affected locally and seasonally by windblown dust. During the Shell Chukchi Sea PSD permit process, Shell asserted that the summer and autumn elevated $PM_{2.5}$ and PM_{10} values measured at the Wainwright station were attributed to windblown or resuspended dust from bare ground, dirt roads, and the Wainwright airport (Shell 2009a). PM_{10} and $PM_{2.5}$ values during periods of snow cover (e.g., winter and spring) were much lower. EPA acknowledged that PM_{10} and $PM_{2.5}$ values at the Wainwright monitoring station had higher levels during the summer and fall when the ground is not frozen or snow-covered. EPA further agreed with Shell that PM_{10} and $PM_{2.5}$ values recorded at the Wainwright monitoring station on high-wind days with no precipitation are not representative of air quality expected on Shell's leases on the Chukchi Sea Lease Sale Area 193 (see Table 3.1.6-2). EPA expected the background pollution levels, and especially PM_{10} and $PM_{2.5}$, in Lease Sale Area 193 to be lower than the levels recorded at the Wainwright monitoring station (EPA 2009a).

TABLE 3.1.6-2 Wainwright and Lease Sale Area 193 Background Ambient Concentrations

Pollutant	Averaging Period	Wainwright	Lease Sale Area193	NAAQS/AAAQS
Nitrogen Dioxide (NO_2)	Annual (arithmetic mean)	2.0 μg/m^3	2.0 μg/m^3	100 μg/m^3 (0.053 ppm)
Particulate Matter ($PM_{2.5}$)	24-hour (e)	23 μg/m^3	11 μg/m^3	35 μg/m^3
	Annual (arithmetic mean)	3.3 μg/m^3	2.8 μg/m^3	15 μg/m^3
Particulate Matter (PM_{10})	24-hour (f)	114 μg/m^3	91 μg/m^3	150 μg/m^3
	Annual (arithmetic mean)	15.8 μg/m^3	15.0 μg/m^3	50 μg/m^3
Sulfur Dioxide (SO_2)	3-hour (g)	17 μg/m^3	17 μg/m^3	1,300 μg/m^3 (0.5 ppm)
	24-hour (g)	10 μg/m^3	10 μg/m^3	365 μg/m^3 (0.14 ppm)
	Annual (arithmetic mean)	0.5 μg/m^3	0.5 μg/m^3	80 μg/m^3 0.03 ppm
Carbon monoxide (CO)	1-hour (g)	1,050 μg/m^3	1,050 μg/m^3	40,000 μg/m^3 (35 ppm)
	8-hour (g)	941 μg/m^3	941 μg/m^3	10,000 μg/m^3 (9 ppm)
Ozone (O_3)	1-hour (h)	114 μg/m^3	114 μg/m^3	0.12 ppm (235 μg/m^3)
	8-hour 2008 std (i)	93 μg/m^3	93 μg/m^3	0.075 ppm (147 ug/m^3)

Reference: EPA 2009a, AECOM November 2008 through October 31, 2009 Wainwright Monitoring Station. Shell 2009b

Maritime Emissions

Air quality along the Chukchi Sea coastline and in Lease Sale Area 193 could be affected by emissions from offshore international maritime shipping in the Arctic. Specific emission estimates from shipping activity along the Chukchi Sea coastline have not been tabulated, but the Arctic Council estimated 2004 Arctic-wide emissions (Arctic Council 2009). The Arctic Council Arctic Marine Shipping Assessment (AMSA) 2009 Report estimated 260 thousand tonne/year [kt/y] NO_x; 173 kt/y particulate matter; 179 kt/y SO_2; 25 kt/y CO; and 1,180 kt/y black carbon based on 3,410 kt/y diesel fuel consumption. The AMSA 2009 Report also estimated 2004 Arctic-wide CO_2 emissions of 10,800 kt/y based on 3,410 kt/y diesel fuel consumption.

Arctic Haze

Air quality on the Alaska North Slope is affected regionally and seasonally by a phenomenon known as “arctic haze.” During the late winter, early spring, the arctic atmosphere becomes contaminated with anthropogenic pollution from long-range transport of pollutants from industrial sources on the Eurasian continent (Rahn and Shaw 1980). The industrial sources identified were primarily metals smelters and coal-burning plants. The haze consists primarily of sulfate aerosols and soot (Wilcox and Cahill 2003). Sulfate aerosols and soot are effective at scattering light and reducing visibility. The first scientific observations of arctic haze were made in the 1950s; however, early arctic explorers had noticed atmospheric haze and dirty snow in the 1880s (Law and Stohl 2007). The existence of arctic haze most likely dates back to the widespread use of coal in Europe. Maximum concentrations of sulfates and fine particles in the Arctic were observed at the beginning of the 1980s (Pacyna 1995). Scientists recently determined that the industrial portion of arctic haze has decreased during the past 30 years (Quinn et al. 2009). Scientists also determined that smoke from early, intense fire seasons in Siberia boreal forests and agricultural burning in northern Kazakhstan contributed to the 1998 arctic haze season. In most years, seasonal Siberian forest fires and agricultural burning in Kazakhstan, southern Russia, and eastern Europe are a seasonal occurrence and usually start at the end of April and hence do not contribute to arctic haze (Warneke et al. 2009). Despite the seasonal, long-distance transport of pollutants into the Arctic, regional air contaminants are well below the NAAQS.

Greenhouse Gas Emissions

Estimated 2005 GHG emissions in Alaska totaled nearly 53 million metric tons of CO_2 equivalents (CO_2e) (ADEC 2008). The GHGs estimated in the ADEC report include CO_2, methane, and nitrous oxide. The ADEC report estimated total Alaska industrial sources produced 24.6 $MMtCO_2e$. The Alaska oil and gas industry accounted for approximately 73 percent of the industrial source total or 15.3 $MMtCO_2e$. For comparison, the ADEC report estimated the Alaska total transportation sector (commercial, military, and general aviation; rail, marine, and on-road vehicles) produced 18.8 $MMtCO_2e$.

3.1.7 Acoustic Environment

The need to understand the marine acoustic environment is critical when assessing the effects of oil and gas exploration and development on humans and wildlife. Sounds generated by oil and gas exploration and development within the marine environment can affect its inhabitants' behavior (e.g., deflection from loud sounds) or ability to effectively live in the marine environment (e.g., masking of sounds that could otherwise be heard). Understanding of the existing environment is necessary to evaluate what the potential effects of oil and gas exploration and development may be.

This section summarizes the various sources of natural ocean sounds and anthropogenic sounds documented in the Arctic subregion and, where available, describes the sound characteristics of these sources and their relevance for Statoil's seismic survey.

Ambient sound levels are the result of numerous natural and anthropogenic sounds that can propagate over large distances and vary greatly on a seasonal and spatial scale (National Research Council [NRC] 2003). This is especially the case in the dynamic Arctic environment with its highly variable ice, temperature, wind, and snow conditions. Where natural forces dominate, there will be sounds at all frequencies and contributions in ocean sound from a few hundred Hz to 200 kHz (NRC 2003).

In the Chukchi Sea, the main sources of underwater ambient sound would be associated with:

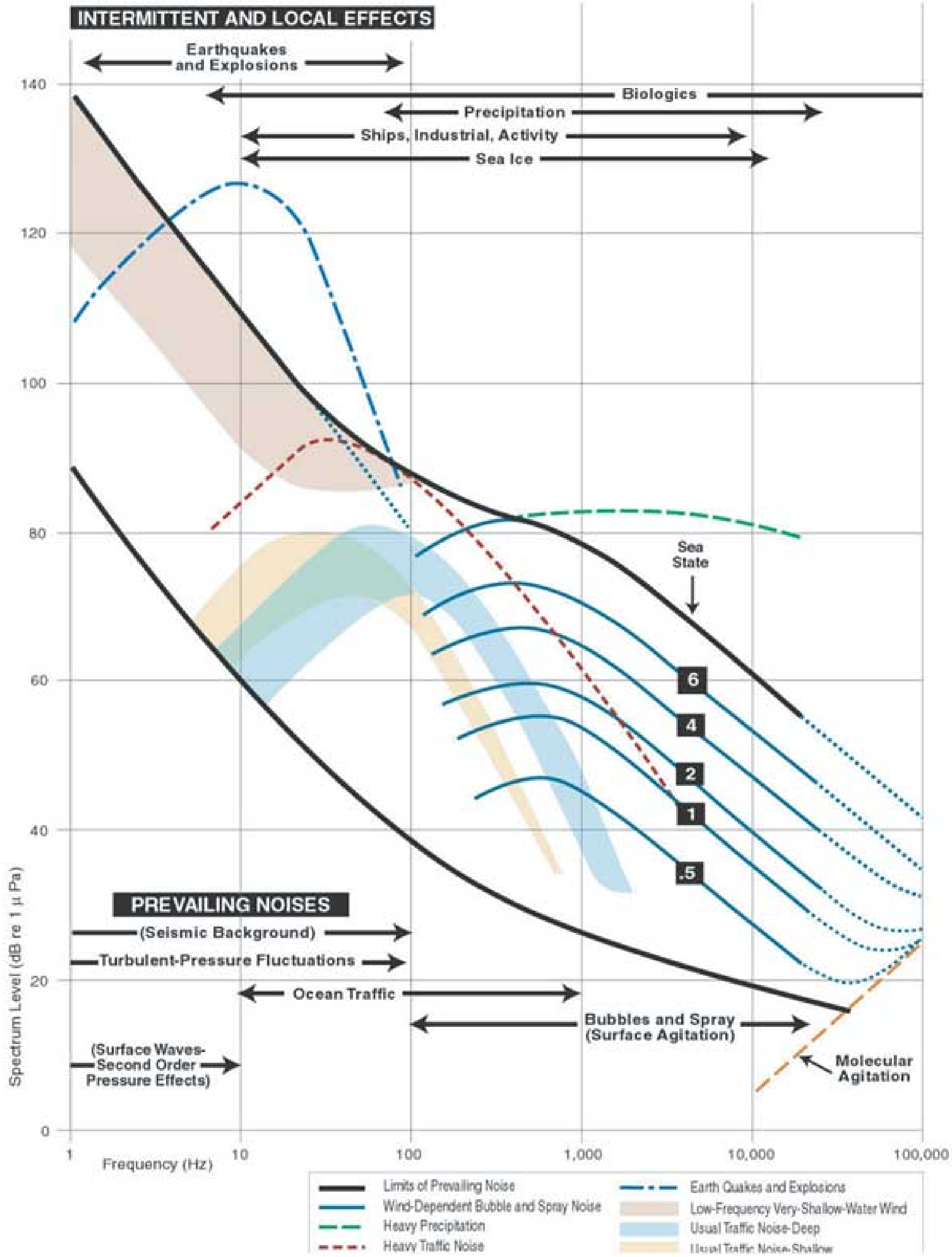
- Ice, wind, and wave action
- Precipitation
- Subsea earthquake activity
- Vessel and industrial transit
- Sonar and seismic-survey activities
- Biological sounds

The contribution of these sources to the background sound levels differs with their spectral components and local propagation characteristics (e.g., water depth, temperature, salinity, and ocean bottom conditions). In deep water, low-frequency ambient sound from 1–10 Hz mainly comprises turbulent pressure fluctuations from surface waves and the motion of water at the air-water interfaces. At these infrasonic frequencies, sound levels depend only slightly on wind speed. Between

20–300 Hz, distant anthropogenic sound (ship transiting, etc.) dominates wind-related sounds. Above 300 Hz, the ambient sound level depends on weather conditions, with wind- and wave-related effects mostly dominating sounds. Biological sounds arise from a variety of sources (e.g., marine mammals, fish, and shellfish) and range from approximately 12 Hz to over 100 kHz. The relative strength of biological sounds varies greatly; depending on the situation, biological sound can be nearly absent to dominant over narrow or even broad frequency ranges (Richardson et al. 1995).

Typical background sound levels within the ocean are shown as a function of frequency (Figure 3.1.7-1; Wenz 1962). The sound levels are given in underwater dB frequency bands written as dB re 1 µPa2/Hz. Sea State or wind speed is the dominant factor in calculating ambient noise levels above 500 Hz.

Figure 3.1.7-1 Background Sound Levels within the Ocean



Source: Wenz (1962); reprinted with permission from the National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. National Academy Press. Washington D.C.

3.1.7.1 Sources of Natural Ocean Sounds

Sources of natural ocean sounds in the Arctic subregion that contribute to the ambient sound levels are from non-biological and biological origins. Examples of non-biological natural sound sources include movements of sea ice, wind and wave action, surface precipitation, and subsea earthquakes. Biological sources of sound production are fish, marine mammals, and sea birds. The contribution of natural sounds to the overall ambient sound level has been well documented for the Beaufort Sea close to Northstar Island (Blackwell et al. 2008).

Information on ambient sound levels in the Chukchi Sea was scarce or lacking prior to 2006. Since then, studies have been conducted in the Chukchi Sea using a large array of bottom- mounted, autonomous acoustic recorders to provide information on ambient sound levels and the contribution of natural and anthropogenic sources (Martin et al. 2009).

Non-Biological Sound Sources

Wind, Waves, Sea Ice, and Precipitation

During the open water season, wind and wave actions are important sources of ambient sound with sound levels increasing as winds and waves increase (Richardson et al. 1995). Wind and waves can cause ice deformation and usually produce low-frequency sounds. Ice deformation has been shown to produce frequencies of 4–200 Hz (Greene 1981). Additionally, the presence, thickness, and movement of sea ice contributes to the ambient sound levels; and as ice melts and breaks apart, it produces additional background sound. Sounds from ice cracking may increase sound levels by as much as 30 dB[1], and can range from 100 Hz–1 kHz (Milne and Ganton 1964). The combination of wind and wave action on the surface creates a background din that ranges between 40–70dB source pressure level (re: 1µPa) in deep water, and up to 90 dB in shallow coastal areas (Stocker 2002). Interaction of ocean waves with the marginal ice zone may raise sound levels by 4–12 dB (Diachok and Winokur 1974).

The presence of sea ice contributes largely to the ambient sound levels and also affects sound propagation. The NRC (2001) has stated that the type of ice cover (i.e., shore-fast pack ice, moving ice pack, and floes) can influence the sound level or intensity. Richardson et al. (1995) have shown that, as areas of sea-ice coverage increase, sounds produced by waves and surf are reduced or eliminated.

Precipitation in the form of rain and snow would be another source of sound. These forms of precipitation can increase ambient sound levels by up to 35 dB across a broad band of frequencies, from 100 Hz to more than 20 kHz (Nystuen and Farmer 1987). In general, it is expected that precipitation in the form of rain would result in greater increases in ambient sound levels than snow. Thus, ocean sounds caused by precipitation are quite variable and transitory. Average precipitation nearest to the lease ranges from 10 inches in Point Hope to 5 inches in Barrow (MMS 2007). Normal snow cover for the Point Hope to Barrow area ranges from 36 inches to 20 inches, respectively.

Air and Water Properties

Air temperature can affect ambient sound levels. The variability in air temperature throughout the day has shown to change received sound levels by 30 dB[1] over the range of 300–500 Hz (NRC 2001). Temperature changes can also cause cracking of sea ice through mechanical means. Milne and Ganton (1964) have observed that, where there is continuous fast-ice cover, the dominant source of ambient sound is the ice cracking induced by thermal stresses.

[1] Decibel (dB) references in this document are expressed relative to 1µPascal per convention when referring to sound underwater. Decibels in an airborne environment are most commonly referred to relative to 20µPascals—the apparent threshold of human hearing. The numerical difference between these two references expressed in decibels is 26dB. For this reason, citations to underwater noise and sound sources may seem quite high for those most familiar with airborne sound-level expressions. For a more thorough explanation of the numerical differences between underwater and airborne sound, see M. Stocker "How Loud is the Navy Noise?" Earth Island, 2002.

The physical properties of water affect the way sound travels through water. In particular, water temperature, salinity, and pressure affect sound speed in water. The speed of sound increases with increasing water temperature, increasing salinity, and increasing pressure (i.e., water depth; DOSITS 2010). A sound wave is refracted when it encounters changes in the speed of sound toward the region of lower sound speed. Therefore, changes in the physical properties of water can affect sound propagation.

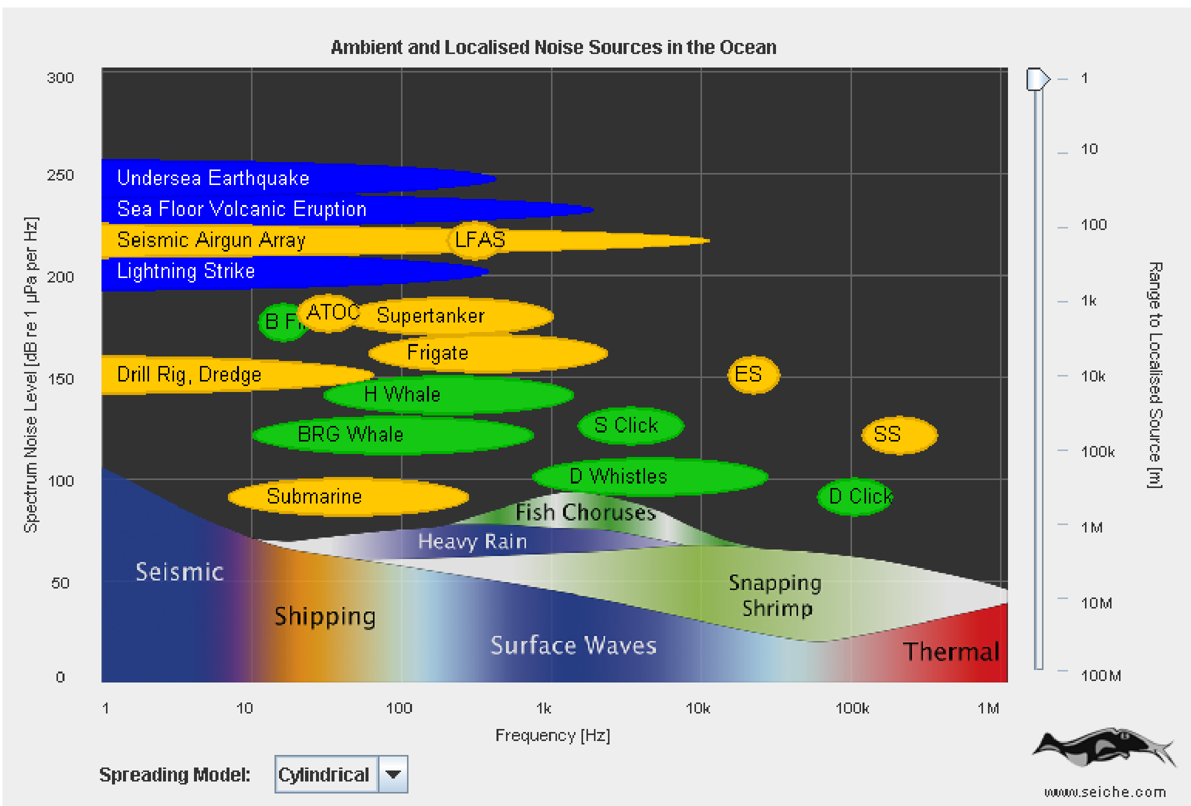
Seismic Events

Seismic events where there is a sudden shift of tectonic plates, or volcanic events where hydrothermal venting or eruptions occur, can produce a continual source of sound in some areas. This sound can be as much as 30–40 dB above background sound and can last from a few seconds to several minutes (Schreiner et al. 1995). Shallow hazard surveys conducted in the Alaskan Chukchi Shelf have found that it is generally not seismically active (Fugro 1989).

Biological Sound Sources

A summary is provided that shows the spectrum sound level (dB) as a function of frequency for various biological sources (Figure 3.1.7-2).

Figure 3.1.7-2 Ambient and Localized Sound Sources in the Ocean



Source: © Seiche Ltd. (2006); with permission.

Marine Fishes

Numerous fish grunt, grind, sing, or scrape to produce sounds for territory, bonding, and hunting purposes. Most audiograms of fishes indicate a low threshold (higher sensitivity) to sounds within the 100 Hz–2 kHz range (Stocker 2002). The data on the effects of sound on fishes are limited.

In the preceding figure, fish choruses are referenced at 75–100 dB within the frequency range of 500 Hz–20 kHz (Seiche Ltd. 2006).

Marine Mammals

Of the sources of biological sound in the ocean, the songs of whales and dolphins are most familiar. Some of the marine mammals that contribute to the background sounds in the Beaufort and Chukchi seas are shown in Table 3.1.7-1.

TABLE 3.1.7-1 Source Level and Frequency of Sounds Produced in Selected Marine Mammals

Species	Source Level[1]	Frequency	Reference
Bearded seal	178 dB		Cummings et al. 1983
Ringed seal calls	95–130 dB	5 kHz	Richardson et al. 1995
Bowhead whales	128–189 dB	20–3,500 Hz	Richardson et al. 1995

[1] re:1 µPa at 1m

Richardson et al. (1995) also referenced that bowhead whale calls are in the frequency modulation FM sound range of 50–400 Hz. Other marine mammals that contribute to the ambient sound and are found in the area include gray whale, walrus, beluga whale, spotted seal, fin whale, and the humpback whale.

3.1.7.2 Sources of Anthropogenic Sounds

The types and intensity of human activities in the arctic marine environment are increasing because of increased potential development of oil and gas reserves, opening up of the Arctic to commercial and recreational shipping, and general development within the Arctic. The major anthropogenic sources of sounds in the Arctic may be grouped into four general categories: (1) vessel transiting; (2) geophysical exploration; (3) vessel sonar; and (4) aircraft traffic. A summary of source levels by activity is shown in Table 3.1.7-2.

TABLE 3.1.7-2 A Comparison of Some Common Sound Levels by Source

Source[1]	Activity	db re: 1µPa at 1m
Vessel activity	Tug pulling barge	171
	Fishing boats	151–158
	Zodiac (outboard)	156
	Supply ship	181
	Tankers	169–180
	Supertankers	185–190
	Freighter	172
Ice breaking	Ice management	171–191
	Ice breaking	193
Dredging	Clamshell dredge	150–162

TABLE 3.1.7-2 A Comparison of Some Common Sound Levels by Source

Source[1]	Activity	db re: 1μPa at 1m
Drilling	Kuluk (conical drill ship)	185
	Artificial island	125
Seismic and acoustics (at seismic source)	Airgun arrays	235–259
	Single airguns	216–232
	Vibroseis	187–210
	Water guns	217–245
	Sparker	221
	Boomer	212
	Depth sounder	180
	Sub-bottom profiler	200–230
	Side scan sonar	220–230
	Military	200–230
Ambient sound	Ambient sound	65–133

[1] Notes: dB = decibels (a logarithmic scaled value)
re: relative
1μPa@1m = 1 microPascal at one meter
Sources: MMS (2007); Richardson et al. (1995); Burgess and Green (1999)

Vessel Transiting

Shipping is the dominant source of sound in the world's oceans in the range from 5 to a few hundred Hz. (National Academy of Sciences 2005). Commercial shipping is the major contributor to sound in the world's oceans and contributes to the 10–100 Hz frequency band (NRC 2003). Some of the more intense anthropogenic sounds come from oceangoing vessels, especially larger ships such as supertankers.

Sound energy in the Arctic is particularly efficient at propagating over large distances, because in these regions the oceanic sound channel reaches the ocean surface. The types of vessels that are commonly found in the Chukchi Sea include vessels to transport goods, such as tugs and barges; scientific research vessels, such as icebreakers; vessels used for local resident transportation and subsistence activities (e.g., whaling), such as skiffs with outboard motors or smaller enclosed vessels; and vessels associated with oil and gas exploration and development, predominately seismic source vessels, support vessels, and drill ships. In addition, interest in the Arctic has led to several tourist cruise ships spending time in arctic waters during the past few years (Lage 2009). In the Beaufort and Chukchi seas, vessel transiting and associated sounds presently are limited primarily to late spring, summer, and early autumn, when open waters are unimpeded by broken ice or ice sheets.

Due to the shortness of the open water season, vessel transiting—particularly large vessel transiting—is minimal in arctic marine waters. Richardson et al. (1995) described the range of frequencies for shipping activities to be from 20–300 Hz. They note that smaller boats used principally for fishing or whaling generate a frequency of approximately 300 Hz (Richardson et al. 1995).

Richardson et al. (1995) have documented that vessels that are 10 km away from a receiver contribute to only background sounds when in shallow water. And the same is true for a vessel that is 4,000 km away, only in deeper water.

Icebreaking vessels used in the Arctic for activities that include research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al. 1995). Even with rapid attenuation of sound in heavy ice conditions, the elevation in sound levels attributed to icebreaking can be substantial out to at least 5 km (Richardson et al. 1995). In some instances, icebreaking sounds are detectable from more than 50 km away.

As examples, the source levels associated with low-frequency pure tones radiated by supertankers and container ships lie in the range 180–190 dB (re: 1 µPa at 1 m), while drillship and dredging operations generate broadband source levels of 185 db (re: 1 µPa per Hz at 1 m) (Richardson et al. 1995). Activities associated with icebreaking have measured source levels at 193 dB (re: 1 µPa at 1 m).

Geophysical Exploration

Geophysical exploration and development activities generate sounds of relatively high intensity in the marine environment. In general, these sounds include seismic sources and drilling. The loudest sounds revealed by the SOSUS (Sound Surveillance System) were the sounds of marine extraction industries such as oil drilling and mineral mining (Stocker 2002). The SOSUS provides fixed arrays in the deep ocean basins for deep-water, long-range detection of acoustic signals. The most prevalent of these sounds are from the seismic airguns used to conduct seismic surveys for oil and gas.

Marine seismic data acquisition uses a burst of compressed air from an airgun array that is directed toward the seafloor. Airgun arrays typically discharge every few seconds. Hydrophones measure energy reflected from the subsurface, providing information about the sub-ocean geological structure. Seismic or geophysical exploration contributes significantly to the sound level (range 216–259 dB), as indicated in Table 3.1.7-2. While most of the energy from the airgun array is focused downward, and the short duration of each pulse limits the total energy expended into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson 1988; Hall et al. 1994).

The peak source levels from seismic sources are typically between 250–255 dB, though horizontal transmission is more in the range of 200 dB (Engås 1996). These sounds in water depths of 25–50 m can be detected 50–75 km away, can exceed 100 km in deeper water (Richardson et al. 1995), and may be heard up to thousands of kilometers away in the open ocean (Nieukirk et al. 2004).

While the seismic airgun pulses are directed toward the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson 1988; Hall et al. 1994). In waters 25–50 m deep, sound produced by airguns can be detected 50–75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al. 1995).

Vessel Sonar

Acoustical systems associated with surface vessels, submarines, and research applications are commonly used in the Beaufort and Chukchi Seas. Types of systems used include multi-beam sonar, sub-bottom profilers, and acoustic Doppler current profilers. Multi-beam sonar operates using active sensors that utilize acoustic energy to collect measurements of seafloor depth and character. Sub-bottom profilers are used to detect moving objects by measuring the Doppler frequency shift of the scattered signal relative to the transmitted frequency. The frequency content of acoustic signals generated by various types of sub-bottom profiling equipment ranges from several tens of Hz to several tens of kHz (Communication Technology 2009). Doppler current profilers are designed to collect detailed maps of the distribution of water currents and suspended materials through the water column and along the ship's path—at depths and resolutions previously considered unattainable. These particular types of equipment contribute significantly to the sound level (range 200–230 dB), as indicated in Table 3.1.7-2.

Depth-sounding and "fish-finding" sonar devices operate in the 15–200 kHz frequency range, with a few watts to a few kilowatts of power (Furuno Company). Other navigational sonars operate in the mid-frequency band of 1–20 kHz (Ocean Imaging Systems 2002). Long-range sonars operate in the 100 Hz–3 kHz range (Department of the Navy 2001). The acoustical power range of these devices is 150–215 dB. These units produce a source sound level of 180 dB as indicated in Table 3.1.7-2.

Aircraft Traffic

Helicopter operations are not planned as a part of the seismic survey, although it is possible, in emergency situations that individuals could be transported to and from vessels via helicopter.

3.2 Biological Environment

3.2.1 Lower Trophic Organisms

Lower trophic organisms serve as the basis of the food web in the Arctic Ocean. They provide nutrition for birds, fish, and marine mammals. The lower trophic communities in the Chukchi Sea in Statoil's project area consist of benthic organisms, phytoplankton, zooplankton, and the epontic community. Abundance and distribution of these organisms depend largely on physical environmental factors such as nutrient availability, light availability, water turbidity, wind, and currents. Currents from the Bering Sea provide primary production that promotes growth and biodiversity in the Chukchi Sea as well as transport detritus and larval invertebrates (MMS 1987). The degree to which ice is present also directly affects the timing and spatial distribution of lower trophic organisms.

3.2.1.1 Pelagic Community

Pelagic organisms are those that live in the water column, such as phytoplankton and zooplankton. Since plankton drift suspended in the water column, their movement is dependent upon ocean currents.

Phytoplankton are microscopic, unicellular algae. They are the source of primary production derived via photosynthesis in the Chukchi Sea. This primary production forms the base of the entire food chain in the Chukchi Sea. Areas with especially high primary productivity, such as coastal areas, support high zooplankton biomass. High primary productivity and zooplankton biomass produce excess material that falls to the seafloor, allowing for increased benthic productivity as well. Figure 3.2.1-1 shows areas in the Chukchi Sea, in relation to Statoil's project area, with high chlorophyll concentrations indicating high levels of primary productivity.

Primary productivity decreases north of the Bering Strait (MMS 1987). Light and nutrient availability are factors that affect primary productivity. Pelagic phytoplankton composition consists mostly of centric diatoms (R. A. Horner 1969). *Nitzschia cylindrus* (R. G. Horner 1982) and *Chaetoceros spp.* (English 1966) are common diatom species found in the Chukchi Sea.

Zooplankton are major food sources for animals in the Chukchi Sea, including the bowhead whale. Species composition changes as one moves further offshore (Brodsky 1957). Offshore areas, such as in Statoil's project area, were characterized by copepod species such as *Metridia lucens*, *Calanus plumchrus*, and *Eucalanus bungii* (English 1966) and by the hydromedusa *Aglantha digitale* (Wing 1974).

3.2.1.2 Benthic Community

Benthic organisms are those that live on or in seafloor sediments. The benthic community within Statoil's project area in the Chukchi Sea can consist of macroscopic algae, benthic microalgae, and benthic invertebrates (MMS 1987). These organisms are important because they provide a crucial link between the primary producers and larger animals, facilitating the transfer of energy within the environment. The benthic community is the food source that supports key marine mammal species near Statoil's project area, including the Pacific walrus and the gray whale. These mammals congregate in Hanna Shoal, adjacent to the project area, for feeding in those shallow waters.

There are no known kelp beds within Statoil's project area as have been found closer to coastal areas south of Lease Sale Area 193. It appears that kelp beds are not frequently found in the Chukchi Sea (MMS 1987).

Van Veen grab samples were taken from sites across the Chukchi Sea to identify groups of benthic invertebrate communities (cluster groups) (Stoker 1981). In the northeastern Chukchi Sea, near Statoil's project area, two cluster groups were identified (groups VI and VIII). Table 3.2.1-1 shows the species composition of these two groups.

TABLE 3.2.1-1 Species Composition of Benthic Cluster Groups Common in the Northeastern Chukchi Sea

Dominant Species	Common Name
Cluster Group VI	
Maldane sarsi	Polychaete worm
Ophiura sarsi	Brittle star
Golfingia margariticea	Peanut worm (sipunculid)
Astarte borealis	Clam
Cluster Group VIII	
Macoma calcarea	Clam
Nucula tenuis	Clam
Yoldia hyperborean	Clam
Ponteporeai femorata	Amphipod

Source: Stoker 1981

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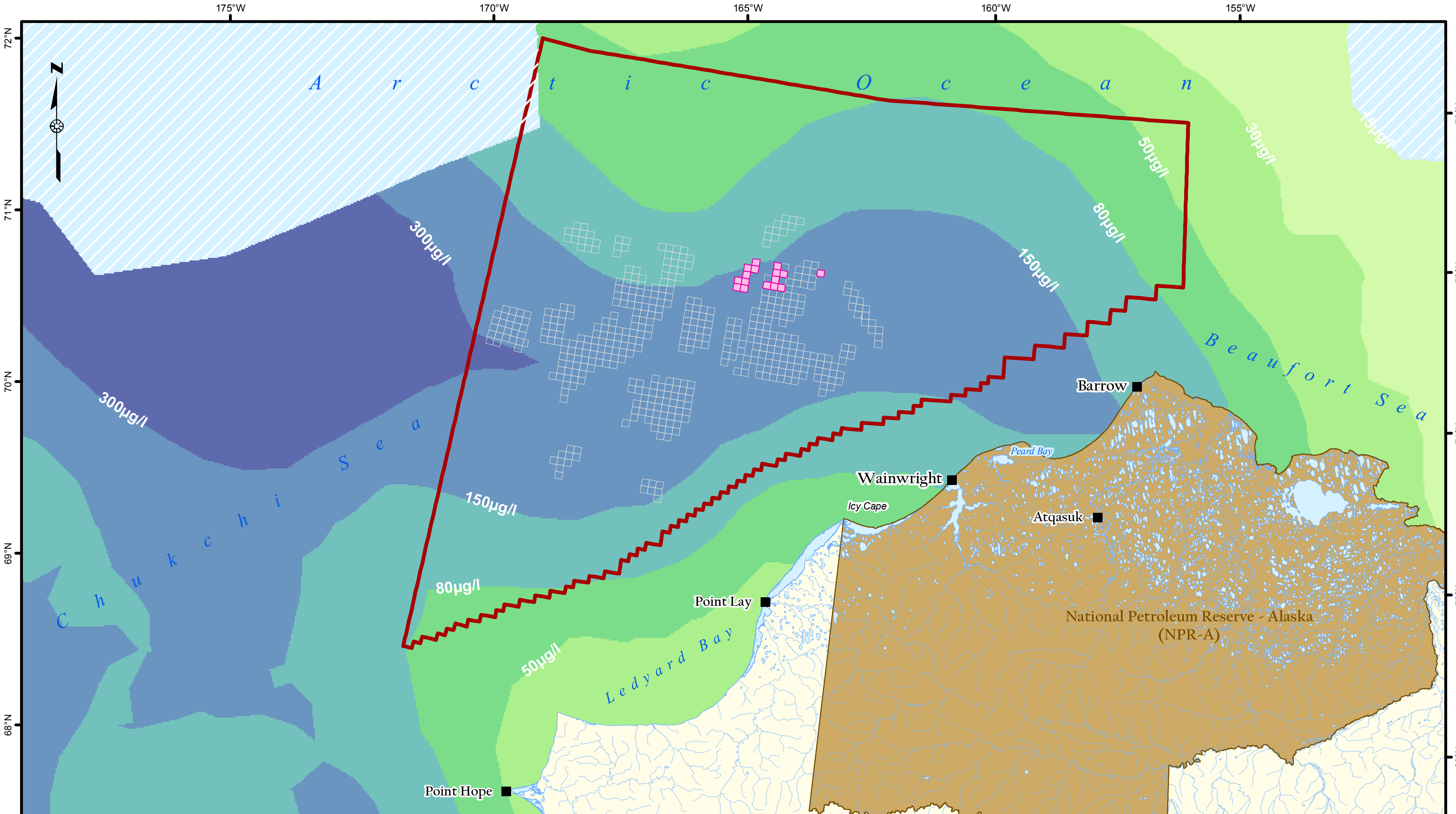

Chlorophyll Concentration (in µg/L):

- 15 - 29
- 30 - 49
- 50 - 79
- 80 - 149
- 150 - 299
- 300 - 512
- No Data

- Village
- Lease Sale 193 Area
- National Petroleum Reserve - Alaska

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area
Source of Chlorophyll Concentration data: Dunton et al., 2003.

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

CHLOROPHYLL A CONCENTRATIONS IN THE CHUKCHI SEA, µg/L

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.1-1

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Video surveys conducted near the Burger prospect (Finney 1989), near Statoil's project area, confirmed that the area was consistent with Cluster Group VI in Table 3.2.1-1 (Boudreau 1989). The brittle star, *Ophiura spp.*, was the predominant species with densities between 100–400 animals/sq m (9–37/sq ft).

The abundance of benthic organisms increases during the open water season. In the project area, abundance and species diversity increase with water depth, because sediments in shallower waters are more prone to frequent ice gouging or complete covering by bottomfast ice. These areas covered by bottomfast ice in the winter are temporarily recolonized during the summer, ice-free months.

The northeastern Chukchi Sea supports a higher biomass of benthic organisms than do surrounding areas (Grebmeier and Dunton 2000). Areas such as this are probably more productive because the pelagic organisms cannot consume all of the phytoplankton. The excess primary production sinks to the seafloor and provides ample nutrition to support higher biodiversity and species abundance. The prevailing currents are generally not strong enough to remove nutrients before they are reused. Some benthic-feeding marine mammals, such as walruses and gray whales, take advantage of the abundant food resources and congregate in these highly productive areas. Harold and Hanna Shoals are two known highly productive areas in the Chukchi Sea rich with benthic animals. Figure 3.2.1-2 shows benthic biomass concentrations in relation to Statoil's project area and Hanna Shoal. Hanna Shoal is adjacent to Statoil's project area.

3.2.1.3 Epontic Community

Epontic organisms are those that live on or are closely associated with the undersurface of sea ice. Included in this community are assemblages of plants, small invertebrates, and cryopelagic fish (MMS 1987). Algae that live on the underside of the sea ice or within the bottom three centimeters provide primary production for not only the epontic community, but the rest of the Chukchi Sea.

The ice algae species composition differs from the pelagic phytoplankton composition in the water column. Ice algae consist mostly of pennate diatoms such as *Navicula marina*, although approximately 200 diatom species have been identified in arctic sea ice(Alexander, Horner and Clasby 1974).

The ice-algal bloom occurs mostly in April and May, prior to the pelagic phytoplankton bloom, which does not occur until the ice has melted in the area and there is a significant increase in light availability for photosynthesis (MMS 1987). Ice algae productivity also increases significantly with the increase in light availability (Alexander, Horner, and Clasby 1974). Years with thicker snow cover on the ice yield less productive populations of ice algae (Alexander, Horner, and Clasby 1974). The overall contribution of ice algae to the primary productivity of the Chukchi Sea may be small in comparison to that of the pelagic phytoplankton community, but it could provide a useful source of food during the spring prior to the pelagic phytoplankton bloom as the ice melts during the summer season, usually around July.

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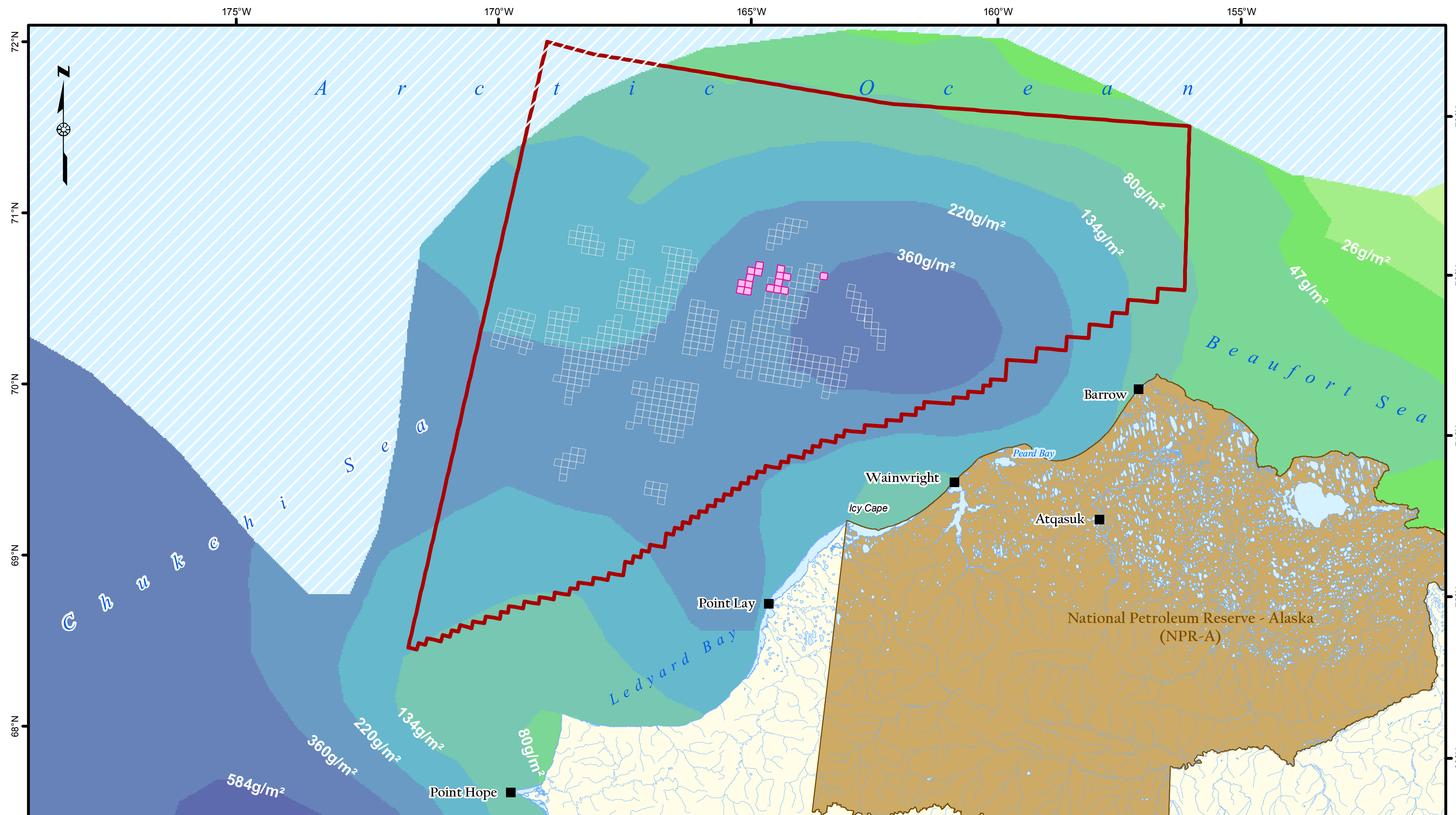

Benthic Biomass Concentration (in g/m²):

5 - 12.9	134 - 219.9
13 - 25.9	220 - 359.9
26 - 46.9	360 - 583.9
47 - 79.9	584 - 723
80 - 133.9	No Data

■ Village
Lease Sale 193 Area
National Petroleum Reserve - Alaska

Lease Owner
Statoil
All Other

NAD83, Alaska Albers Equal Area
Source of Chlorophyll Concentration data: Dunton et al., 2003.

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

BENTHIC BIOMASS CONCENTRATIONS IN THE CHUKCHI SEA (g/m²)
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.1-2

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3.2.2 Fish and Shellfish Resources

During summer, waters of the Chukchi Sea host an array of marine and migratory fish species. Marine fishes using the Chukchi Sea comprise year-round residents or migrants from the nearby Beaufort and Bering Seas. Migratory fishes present in the Chukchi Sea may travel from inland streams of the Chukchi or Beaufort, Bering, or Russian Sea regions. Shellfish occupy the benthic habitat with a pattern of distribution influenced by prey availability and sediment type. Historical and recent surveys have provided a list of species occupying these waters (Andriyashev 1954; Fechhelm et al. 1984; Barber et al. 1994; Norcross et al. 2009; Moss et al. 2009; NOAA 2009). Marine and migratory fishes and shellfish documented in the northeastern Chukchi Sea are listed in Table 3.2.2-1; these species are consumed by marine mammals and birds, harvested by residents of the North Slope for subsistence use, and are the most abundant fishes in the Chukchi Sea. For more information on subsistence, see Section 3.3.4.

In the last two decades, arctic fish surveys have looked at distribution and abundance with regard to interannual variation in oceanographic conditions and reduced ice cover. Barber et al. (1994) and Norcross et al. (2009) looked at the influence of watermasses on fish distribution and abundance. Moss et al. (2009) looked at the distribution and growth of pink and chum salmon in Northern Bering and Chukchi Sea waters with diminished ice cover. This section addresses marine and migratory fishes and shellfish based on abundance, distribution, and life history.

TABLE 3.2.2-1 Marine and Diadromous Fishes and Shellfish of the Northeastern Chukchi Sea

Family	Common Name and Scientific Name	Coastal Distribution	Offshore Distribution	Subsistence Harvest
Marine Fishes				
Gadidae	Arctic cod *(Boreogadus saida)*	+	+	Yes
	Saffron cod *(Elignus gracilis)*	+	+	Yes
	Walleye Pollock *(Theragra chalcogramma)*	-	+	Yes
Cottidae	Arctic staghorn sculpin (*Gymnocanthis tricuspis*)	+	+	Rare
	Arctic sculpin (*Myoxocephalus scorpioides*)	+	+/-	Rare
	Fourhorn sculpin (*Myoxocephalus quadricornis*)	+	+/-	Rare
Osmeridae	Capelin *(Mallotus villosus)*	+	-	Yes
	Rainbow smelt (*Osmerus Mordax)*	+	+	Yes
Ammodytidae	Pacific sand lance *(Ammodytes Hexapterus)*	+	+	No

TABLE 3.2.2-1 Marine and Diadromous Fishes and Shellfish of the Northeastern Chukchi Sea

Family	Common Name and Scientific Name	Coastal Distribution	Offshore Distribution	Subsistence Harvest
Clupeidae	Pacific herring *(Clupea harengus pallasi)*	+	+	Yes
*Pleuronectidae***	Bering flounder *(Hippoglossoides robustus)*	+	+	Yes
*Zoarcidae***	Wattled eelpout (*Lycodes palearis)*	+	+	No
*Stichae idae***	Slender eelblenny (*Lumpenus febricii)*	+	+	No
Salmonidae	Pink salmon *(Oncorhynchus gorbuscha)*	+/-	+/-	Yes
	Chum salmon *(Oncorhynchus keta)*	+/-	+/-	Yes
	King salmon *(Oncorhynchus tshawytcha)*	-	-	Yes
	Sockeye salmon *(Oncorhynchus nerka)*	-	-	Yes
	Arctic char *(Salvelinus alpinus)*	+/-	-	Yes
	Dolly Varden *(Salvelinus malma)*	+/-	-	Yes
	Broad whitefish *(Coregonus nasus)*	+	-	Yes
	Humpback whitefish *(Coregonus pidschian)*	+	-	Yes
	Round whitefish *(Prosopium cylindraceum)*	+	-	Yes
Majidae	Snow crab *(Chionoecetes opilio)*	+	+	Yes

(+) common; (+/-) incidental or seasonal; (-) rare
Sources: Barber et al. 1994; Norcross et al. 2009; Johnson et al. 2009; Fehhelm et al. 1984

3.2.2.1 Marine Fishes

Most of the 66 marine fish species documented within the Chukchi Sea belong to eight families: Gadidae, Cottidae, Osmeridae, Ammodytidae, Clupeidae, Pleuronectidae, Zoarcidae, and Stichaeidae. Fish may utilize the pelagic, demersal, or benthic zones; or in some cases, they will distribute all through the water column. The availability of fish for marine mammals and bird consumption essentially sustains arctic food webs. Arctic cod are one of the most important prey species supporting the arctic food web. Barber et al. (1994) found Arctic cod to be the most abundant fish within the Statoil lease area. Using the statistical method of cluster analysis on marine fish surveyed in the Chukchi Sea lease sale areas, Barber et al. (1994) catagorized species composition and abundance into eight unique assemblages based on similar patterns of fish abundance and biomass per square kilometer in the survey area The results of their survey found a total of eight assemblages, six of the most abundant assamblages are provided in Table 3.2.2-2; Figure 3.2.2-1. Arctic cod were the most abundant species idenitified throughout the survey areas. Other findings included higher diversity of fish species in nearshore coastal waters of the southern extent of the survey area.

TABLE 3.2.2-2 Estimated Mean Abundance (fish per sq km) among Six Northeastern Chukchi Sea Fish Assemblages.

		Assemblage					
Common Name	**Scientific Name**	**I**	**II**	**III**	**IV**	**V**	**VI**
Arctic Cod	*Boreogadus saida*	43,733	16,419	5,280	8,172	16,096	6,100
Saffron Cod	*Elignus gracilis*	684	2	170	19	10,956	0
Sculpin	*Cottidae*	3,391	49	44	2	4,492	0
Staghorn Sculpin	*Gymnocanthis tricuspis*	1,005	87	889	156	2,618	7
Bering Flounder	*Hippoglossoides robustus*	1,599	72	0	61	15	3
Warty Sculpin	*Myoxocephalus verrucosus*	178	0	429	177	773	9
Hamecon	*Artediellus scaber*	20	0	0	11	1,061	4
Walleye pollock	*Theragra chalcogramma*	69	0	0	26	861	0
Ribbed sculpin	*Triglops pingelii*	70	3	120	59	722	0
Capelin	*Mallotus villosus*	437	0	0	40	0	0
Wattled eelpout	*Lycodes palearis*	453	0	0	139	323	0
Pacific herring	*Clupea harengus pallasi*	195	0	0	139	323	0
Slender eelblenny	*Lumpenus febricii*	235	18	2	14	141	0
Candadian eelpout	*Lycodes Polaris*	260	64	2	0	6	0
Eelpout	*Zoarcidae*	76	7	4	284	13	5
Sturgeon poacher	*Podothecus accipenserinus*	60	0	18	5	280	0
Pacifc cod	*Gadus macrocephalus*	21	0	1	6	273	0
Variegated snailfish	*Liparidae*	129	2	0	15	29	0
Rainbow smelt	*Osmerus modax*	0	0	0	0	258	0
Butterfly sculpin	*Hemilepidotus papilio*	89	0	0	13	0	0
Hookear sculpin	*Artediellus uncinatus*	80	0	0	0	20	0

Source: Barber et al. 1994
Note: The estimated mean abudnance is based on the most abundant demersal fish in the Northeastern Chukchi Sea.

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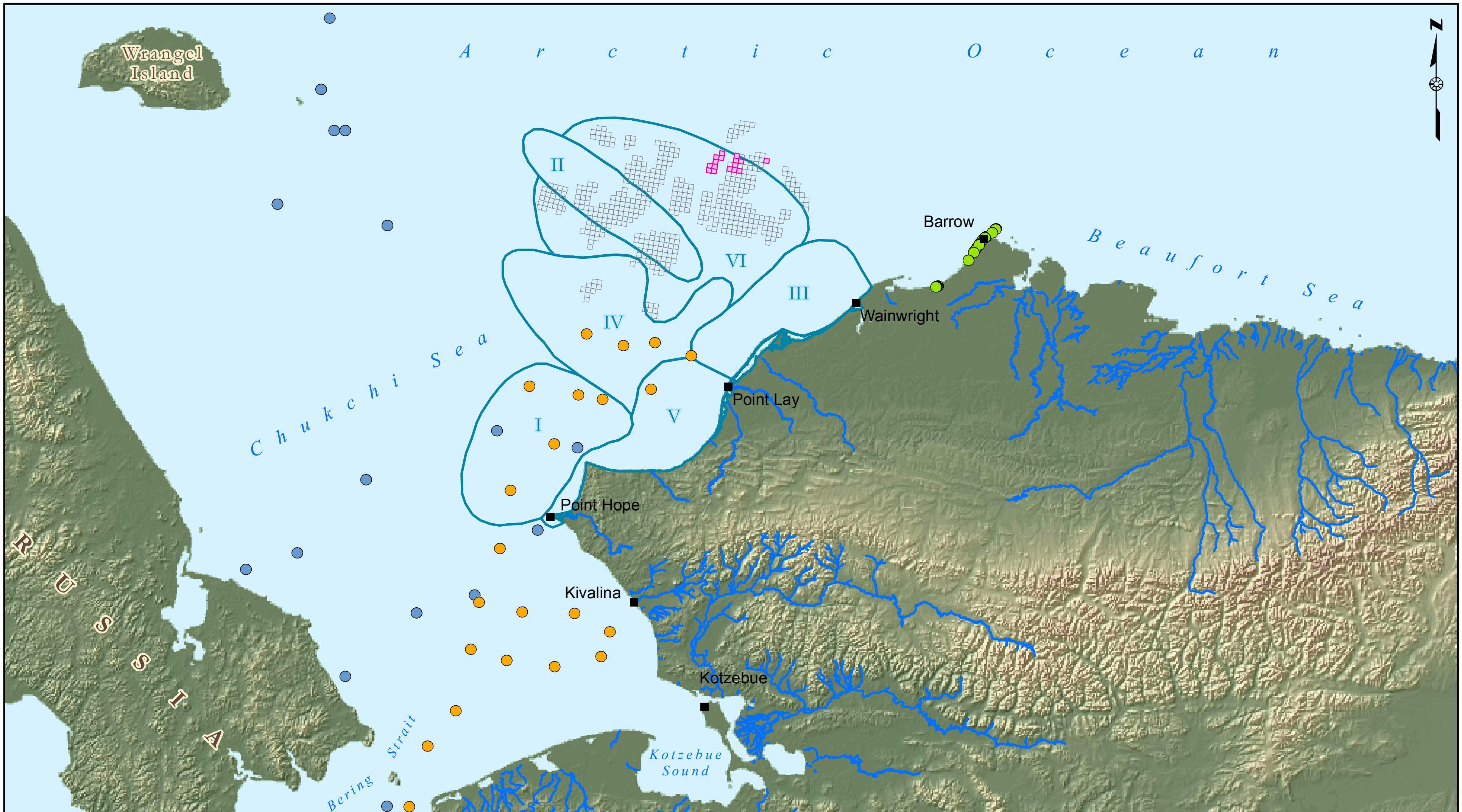

Moss Pink Chum Average

- Pink and Chum Salmon Catch

Norcross 2009

- Demersal Fish Catch

Chukchi Sea Fish Atlas

- Coastal Fish Catch

NAD83, Alaska Albers

- Demersal Fish Assemblages
- Anadromous Stream
- Town

Lease Owner

- Statoil
- All Other

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OVERVIEW OF FISH DISTRIBUTION DATA FOR THE NORTHEASTERN CHUKCHI SEA

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE:
0 25 50 100
Miles

FIGURE:
3.2.2-1

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Gadidae Family (Cods)

The distribution of Gadids fluctuates seasonally, depending on ocean currents and water temperature. Compared to other fish, Gadids prefer cold water (Gillispie 1993). Variations in water temperature may influence the northern and southern extent of Gadids. Walleye pollock, for example, may move into Northern Chukchi Sea waters during summer when water temperature is warmer (Gillispie 1993). Of the Gadids present in Chukchi Sea waters, Arctic cod are the most abundant (Gillispie 1993). Arctic cod, saffron cod, and walleye pollock belong in the Gadidae family, and all three species are prevalent within the Chukchi Sea. Arctic cod is the most abundant species documented in the Chukchi Sea.

Gadids mature at a young age, experience rapid growth, and produce large numbers of offspring (up to 200 viable eggs per female) (Gillispie 1993; Craig et al. 1989). When the Gadid population decreases, marine mammals and seabird populations depending on Gadids for prey also decrease (Gillispie 1993).

Arctic Cod

Abundance

Based on their northeastern Chukchi Sea survey, Barber et al. (1994) estimated a mean abundance of 95,800 fish per sq km. They are a critical component of the food web, and their biomass supports species linked to higher trophic levels, such as the bowhead whale and various coastal birds.

Distribution

Arctic cod can be expected to occur in the 2010 Chukchi 3D Seismic survey project area. They follow pack ice, which provides protection from predators such as marine mammals and seabirds. The ice edge additionally serves as a productive zone where invertebrates can be foraged upon. Arctic cod can be expected to frequent lagoons along the Chukchi Sea coastal zone when temperatures drop from their normal mid-summer range and fall to 0ºC (32ºF), usually in mid-August (Gillispie 1993). As juveniles and adults they can be expected to disperse throughout the entire shelf (0–500 m; 0–1,641 ft) (NPFMC 2009).

Life History

The eggs and larvae of Arctic cod are most often found in pelagic waters or directly under ice. As fish grow into juveniles or young-of-the-year, they remain within surface waters, traveling to greater depths as they grow (Gillispie 1993). Maturity occurs between 1–4 years of age, with spawning taking place January–February (Gillispie 1993).

Saffron Cod

Abundance

During a 2004 demersal and larval fish survey of the Chukchi Sea, a total of 69 saffron cod were caught in waters of the southern Chukchi Sea and beyond the Russian boundary line northeast of Wrangel Island (Norcross et al. 2009). In another fish survey, the estimated mean abundance was 11,831 per sq km (Barber et al. 1994).

Distribution

Saffron cod are considered semi-demersal; they tend to occupy nearshore waters where the depth is less than 50 m (164 ft) (NPFMC 2009). There are no studies indicating that saffron cod utilize or occupy the ice edge like their close relative, the Arctic cod (Gillispie 1993).

Life History

Spawning takes place in the intertidal zone in waters between 2–10 m (7–33 ft) deep. Fish lay their eggs in sand and other benthic substrate, and eggs settle at the bottom. Eggs are coated with an adhesive that attaches to rocks or kelp. When eggs hatch, the larvae float to surface waters and later settle in the demersal zone as adults (Sample and Wolitira 1985; Gillispie 1993). Maturity occurs between 2–3 years of age, and total lifespan can last up to 9 years. Spawning typically takes place from December–March (Wolotira 1985).

Walleye Pollock

Abundance

Barber et al. (1994) estimated a total of 956 walleye pollock per sq km throughout the northeastern Chukchi Sea. Though there was less sampling time involved, a trawl survey occurring in the southern Chukchi Sea and beyond the Russian boundary line northeast of Wrangel Island captured a total of four walleye pollock in summer 2004 (Norcross et al. 2009, in press) (see Figure 3.2.2-2).

Distribution

Walleye pollock are pelagic spawners, dispersing eggs at depths of 150–300 m (490–980 ft). As the eggs develop, they rise up the water column, remaining at about 150 m (490 ft). During their larval stage, pollock typically move into the upper 50 m (164 ft) of the water column (Gillispie 1993). When they develop into juvenile fish, they travel between shallow and deep waters daily (Gillispie 1993).

Life History

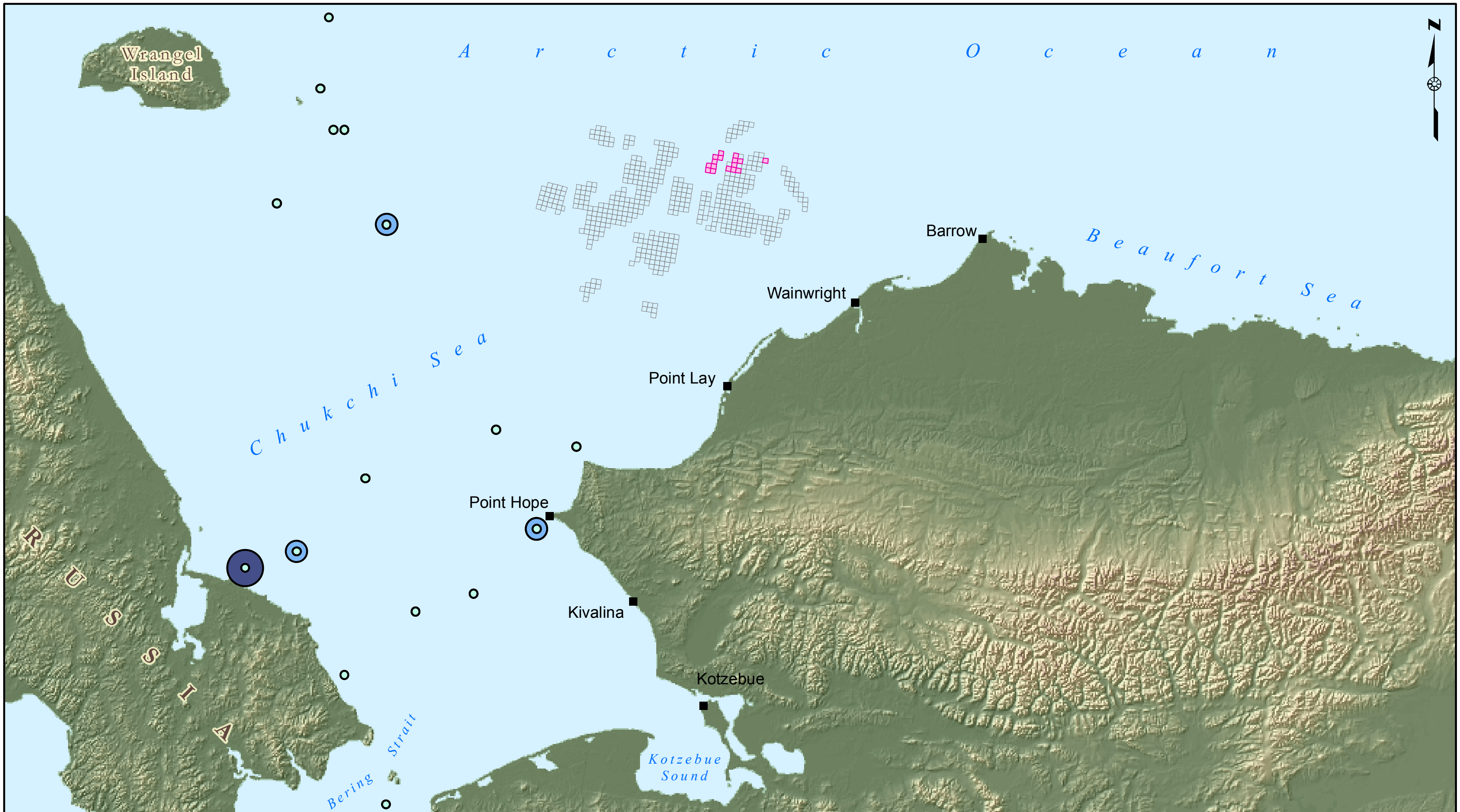
Walleye pollock have been reported to live up to 28 years (Barber et al. 1994). Walleye pollock mature between the ages of 3–4 years of age. They have a relatively long spawning period that can last anywhere from January–August; the peak typically occurs mid-April–mid-May (Gillispie 1997).

Cottidae Family—Sculpins

A variety of sculpin species occur in the Chukchi Sea. Marine surveys often identify sculpins to the family taxonomic level. The most abundant cottid species in the Chukchi Sea includes Arctic staghorn sculpin (*Gymnocanthis tricuspis*), Arctic sculpin (*Myoxocephalus scorpioides*), fourhorn sculpin (*Myoxocephalus quadricornis*), hamecon (*Artediellus scaber*), warty sculpin (*Myoxocephalus verrucosus*), and ribbed sculpin (*Triglope pingeli*) (Barber et al. 1994; Johnson et al. 2009) (see Figure 3.2.2-3).

Abundance

Three of the most recent fish surveys captured Cottidae during their sampling efforts (Barber et al. 1994; Norcross et al. 1433; Johnson et al. 2009). Biomass estimates for trawls conducted in 1976 and 1990 show an increase in sculpins (NPFMC 2009). Chukchi Sea estimates for sculpin in 1976 were 2,087 metric tons and 15,030 metric tons in 1990 (NPFMC 2009) A survey occurring throughout the lease sale area estimated a mean abundance of 16,578 fish per sq km (Barber et al. 1994). A survey conducted in coastal waters from Point Barrow to Skull Cliff counted a total of 1,857 juvenile and adult sculpins (Johnson et al. 2009). A survey ranging from the southern Chukchi Sea to northeast of Wrangel Island counted a total of 778 sculpins in the Cottidae family (Norcross et al. 2009 in press).



Reference: Norcross B.L., B.A. Holladay, M.S. Busby, and K.L. Meir Demersal and larval fish assemblages in the Chukchi Sea. Deep-Sea Research II. 2009. doi:10.1016/j.dsr2.2009.08.006

NAD83, Alaska Albers

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DEMERSAL FISHES CAUGHT FROM THE BERING STRAIT TOTHE NORTHEASTERN CHUKCHI SEA
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 25 50 100 Miles

FIGURE: 3.2.2-2

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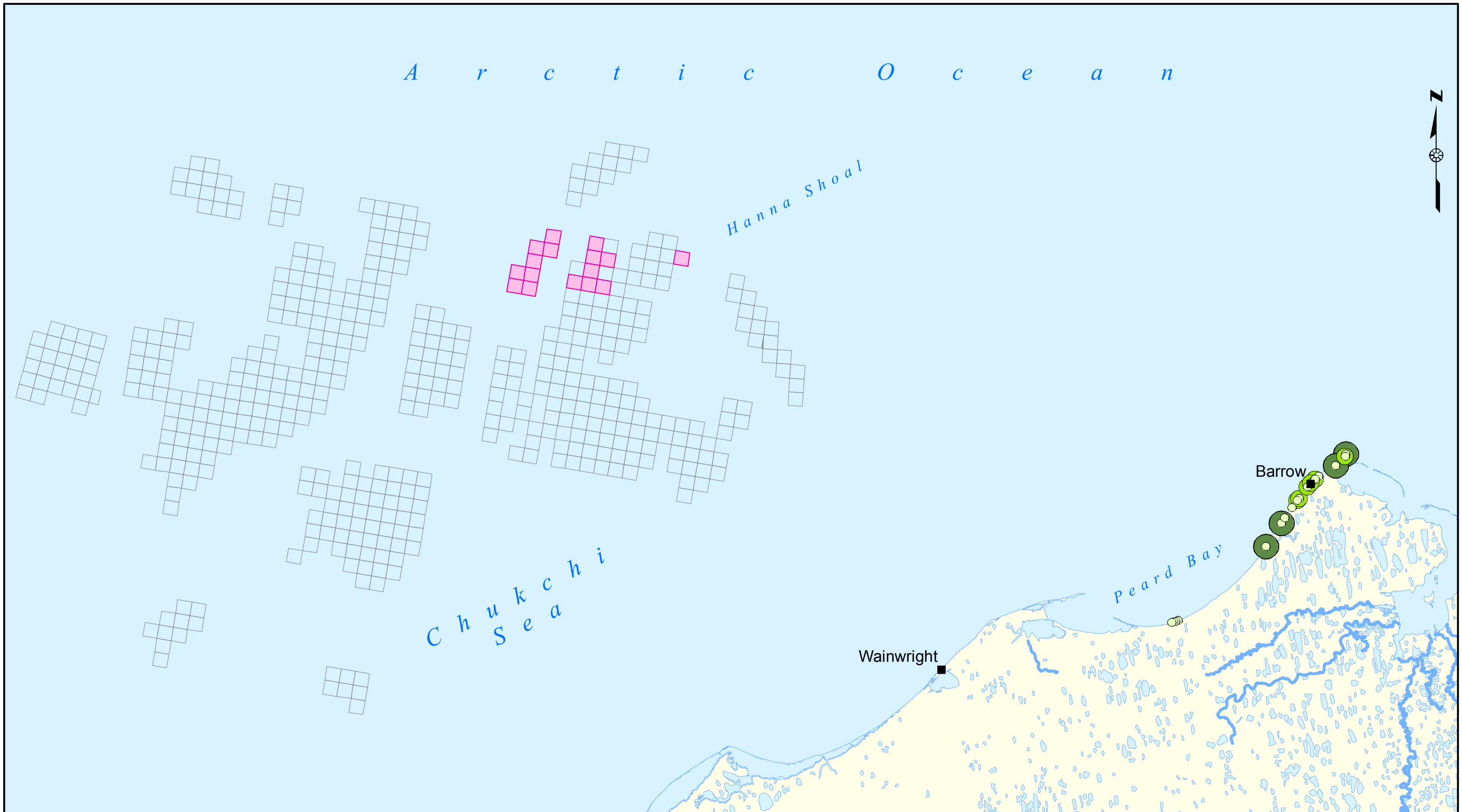

Cumulative Coastal Fish Catches
- 1 - 100
- 101 - 300
- 301 - 2501

Lease Owner
- Statoil
- All Other

■ Town

NAD83, Alaska Albers

Reference: Johnson, S.W., J.F. Thedinga, A.D. Neff, and J.C. George. Accessed December 11, 2009 National Oceanic and Atmospheric Administration (NOAA). Nearshore Fish Atlas of Alaska. Chukchi and Beaufort Sea Locations. http://www.fakr.noaa.gov/habitat/fishatlas/.

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COASTAL FISHES ALONG THE NORTHEAST CHUKCHI SEA
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 12.5 25 50 Miles

FIGURE: 3.2.2-3

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Distribution

As demersal fishes, Cottids can be expected to occur all throughout OCS waters of the Chukchi Sea. Arctic staghorn sculpin can be expected to occur at 0–250 m (0–820 ft), ribbed sculpin at 20–150 m (66–492 ft), fourhorn sculpin at 0–25 m (0–82 ft), Arctic at 0–25 m (0–82 ft), and hamecon at 0–500 m (0–1,640 ft). Typical distribution occurs anywhere from shallow coastal waters, up to a depth of 500 m (1,640 ft). Cottids have been associated with sand, pebble, gravel, and rocky bottoms, with some species preferring the mud or clay bottoms in brackish coastal waters (Mecklenberg et al. 2002).

Life History

Male sculpins, such as the Arctic staghorn, may reach sexual maturity between 2–3 years of age and sometimes as late as age 4 (Smith et al. 1997; Andriyashev 1964). Females reach sexual maturity between the ages of 3–4 years (Smith et al. 1997). Spawning events have been documented as early as September, but may also occur as late as December and January (Smith et al. 1997).

Osmeridae Family—Smelt and Capelin

Both rainbow smelt and capelin are important forage fishes of the Osmeridae family occupying waters of the Chukchi Sea. Both species provide important forage items to other fish, marine mammals such as the harbor porpoise and ringed seal, and several sea birds (NPFMC 2009; Yang and Nelson 2000). Rainbow smelt are classified as anadromous.

Abundance

Interannual abundance fluctuates, and biomass estimates based on 1976 and 1990 surveys showed a variation of 4,191 metric tons and 272 metric tons, respectively (NPFMC 2009). More recently (2005–2008), nearly 6,000 capelin were caught in coastal fish surveys near Point Barrow (Johnson et al. 2009). Barber et al. (1994) estimated a mean abundance of 477 fish per sq km in waters throughout the Chukchi Sea Lease Sale area.

Distribution

Osmeridae can be expected to occur in the epipelagic and epibenthic waters of the Chukchi Sea coastline, within small bays, and along the coastal shelf (0–50 m [0–164 ft]). Ideal habitat for both species consists of sand and gravel along with small cobbles (NPFMC 2009).

Life History

Spawning occurs in early August in coastal waters of the Chukchi Sea. Spawning usually occurs as the icepack in coastal waters retreats and nearshore waters are between 5–9ºC (41–48ºF) (Yang et al 2005). Nursery areas may occur in the inshore area where young may overwinter.

Ammodytidae—Pacific Sand Lance

Pacific sand lances are an important ecosystem component species because they provide important forage to both marine mammals and birds throughout the Chukchi Sea (NPFMC 2009). Pacific sandlances are present in both coastal and offshore waters of the Northeastern Chukchi Sea (Table 3.2.2-1).

Abundance

Pacific sand lances were documented as the most abundant species during a 1970 survey of the Chukchi Sea (Quast 1972). Surveys conducted along Point Barrow to Skull Cliff (2004–2008) captured a total of 197 Pacific sand lance (Johnson et al. 2009) (Figure 3.2.2-3).

Distribution

Preferred habitat is in the nearshore zone in waters less than 50 m (164 ft), but they may travel to depths of 275 m (902 ft), occupying sandy substrates (Robards et al 2002). Fish will burrow in fine-grained sand and gravel, avoiding any mud that may prevent oxygen exchange.

Life History

Fish spawn by burrowing in sand along the intertidal or subtidal zone late August through February. The embryos may take up to 67 days to develop and may be exposed to the intertidal zone and cold air temperatures (Robards et al. 1999).

Clupeidae—Pacific Herring

Pacific herring travel in schools, and they are commercially fished in Bristol Bay and Southeast Alaska, but currently no fishery for herring occurs in arctic waters.

Abundance

The estimated mean abundance of Pacific herring was 657 fish per sq km in the northeastern Chukchi Sea (Barber et al. 1994).

Distribution

Pacific herring are widely distributed throughout the North Pacific Ocean and adjacent seas. While the majority of herring can be expected to occur in nearshore waters, they are also distributed in deep offshore waters up to 400 m (1,312 ft) in depth (Fechhelm et al. 1984).

Life History

Spawning typically occurs during June–July by fish of ages 3–4 years, with some spawning as late as 6 years old (ADFG Notebook Series; Fechhelm et al. 1984). Herring spawn in silt-free coastal waters, with eggs deposited on kelp or vegetation available at the spawning site. Herring spawn along the Chukchi Sea coast in areas such as Kaseguluk Lagoon in early summer (Fechhelm et al. 1984).

3.2.2.2 Shellfish

Abundance

Snow crab increase in abundance northeast of Cape Lisburne. The biomass estimate in the Chukchi Sea for snow crab was 66,491 metric tons per sq km (Barber et al. 1997).

Distribution

Snow crab occur throughout the OCS of the Chukchi Sea (NPFMC 2004). Paul et al. (1997) suggested prey and sediment may drive snow crab distribution. Snow crab occupy soft sediments in the eastern region of the northern Chukchi Sea (Grebmeier et al. 2006). When surveying the Chukchi Sea lease sale area, Paul et al. (1997) found the greatest distribution of snow crab occurred in the southern portion of the lease sale area and the offshore region.

Life History

Snow crabs in the Northern Chukchi Sea are generally smaller than those occurring in the Bering Sea (Paul et al. 1997). The average carapace width of snow crab in the Chukchi Sea was estimated 50 millimeters (mm [2 inches]), while for crab from the Gulf of Alaska, it was approximately 80 mm (3.1 inches) (NPFMC 2009). In another study North of Barrow at the Chukchi/Beaufort boundary, the carapace width of snow crabs ranged from 55–119 mm (2.16–4.7 inches), with an average of 80.5 mm (3.2 inches) (NOAA 2009).

While snow crab in arctic waters are not typically large enough to meet commercially legal carapace sizes, NOAA (2008) estimated 22.1 percent of snow crabs in the survey area north of Barrow were a commercially viable size. In the Bering Sea and Aleutian Islands Management Area, the commercially legal carapace width is 100 mm (3.9 inches).

Females reach sexual maturity at approximately 5 years of age, while males mature at age 6 (NPFMC 2004). After males and females mate, eggs will remain with the female for a year until free-swimming larvae hatch. The larvae remain in tidally influenced surface waters until they develop into the crab form and settle on the ocean floor.

3.2.2.3 Migratory Fishes

Migratory fish of the northeastern Chukchi Sea include both anadromous and amphidromous forms, twelve of the most commonly occuring species in waters of the Northeastern Chukchi Sea are featured in Table 3.2.2.3-1. Amphidromous migrate between freshwater and brackish and nearshore coastal waters, primarily for feeding, and return to streams to overwinter. Amphidromous fishes of the Arctic are limited by the availability of overwintering habitat, pools between 1.5–2.0 m (5–6 ft), that do not freeze during winter (Craig 1989). Migratory fishes are not as abundant in the northeastern Chukchi Sea as they are in either the southern Chukchi Sea or the Beaufort Sea (Craig 1984).

Anadromous fishes, such as Pacific salmon, migrate from freshwater streams to the sea to optimize feeding and growth. At maturity, they return to freshwater to spawn, where they die soon after spawning. In the northeastern Chukchi Sea, anadromous fishes are considered rare or incidental. Sufficient water is required for their overwintering and survival. In summer 2007, juvenile pink and chum were documented feeding in the Chukchi Sea (Moss et al. 2009). While it is likely that fishes were utilizing Chukchi Sea waters only until temperatures decreased, before returning to southern waters, this is the first record of juvenile Pacific salmon occurring at this abundance (Moss et al. 2009) (Figure 3.2.2-2).

TABLE 3.2.2.3-1 Migratory Fish Species commonly found in the Northeastern Chukchi Sea.

Common Name	Scientific Name
Chum salmon	*Oncorhynchus keta*
Pink salmon	*Oncorhynchus gorbuscha*
Chinook salmon	*Oncorhynchus tshawytscha*
Sockeye salmon	*Oncorhynchus nerka*
Coho salmon	*Oncorhynchus kisutch*
Arctic char	*Salvelinus alpinus*
Dolly Varden	*Salvelinus malma*
Bering cisco	*Coregonus laurette*
Least cisco	*Coregonus sardinella*
Broad whitefish	*Coregonus nasus*
Humpback whitefish	*Coregonus oidschian*
Round whitefish	*Prosopium cylindraceum*

Reference: Moss et al. 2009; Craig 1989;

Salmonidae

The Salmonidae family includes Pacific salmon, char, and whitefishes (Mecklenburg 2002). All fishes within the Salmonidae spawn in freshwater. The State of Alaska *Anadromous Waters Catalog* lists freshwater streams inland of the Chukchi Sea with fishes belonging to the Salmonidae family.

Salmon

All five Pacific salmon species (pink, chum, coho, sockeye, and king) occur in the Chukchi Sea. Pink and chum salmon are the most abundant of the Pacific salmon documented in the Chukchi Sea

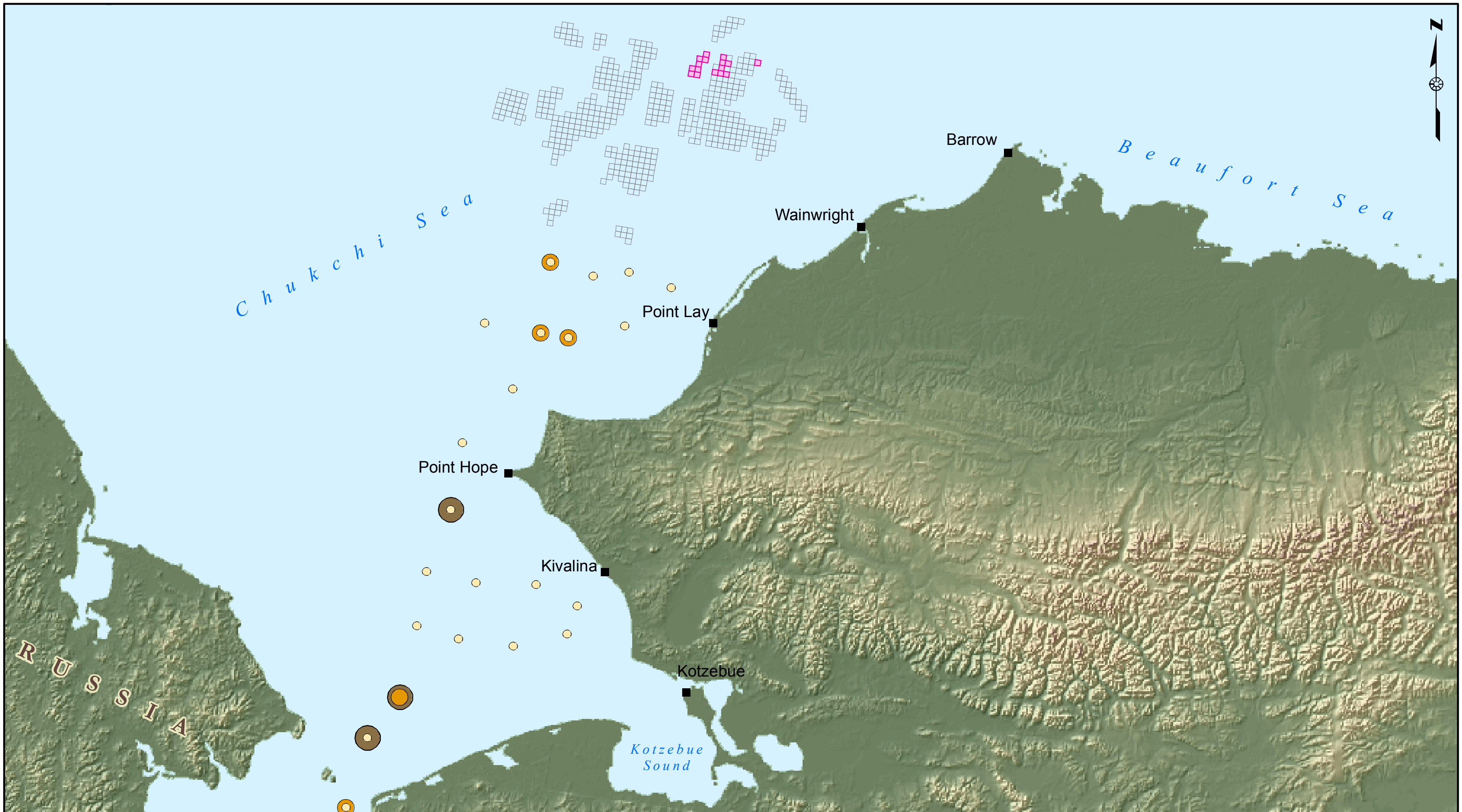
(Gusey 1988; Moss et al. 2009). Significant proportions of Pacific salmon are not anticipated in proposed 2010 seismic survey locations. Pacific salmon migrate as fry to the marine environment, where they spend most of their lives and return to the freshwater environment as adults to spawn (Mecklenburg 2002). Moss et al. (2009) performed surface trawls, capturing juvenile pink and chum salmon throughout portions of the Chukchi Sea, during August and early September in 2007 (Figure 3.2.2-2) (66.0–70ºN). Trawls were performed to the southern extent of the Chukchi Sea Lease Sale area, but did not extend into the proposed 3D seismic locations.

Char

The char include Dolly Varden and Arctic char. Both fish travel to sea for purposes of feeding during the productive summer months and return to inland rivers and streams sufficient in depth to provide suitable overwintering habitat. In appearance, Dolly Varden are similar to their cousin, Arctic char, but their genetic makeup differs (Mecklenburg et al. 2002). Both Dolly Varden and Arctic char are present along the northeastern Chukchi Sea, in the Sulupoaktak Channel, and the Pitmegea, Kukpowruk, Kokolik, and Utukok Rivers (Johnson and Klein 2009). Both fishes are harvested for subsistence use in Chukchi Sea villages. For more information on subsistence fish resources, see Section 3.3.4.

Whitefishes

Five forms of whitefish exist in the Chukchi Sea: broad whitefish, humpback whitefish, round whitefish, least cisco, and Arctic cisco. Both broad and humpback populations remain in freshwater or travel to brackish and nearshore waters; round whitefish remain in freshwater (Gusey 1988; Mecklenburg 2002). Broad whitefish are found in estuaries, lakes, and streams and often reside in moving rivers (Gusey 1988). They overwinter in river channels and large lakes. Humpback whitefish are found in rivers, lakes, and brackish waters. There are both anadromous and freshwater species. Round whitefish habitat includes streams and lakes. Arctic and least cisco are anadromous and are distributed in coastal areas, including estuaries in the nearshore environment. They both also spawn in coastal rivers (Gusey 1988). All whitefish occurring in the Chukchi Sea are important to the local subsistence harvest.



Pink and Chum Salmon Catch

- 1 - 200
- 201 - 500
- 501 - 1977

Lease Owner

- Statoil
- All Other

■ Town

Statoil

JUVENILE PINK AND CHUM SALMON IN THE CHUKCHI SEA

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 25 50 100 Miles

FIGURE: 3.2.2-4

Reference: Moss, J.H., J.M. Murphy, E.V. Farley, L.B. Eisner, and A.G. Andrews. 2009. Juvenile pink and chum salmon distribution, diet, and growth in the northern Bering and Chukchi seas. N. Pac. Anadr. Fish Comm. Bull. 5: 191-196.

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3.2.3 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act defines EFH as:

"Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. In this definition of EFH: "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; and "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; (NPFMC 2009). Federal agencies that authorize projects that may adversely affect EFH are requires to consult with the National Marine Fisheries Service (NMFS) in accordance with EFH regulations."

EFH applies to all inland freshwater rivers and streams that support Pacific salmon and that flow into the Chukchi Sea. The State of Alaska's *Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* specifies the anadromous fish streams that are under EFH jurisdiction. Pink salmon have been documented in the Kugru, Kuk, Utukok, Kokolik, Kukpowruk, Pitmegea, and Kukpuk Rivers; and small stocks of chum salmon are found in the Kugru, Kuk, and Pitmegea Rivers. Pink and chum salmon can also be expected around Peard Bay, Wainwright Inlet, Kasegaluk Lagoon, and Ledyard Bay, as they offer warm, productive waters for prime feeding during the summer (Fechhelm et al. 1984).

The North Pacific Fishery Management Council has published an Arctic Fishery Management Plan (FMP) that provides policy recommendations for potential commercial fisheries in the Chukchi Sea. The FMP requires that EFH species be identified prior to the opening of a commercial fishery, but a commercial fishery is not anticipated anytime soon (NPFMC 2009). Should a commercial fishery be opened, the fish species protected under EFH designation will likely include Arctic cod, saffron cod, and snow crab (NPFMC 2009).

3.2.4 Threatened and Endangered Species

Species that are listed pursuant to the ESA are given special status based on risk assessment and population levels. The ESA is regarded as one of the most comprehensive wildlife conservation laws in the world. The purpose of the ESA is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species (USFWS 2005). The law is administered by the USFWS for terrestrial and freshwater organisms and by the NMFS for mainly marine species such as marine mammals and whales (USFWS 2005).

Industrial companies that want to operate within the range of listed species will likely need to undergo ESA Section 7 consultation. Section 7 "requires federal agencies to consult with the USFWS or NMFS to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species" (USFWS 2005). If a project is determined to jeopardize an ESA species, a biological opinion offering "reasonable and prudent alternatives" on the proposed action will be issued to avoid jeopardizing the listed species.

The species discussed below have been designated as threatened or endangered, or may be candidate species for protection under the ESA.

3.2.4.1 Spectacled Eider

The spectacled eider (*Somateria fischeri)* was listed as a threatened species on May 10, 1993. Critical habitat was designated by the USFWS on February 6, 2001.

The spectacled eider was federally designated as threatened throughout its range in 1993 and is an Alaska Species of Special Concern. The breeding distribution of the spectacled eider includes the central coast of the Yukon-Kuskokwim Delta, the Arctic Coastal Plain of Alaska, and the Arctic Coastal Plain of Russia (USFWS 2005). Previous surveys of the eastern Chukchi Sea (Divoky 1987) have recorded spectacled eiders at low densities over 80 km (50 mi) offshore near the project area.

Distribution

Spectacled eiders nest along the Alaskan coast from the Nushagak Peninsula north to Barrow and east nearly to the Canadian border. The threatened spectacled eider population is estimated to be about 360,000 worldwide, which includes nonbreeders. Critical habitat for the spectacled eider includes Ledyard Bay, the offshore area northeast of Cape Lisburne. This area is used for molting by spectacled eiders July through October (USFWS 2005).

Figure 3.2.4-1 illustrates the varying densities of spectacled eiders surveyed on the Chukchi Sea coast. Surveys conducted by Larned et al. (2005) show that some of the highest densities of spectacled eiders on the North Slope are found between the Dease Inlet and Barrow.

Life History

Male and female spectacled eiders achieve full breeding plumage in either their third or fourth year, though it can occur earlier. Pair bonds between the sexes are made before reaching the breeding grounds in May (USFWS 2006).

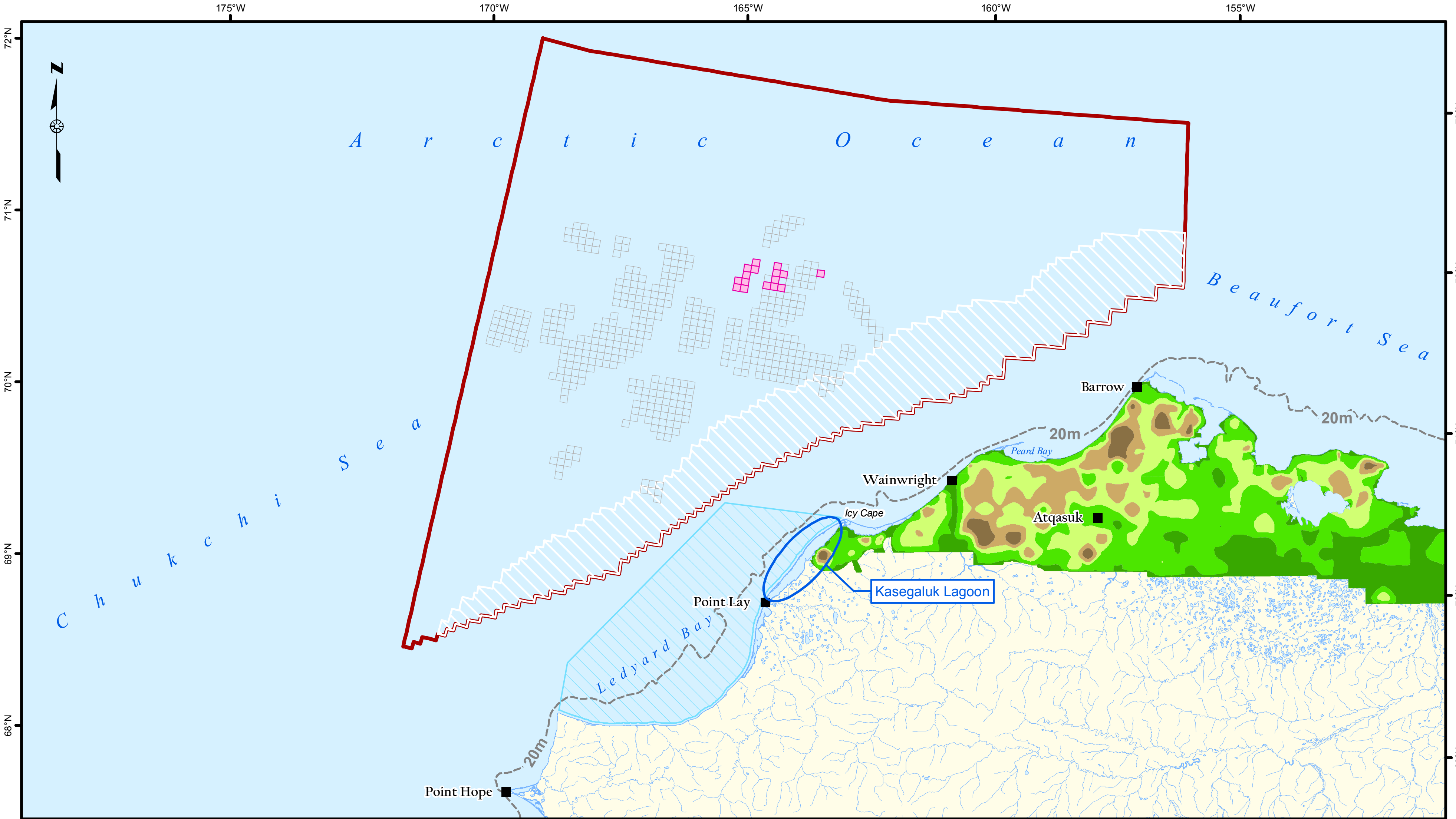
Nests are made of grass and sedge and placed in sedge meadows on tundra, usually within close proximity to lakes. Females will produce a clutch of one–eight eggs that incubate for less than a month. Within 2 months (about 50 days), the young fledge and disperse with the hen to freshwater lakes (USFWS 2006).

Breeding males leave the nest site by mid- to late June to feed and molt in the marine environment. Ledyard Bay is an important area for molting males during this time due to its high benthic productivity and relatively protected waters. Spectacled eider molting is very quick compared to other waterfowl, a process that requires large amounts of energy to complete (Feder et al. 1989; 1994a; 1994b). Non-breeding eiders are believed to congregate in nearshore waters throughout their range (USFWS 2006; 2002b).

Abundance and Trends

Spectacled eider population estimates on the North Slope have been developed from aerial survey data between 1993 and 2007. The population is considered to be relatively stable at an estimated size of 4,000–9,000 individuals (Larned et al. 2007).

Populations of spectacled eiders on the Yukon-Kuskokwim Delta have crashed to about 4 percent of their size since they were estimated in the 1970s (Stehn et al. 1993). Russian population estimates are less reliable due to varying survey techniques (Sea Duck Joint Venture 2003). The spectacled eider was listed as a threatened species on May 10, 1993. Critical habitat was designated by the USFWS on February 6, 2001.



Spectacled Eider Densities:

- Low
- Medium Low
- Medium
- Medium High
- High

- Village
- Lease Sale 193 Area
- 20m. Isobath
- Lease Blocks Under Stipulations 4, 5 & 7
- Ledyard Bay Critical Habitat Area
  Designated Spectacled Eider Critical Habitat

Lease Owner

- Statoil
- All Other
- Sensitive Habitat Area

Statoil

SPECTACLED EIDER DENSITIES AND CRITICAL HABITAT

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.4-1

NAD83, Alaska Albers Equal Area.
Bird Density data source: U.S. Fish and Wildlife Service, Arctic Coastal Plain Survey 1993-2005

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3.2.4.2 Steller's Eider

The Alaska breeding population of Steller's eider (*Polysticta stelleri)* was federally designated as threatened in 1997 and is an Alaska Species of Special Concern. The Alaska breeding population is primarily confined to the Arctic Coastal Plain of Alaska's North Slope, with a distinct concentration around Barrow (USFWS 2002). No critical habitat areas have been designated for the Steller's eider on the North Slope of Alaska or the Chukchi Sea. Previous surveys of the eastern Chukchi Sea (Divoky 1987) have recorded Steller's eiders at low densities over 80 km (50 mi) offshore near the project area.

Distribution

Historically, Steller's eiders nested throughout the coastal areas of western and northern Alaska. Today, the Alaska breeding population is primarily confined to the Arctic Coastal Plain in low densities and is extremely scarce in western Alaska. Figure 3.2.4-2 shows densities of observed Steller's eiders from recent aerial surveys conducted by the USFWS. Currently, most Steller's eider nesting occurs in the Barrow area (USFWS 2002). The Colville River roughly marks the easternmost limit of the Steller's eider range, with the exception of a few individuals observed in the vicinity of Prudhoe Bay (USFWS 2002; Anderson et al. 2004).

Life History

Steller's eider is the smallest of the four northern eider species. Steller's eiders are diving ducks that spend the bulk of their life in shallow coastal waters to forage on mussels, though they will also feed on other invertebrates when available (USFWS 2005; 2006).

Like the spectacled eider, Steller's eiders probably form pair bonds before reaching the breeding ground, and breeding females likely return to the same nesting site each year (USFWS 2006). Pairs reach the nesting site in early June (Bent 1987), and nests are established in coastal wetland tundra or shallow inland lakes. They are made of grass, sedge, lichens, and downy feathers (American Ornithologists Union 2001). Clutches average five eggs, but can vary between two and ten eggs (Bent 1987; Bellrose 1980; Quakenbush et al. 1995). Estimates of nesting success can vary widely from year to year for many reasons, but Quakenbush et al. (1995) report that higher nesting rates corresponded with high lemming abundance. A higher abundance of an alternative prey source could reduce predation pressure on Steller's eider nests.

Breeding males soon leave the nest for shallow coastal waters to molt and forage. Small flocks may also form to forage in deeper waters. Non-breeding males and females that failed to nest are thought to move throughout the summer range like spectacled eiders.

As with many other seabirds at northern latitudes, eiders especially, this species is considered to live at the limits of its energy demands. This high energetic demand requires that nesting females continue feeding while on nest. Their diet during this period is typically composed of midge larvae found in arctic tundra lakes and ponds (USFWS 2006). During molting and staging periods, Steller's eiders typically forage for mussels at depths of at least 9 m (30 ft). Winter feeding is characterized by opportunistic feeding on a variety of other marine invertebrates.

Abundance and Trends

The threatened Alaska breeding population is thought to be in the hundreds or low thousands on the Arctic Coastal Plain and in the dozens on the Yukon-Kuskokwim Delta (USFWS 2005).

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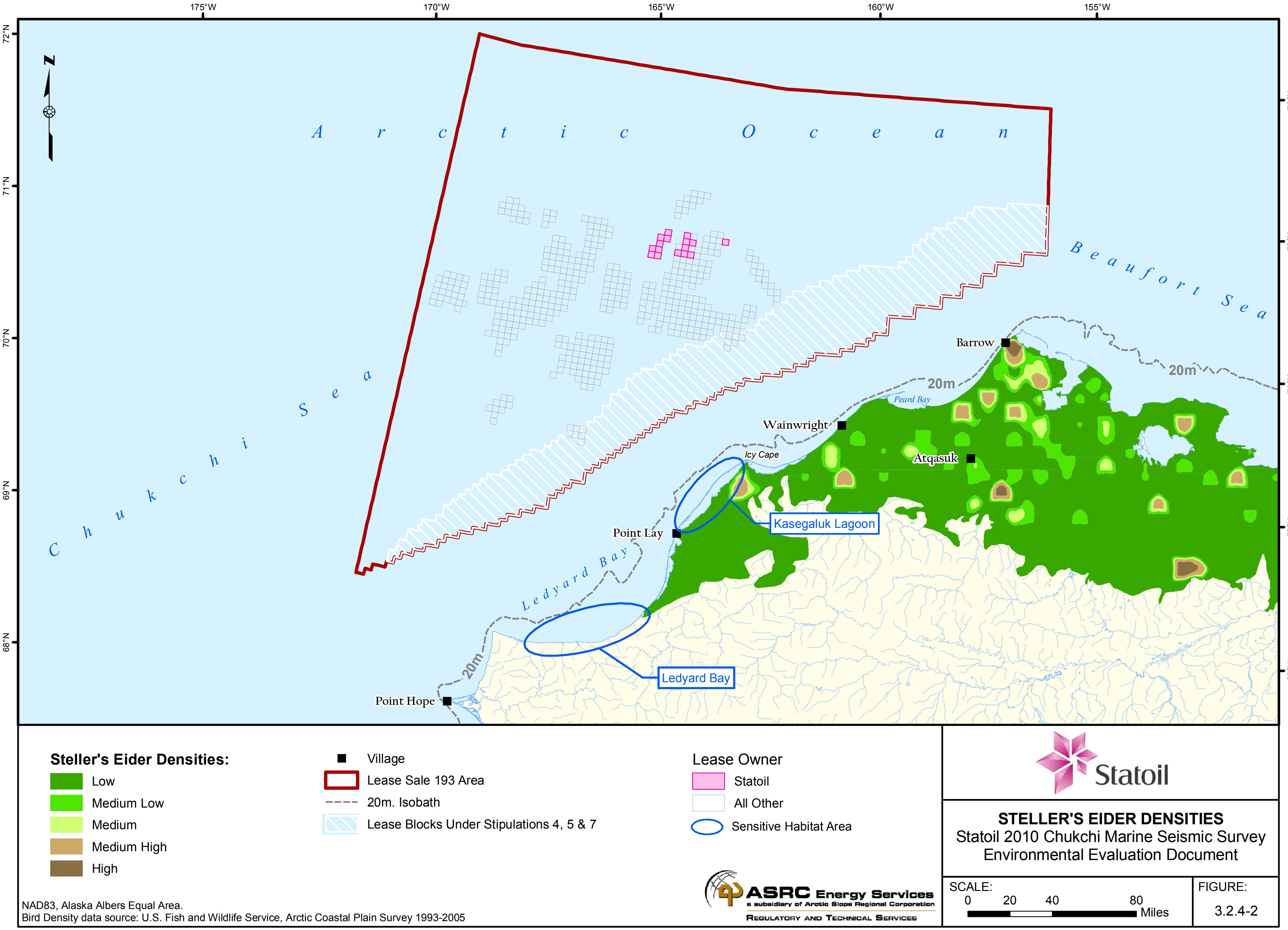

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3.2.4.3 Kittlitz's Murrelet

The Kittlitz's murrelet (*Brachyramphus brevirostris*) is a candidate species for protection under the ESA. Its candidacy is based on sharp declines in estimated population size (Federal Register 69[86]:24875-24904). The cause of the decline is suspected to be glacial retreat and cyclical changes to the marine environment (USFWS 2006; Day et al. 2000).

The Kittlitz's murrelet is a small diving seabird within the family Alcidae, which includes puffins, guillemots, and murres. Its breeding plumage is golden-brown mottled with white that can be mistaken easily for the marbled murrelet (*B. marmoratus*).

Distribution

A large proportion of the world's population of Kittlitz's murrelets breed, molt, and winter in Alaska (Day et al. 1999); however, breeding populations have been recorded on the Kamchatka Peninsula of Russia (Vyatkin 1999). In the Chukchi Sea, these birds are typically found along the northern Seward Peninsula and near Cape Lisburne, north of Point Hope (Day et al. 1999).

The breeding distribution of the Kittlitz's murrelet in the Arctic is restricted to the inland areas of the northeastern portion of the Seward Peninsula and the Cape Lisburne areas. There may be breeding habitat as far north as Cape Beaufort on the coast of Ledyard Bay, but suitable breeding habitat does not exist north of Wainwright (Pitelka1974).

Open water areas are of particular importance to this species in foraging. Consequently, Divoky (1987) recorded Kittlitz's murrelets 21–212 km (13–132 mi) offshore, with the furthest records occurring in late August. Winter distribution is poorly understood, but it is believed that Kittlitz's murrelets follow the advancing ice south into the pelagic waters of the Bering Sea or Gulf of Alaska to feed on prey associated with ice plankton blooms (Day et al. 1999; USFWS 2009).

Life History

Kittlitz's murrelets are known for their predator-avoidance strategy of solitary nesting on inland sites that are typically inaccessible to mammalian predators and humans (Murphy et al. 1984; Nelson 1997; Day et al. 1999). These inland nests are usually placed on the ground within scree fields or even rock cliffs as far as70 km (43.5 mi) from the ocean. Egg laying begins in June (Day et al. 1999), and both male and female incubate the single egg for approximately 30 days. Kaler et al. (2008) report evidence that Kittlitz's murrelets may attempt to renest in the same season. Juvenile Kittlitz's murrelets have very cryptic markings to avoid predation and are able to fledge in August (Day et al. 1999; Kaler et al. 2009). Information on annual or lifetime breeding success is poorly understood.

Kittlitz's murrelets feed on Pacific capelin, Pacific sandlance, Pacific herring, and walleye pollock during the breeding season (Piatt et al. 1994; Day and Nigro 2000; Agness 2006; Kissling et al. 2007). Although the primary source of prey for the Kittlitz's murrelet is schooling fish, they are also known to switch food sources to invertebrates at certain times of the year (Ostrand et al. 2004).

Abundance and Trends

The USFWS (2009) currently estimates the global population of Kittlitz's murrelets at 24,678 total individuals. This estimate makes the species one of the rarest seabirds in all of North America, with a large portion of the global population breeding and living in Alaska. Russian data on the species are scarce, but one estimate has the Kamchatka Peninsula population at 5,000 individuals (Vyatkin 1999).

Current trends of the Kittlitz's murrelet population as a whole are not well known. Long-term studies of populations in southcentral and southeast Alaska have shown dramatic declines of up to 90 percent in some areas (USFWS 2009). There is debate over the reliability of the data used to estimate declines of that magnitude (Day and Nigro 1998). Trend data for Kittlitz's murrelet in the Chukchi Sea are unavailable. Surveys conducted by Divoky (1987) found that Kittlitz's murrelet were rare, though they were relatively more abundant in August.

3.2.4.4 Yellow-Billed Loon

Due to concerns about subsistence harvest levels and low range-wide population levels, the yellow-billed loon (*Gavia adamsii*) was designated as a candidate species for protection under the ESA on March 25, 2009 (Federal Register 74(56):12932-12968). Due to its candidate species status, no critical habitat designation has been proposed.

Five loon species compose the family Gaviidae, all of which are found in Alaska. The yellow-billed loon is the largest of these species and has the most northern distribution.

Distribution

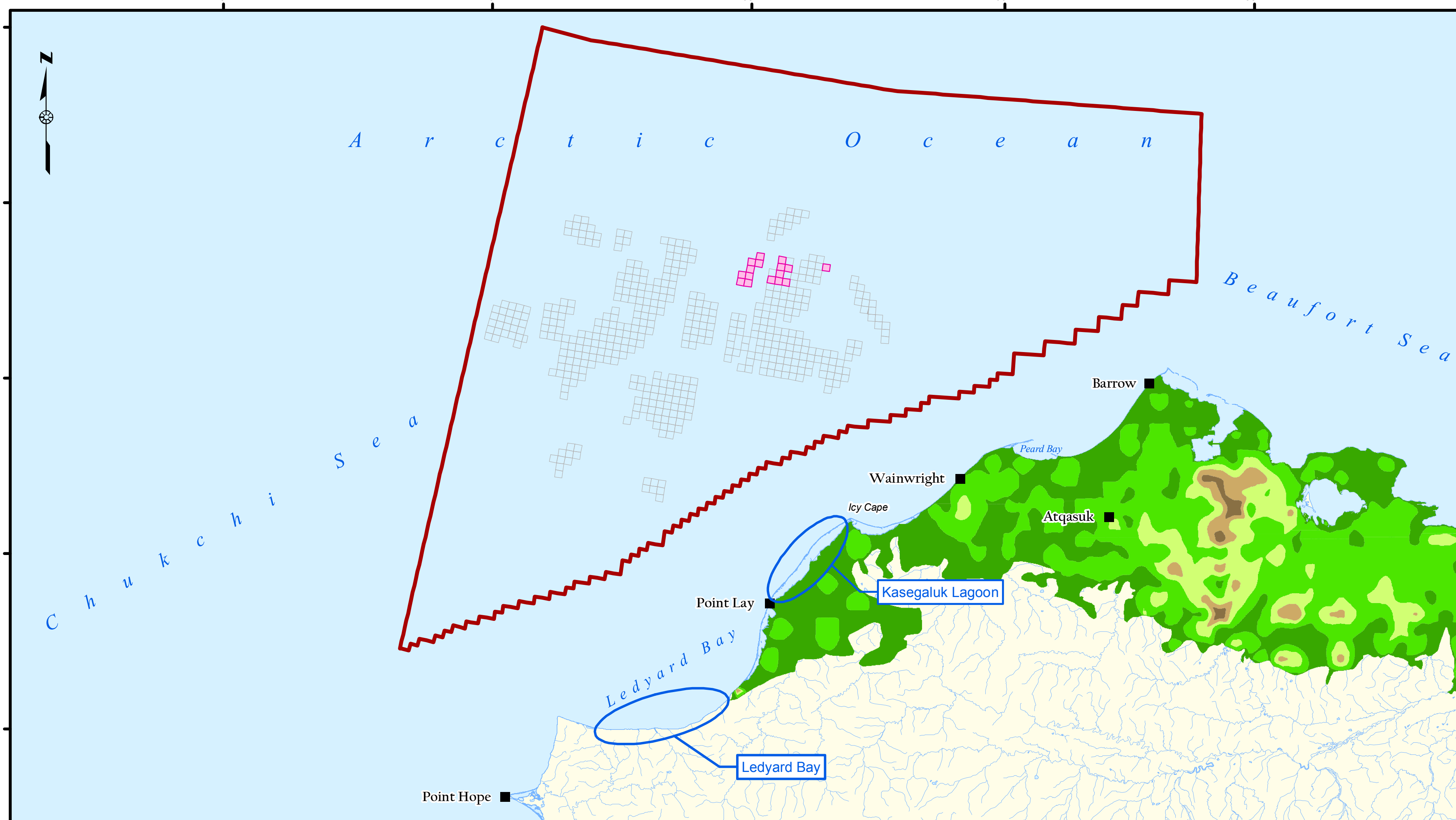
The breeding range of the yellow-billed loon stretches from Hudson Bay in Canada to the Pechora River Delta in western Russia. The furthest south that the species is known to breed is on St. Lawrence Island in the Bering Sea (Earnst 2004; USFWS 2009). The U.S. breeding population is distributed throughout the National Petroleum Reserve-Alaska (NPR-A). Yellow-billed loon nesting densities are variable and can be seen in Figure 3.2.4-3.

Yellow-billed loons are largely associated with large, deep, tundra lakes during the breeding season (Johnson and Herter 1989). Their distribution is clumped at larger scales with low densities overall due to the patchiness of their preferred habitat (USFWS 2009). Aerial surveys conducted by the USFWS have reported that, after fledging, the nearshore areas along the Chukchi Sea are important to the species (Fischer et al. 2002; Lysne et al. 2004). The majority of observations of yellow-billed loons have been made between Barrow and Peard Bay.

Wintering grounds are pelagic marine waters in southcentral and southeast Alaska through British Columbia and in Eurasia off the coast of Norway, Kamchatka Peninsula, Japan, North Korea, and China (Earnst 2004). Telemetry data reported by Schmutz (2009) indicate that a large proportion of the yellow-billed loons from the North Slope winter in North Korea, Japan, and China. To reach their wintering ground it was found that individuals stayed within 12 km (20 mi) of the coast. Non-breeders remain in coastal marine waters throughout the year (USFWS 2009). Yellow-billed loons depart the summer breeding grounds in late August or mid-September (Johnson and Herter 1989).

Life History

Yellow-billed loons are considered to be a "K-selected" species, meaning individuals are long-lived and reproduce at relatively low rates. High adult survival is a key attribute for these species to maintain populations at a healthy level. The small population size and low density has made this species particularly difficult to study. Consequently, not much is known specifically about the typical lifespan or survivorship of individuals of this species (USFWS 2009).



Yellow-Billed Loon Densities:

- Low
- Medium Low
- Medium
- Medium High
- High

Village
Lease Sale 193 Area
Sensitive Habitat Area

Lease Owner
- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Bird Density data source: U.S. Fish and Wildlife Service, Arctic Coastal Plain Survey 1993-2005

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Regulatory and Technical Services

Statoil

YELLOW-BILLED LOON DENSITIES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.4-3

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On the North Slope, nesting of yellow-billed loons begins in mid-June. Yellow-billed loon nesting ecology is characterized by a narrow set of parameters. Nesting lakes are typically greater than 2 m (6.56 ft) deep, which means they can provide overwintering habitat to various fish species. These lakes are also relatively large (greater than 33 acres).

Two eggs are commonly laid and incubated for about 1 month before hatching. There is not much information available on nest success, and Earnst (2004) described a low probability of renesting due to the short summer in the Arctic. Nest success can also vary greatly due to late ice melting and dramatic flooding events (Earnst 2004). The family may leave the nesting lake soon after hatching to rear the juveniles until they fledge. Males and females both provide food and protection to the brood (North 1994).

Abundance and Trends

The USFWS estimates the global breeding population is between 16,000–32,000 individuals. As shown below in Figure 3.2.4-3, yellow-billed loon densities are patchy across the Arctic Coastal Plain. Earnst et al. (2005) estimated that 3,369 individuals were on the breeding grounds of the NPR-A. The total North Slope population is estimated to be 4,892 (Earnst et al. 2005). The global breeding range is considered to be under-surveyed (USFWS 2009).

3.2.4.5 Polar Bear

Polar bears are the top predators of the Arctic marine ecosystem (Amstrup 2003) and are distributed throughout regions of arctic and subarctic waters where the sea is ice-covered for large portions of the year. The Statoil seismic survey will be conducted within the area considered sea ice habitat; however, the project activity is planned for the open water season when sea ice is not present. Considering this, the probability of polar bears occurring in the project area will be extremely low.

The total number of polar bears worldwide is estimated to be 20,000–25,000 bears (Schlebe 2006). Patterns in spatial segregation suggested by telemetry surveys, tagging studies, and Traditional Knowledge resulted in recognition of 19 partially discrete polar bear groups (Aars 2006). Because the principal habitat of polar bears is sea ice, it is considered a marine mammal (Amstrup 2003), and it is included in the species protected under the MMPA. On May 15, 2008, the polar bear was listed as a threatened species range-wide under the ESA (Register 2008). As part of a settlement agreement for ongoing litigation, the USFWS published a proposed rule for critical habitat designation for the polar bear on October 29, 2009. The proposed habitat is comprised of approximately 519,403 square kilometers located in Alaska and adjacent territorial and U.S. waters. The court-ordered deadline for a final determination on the proposed critical habitat designation is June 30, 2010.

Life History

Polar bears exist in relatively small populations and have low reproductive rates, requiring a high rate of survival to maintain population levels. The average reproductive interval for a polar bear is 3–4 years, and a female may produce 8–10 cubs in her lifetime, of which only 50–60 percent will survive to adulthood (Amstrup 2003).

In the northern Alaska coastal areas, pregnant females enter maternal dens by late November and emerge as late as early April. Maternal dens typically are located in snow drifts in coastal areas, stable parts of the offshore pack ice, or on landfast ice (Amstrup and Gardner 1994). Studies indicate that more bears are now denning nearshore rather than in far offshore regions (Fischback, Amstrup, and Douglas 2007). The highest density of land dens in Alaska occur along the coastal barrier islands of the eastern Beaufort Sea and within the Arctic National Wildlife Refuge (USFWS 2009). Insufficient data exist to accurately quantify polar bear denning locations along the Alaskan Chukchi Sea coast; however, dens in the area appear to be less concentrated than for other areas in the Arctic. The majority of denning of Chukchi Sea polar bears occurs on Wrangel Island, Herald Island, and other locations on the northern Chukotka coast of Russia (USFWS 2009).

Polar bears derive essentially all their sustenance from marine mammal prey. The high fat intake from specializing on marine mammal prey allows polar bears to thrive in the harsh Arctic environment (USFWS 2009, Stirling and Derocher 1990, Amstrup 2003). Over much of their range, polar bears are dependent on the ringed seal (*Phoca hispida*) (Smith 1980). Where common, bearded seals (*Erignathus barbatus*) can be a large part of polar bear diets and are probably the second most common prey item (Derocher, Wiig and Anderson 2002). Walrus (*Odobenus rosmarus divirgens*) can be seasonally important in some parts of the polar bear‘s range (USFWS 2009). Polar bears occasionally rely on belugas (*Delphinapterus leucas*), narwhals (*Monodon monoceros*), harbor seals (*P. vitulina*), and marine mammal carcasses along the shoreline (USFWS 2009).

Distribution and Status

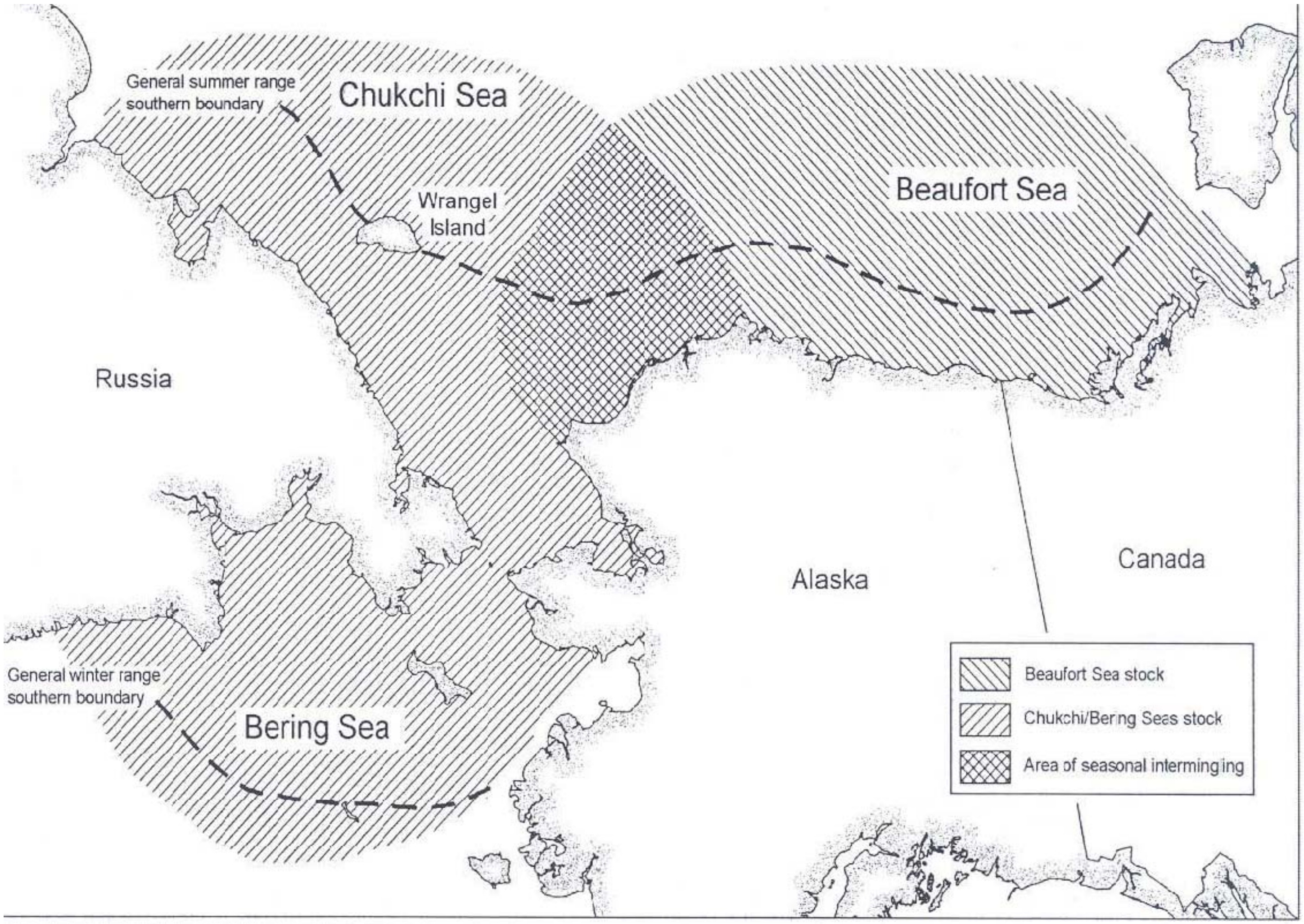
There are two polar bear stocks recognized in Alaska: the southern Beaufort Sea (SBS) stock and the Chukchi/Bering Seas (CBS) stock, though there is considerable overlap between the two in the western Beaufort/eastern Chukchi Seas (MMS 2007). The ranges of these stocks are shown in Figure 3.2.4-4.

The SBS population ranges from the Baillie Islands, Canada, west to Point Hope, Alaska, and is subject to harvest from both countries. The CBS stock ranges from Point Barrow, Alaska, west to the Eastern Siberian Sea (MMS 2007). The CBS population is widely distributed on the pack ice of the northern Bering, Chukchi, and eastern portions of the Eastern Siberian seas (Garner, Knick, and Douglas 1990; Garner, Amstrup, et al. 1994; USFWS 2009). Polar bears are seasonally abundant in the Chukchi Sea (project area), and their distribution is influenced by the movement of seasonal pack ice. Polar bears in the Chukchi and Bering seas move south with advancing ice during fall and winter and move north in advance of receding ice in late spring and early summer (Garner, Knick and Douglas 1990, USFWS 2009).

The size of the SBS population was estimated at 1,800 animals in 1986 (USFWS 2009). The population estimate of 1,526, which is based on data collected from 2001–2006 (Regehr, Amstrup and Stirling 2006), is considered the most current and valid U.S. population estimate (USFWS 2010).

A reliable population estimate for the CBS stock currently does not exist (USFWS 2009; USFWS 2010). Reliable estimates of population size based upon mark and recapture studies are not available for this region, and measuring the population size is a research challenge. The current Russian polar bear harvest is believed to exceed sustainable levels, as models run by the USFWS indicate that the average annual harvest of 180 bears could potentially reduce the population by 50 percent within 18 years (USFWS 2003). The International Union for Conservation of Nature (IUCN) Polar Bear Specialist Group (Aars 2006) estimated this population to be approximately 2,000 animals, based on extrapolation of multiple years of denning data for Wrangel Island, assuming that 10 percent of the population dens annually as adult females (Aars 2006). Due to the lack of information concerning the CBS population and due to the high levels of illegal harvest, the IUCN Species Survival Commission Polar Bear Specialist Group has designated it as “declining” (MMS 2007; Aars 2006; USFWS 2009 2010).

Figure 3.2.4-4 Range Map of Beaufort Sea and Chukchi Sea Polar Bear Stocks



Source: U.S. Fish and Wildlife Service 2009

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Habitat

The size of a polar bear‗s home range is determined, in part, by the annual pattern of freezeup and breakup of sea ice and, therefore, by the distance a bear must travel to access prey (Durner et al. 2004). Polar bear life history is intimately linked to the sea ice environment, with sea ice providing the platform from which bears hunt, travel, mate, and sometimes den (Amstrup 2003).

Seasonal movement patterns of polar bears illustrate their association with ice, as these movements appear correlated to the patterns of ice formation and ablation. Measured monthly movements of polar bear in the Beaufort Sea showed movements to the north from May–August. In October bears moved back to the south (Stirling and Derocher 1990, Amstrup, Durner and McDonald 2000), as October is usually the month of freezeup in the southern Beaufort Sea and ice becomes available over the shallow water near shore. Polar bears prefer shallow-water areas, perhaps reflecting similar preferences as their primary prey, ringed seals, as well as the higher productivity in these areas (Durner et al. 2004; MMS 2007).

The distribution of seals and the habitat selection patterns by bear in the Beaufort Sea suggest that most polar bears do not feed extensively in the summer (Durner et al. 2004; MMS 2007); in fact, 75 percent of bear locations in the summer occur on sea ice in waters greater than 350 m (1,148 ft) deep, which places them outside of prey concentrations and outside the proposed seismic survey area. Amstrup, Durner, and McDonald (2000) showed that polar bears in the Beaufort Sea have their lowest level of movements in September, which correlates with the period when the sea ice has carried polar bears beyond the preferred habitat of seals (MMS 2007).

The months showing the highest movement rate for polar bears and highest activity area in the Beaufort Sea were June–July and November–December (Gloerson et al. 1992). The mean annual distance moved by six bears (followed by satellite telemetry) in the Chukchi Sea was 5,542 km (3,444 mi). To illustrate the potential mobility of polar bears in regions of continually changing ice patterns, the mean rate of northerly spring movement was approximately 14 km/day (9 mi/day) (Garner, Knick, and Douglas 1990). The sea ice of the Chukchi and Beaufort Seas is dynamic and unpredictable, and the mobility of polar bears in these areas appears to be directly correlated to that variability (Garner, Knick, and Douglas 1990; Gloerson et al. 1992). The coast, barrier islands, and shorefast ice edge provide a corridor for polar bears during the fall, winter, and spring months. Late winter and spring leads that form offshore from the Chukchi Sea coast also provide important feeding habitat for polar bears (MMS 2007). These polynyas reach their maximum extent in June and may extend into the project area. By July, however, the polynyas no longer exist, and this area becomes relatively ice-free.

Recent research has indicated that the total sea ice extent has declined over the last few decades, in both nearshore areas and in the amount of multi-year ice in the polar basin (Parkinson and Cavalieri 2002). As a result, of potential effects from predicted ice conditions, USFWS found the polar bear to be threatened. On October 21, 2009, the USFWS proposed to designate critical habitat for the polar bear (USFWS 2009).

The area USFWS has proposed as critical habitat for polar bear covers 322,739 sq km 200,541 sq mi) of U.S. land and water and is categorized into three types of habitat: sea ice habitat, terrestrial denning habitat, and barrier island habitat.

3.2.4.6 Bowhead Whale

Bowhead whales were listed as endangered on June 2, 1970. On August 30, 2002, NMFS declined a petition to designate critical habitat for the Western Arctic Stock (Bering Sea Stock).

Distribution

The International Whaling Commission (IWC) recognizes five stocks of bowhead whales worldwide. The Western stock is the largest of the five stocks and the only stock that may be encountered during Statoil's proposed seismic activities. In Alaska, most bowhead whales winter in the Bering Sea between November and March. In the spring and early summer, they follow offshore leads through the Chukchi Sea to summer in the Canadian Beaufort Sea through September (H. M. Braham 1980, S. R. Moore 1993). Figure 3.2.4-5 shows the general route followed by bowhead whales during their seasonal migrations through the Chukchi and Beaufort Seas in relation to Statoil's lease blocks. Statoil will likely encounter some bowhead whales in the vicinity of their project activities. They are also commonly found aggregating near polynas before migrating (S. R. Moore 1993). During the fall, the bowheads migrate west from the Beaufort Sea, returning to the Bering Sea (Figure 3.2.4-5). Statoil's lease blocks are located within the generalized fall bowhead migration route. The route taken by the whales each year is influenced by the ice cover. During years with high ice coverage, the whales tend to migrate further offshore in deeper water (S. J. Moore 2000).

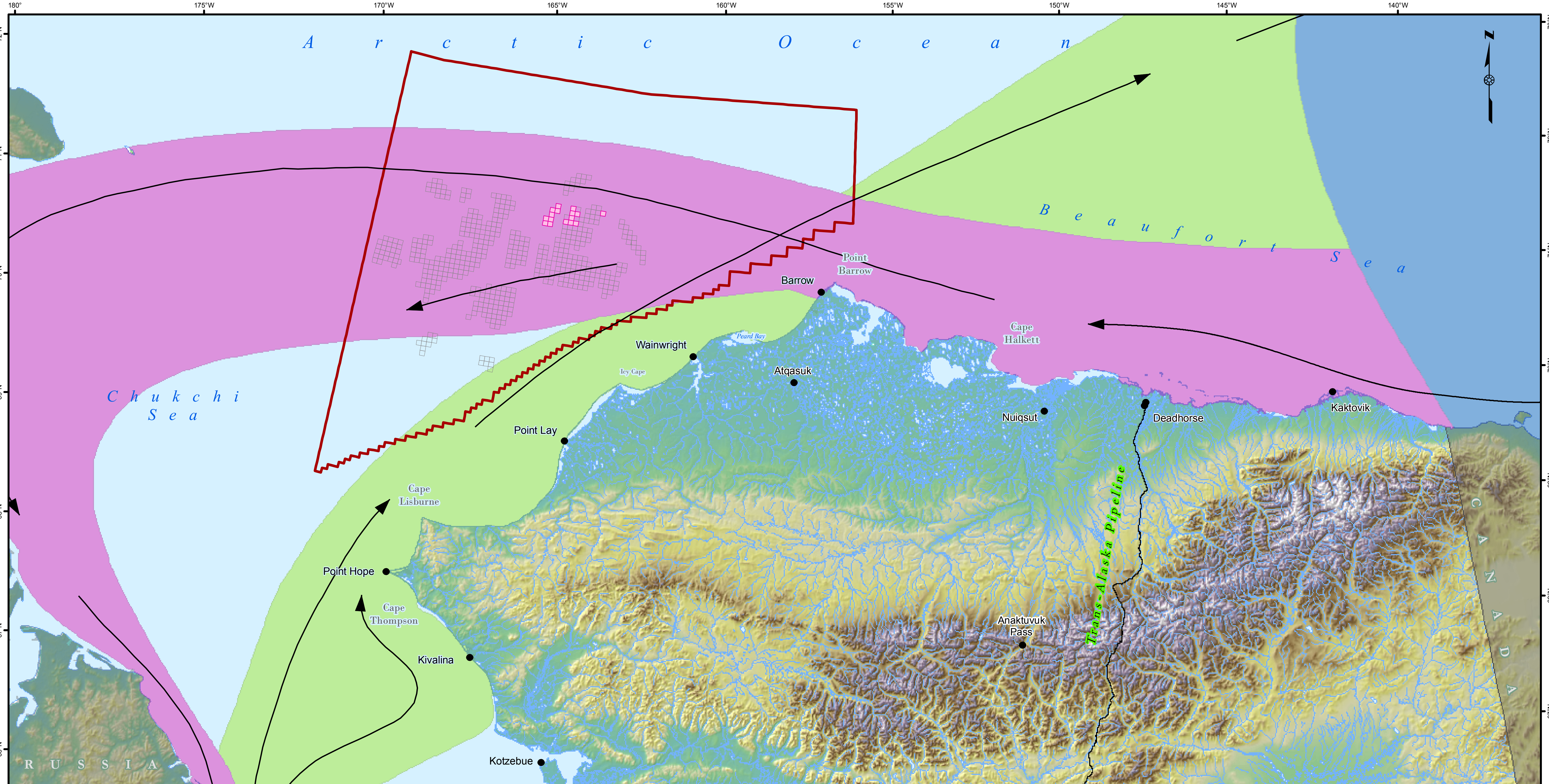
Bowhead whales are found throughout the Lease Sale 193 area, including areas in and around Statoil's proposed 2010 seismic project. Figure 3.2.4-6 shows bowhead whale sightings in the Chukchi Sea through 2007. No bowhead whales were observed during monitoring surveys (Brueggeman et al. 1990; Brueggeman et al. 1991) conducted near exploration drilling in the Burger, Crackerjack, Klondike, and Popcorn Prospects in 1989 and 1990. Statoil provided partial funding for a series of marine mammal surveys in the Chukchi Sea in 2008. Surveys were conducted from vessels and aircraft, and ocean bottom hydrophones were used to listen to marine mammal calls. Very small numbers of bowheads in the vicinity of Statoil's lease blocks were observed in the Chukchi as early as August 28 during partially Statoil-funded marine mammal surveys. See Table 3.2.4-1 for a summary of sightings for 1989–1990 and 2006–2008 surveys.

TABLE 3.2.4-1 Results of Vessel-Based and Aerial Marine Mammal Surveys in the Chukchi Sea

	Number of Individuals				
	1989	**1990**	**2006**	**2007**	**2008**
Survey of Burger Prospect[1]	0	0	N/A	N/A	2
Joint Monitoring Results[2]	N/A	N/A	74	44	51

Sources:
[1] Brueggeman, J., C. Malme, R. Grotefendt, D. Volsen, J. Burns, D. Chapman, D. Ljungblad, G. Green 1990; Brueggeman, J., D. Volsen, R. Grotefendt, G. Green, J. Burns, D. Ljungblad 1991; J. Brueggeman 2009
[2] LGL. 2007. Joint Monitoring Program in the Chukchi and Beaufort Seas, July–November 2006

MMS conducted surveys (Bowhead Whale Aerial Survey Project [BWASP]) between 1987 and 2007 to investigate how bowhead whales travel through the Chukchi Sea during their migration. Figure 3.2.4-6 shows bowhead whale sightings during the surveys. The survey effort was not consistent throughout all areas of the Chukchi Sea; coastal areas were given more effort.



Bowhead Whale Migration Pattern

Fall Bowhead Whale Migration Area

Spring Bowhead Whale Migration Area

Summer Bowhead Whale Migration Area

Village

Road

Pipeline

Lease Sale 193 Area

Lease Owner

Statoil

All Other

SOURCE: Bowhead whale Migration Routes and Seasonal Ranges derived from a map created by the North Slope Borough Department of Planning and Community Services, Geographic Information Systems Division, 2003.
*NOTE: The North Slope Borough and Northwest Arctic Borough boundaries extend to the 3 mile State of Alaska jurisdictional boundary.
AEWC Whaling Captains, at a meeting on 02/11/08, challenged the accuracy of this depiction.
NAD83, Alaska Albers Equal Area.

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BOWHEAD WHALE MIGRATION ROUTES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 25 50 100 Miles

FIGURE: 3.2.4-5

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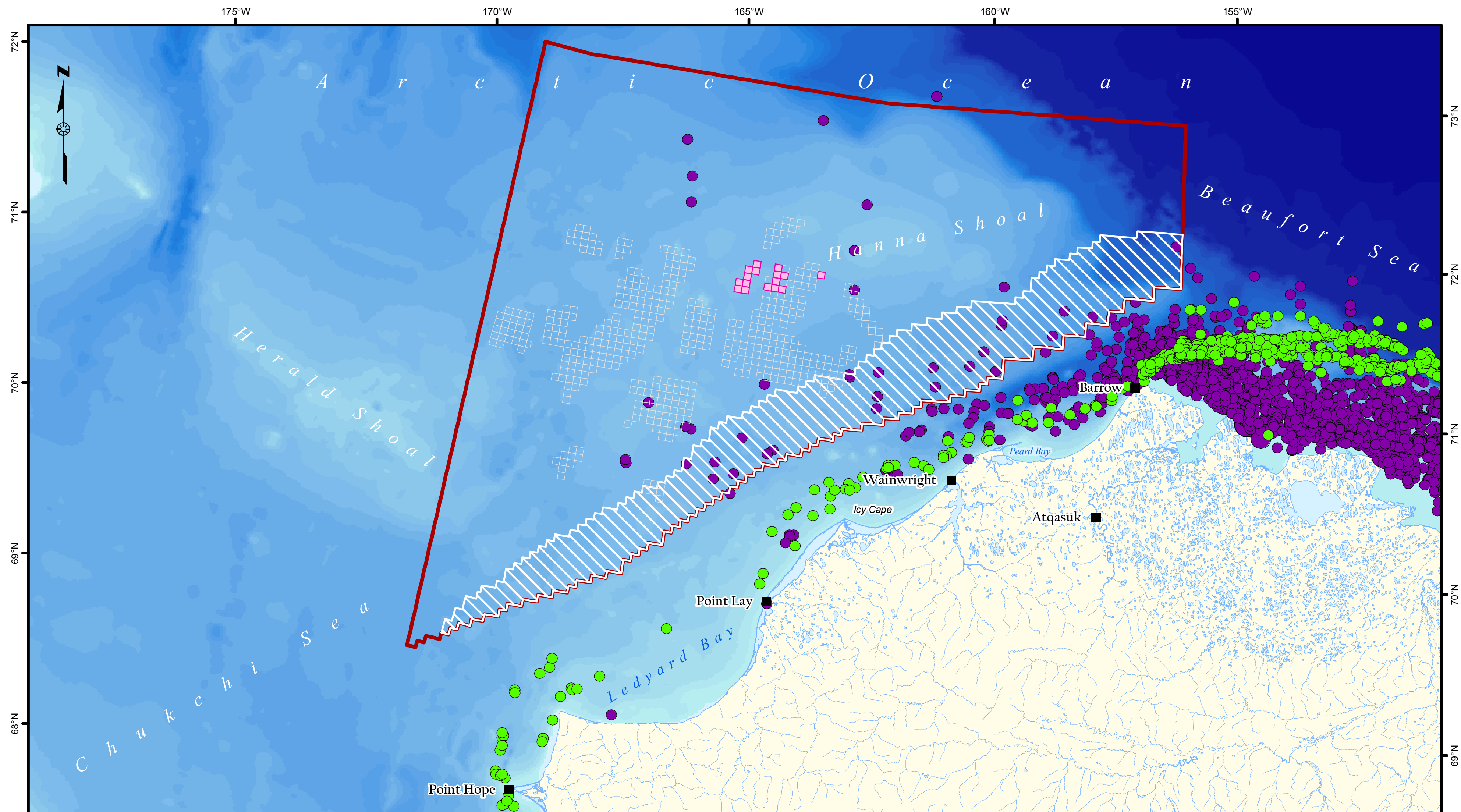

Bowhead Whale sightings (April-June)
Total number counted in sighting:
- 1 - 15
- 16 - 30
- 31 - 45
- 46 or more

Bowhead Whale sightings (July-October)
Total number counted in sighting:
- 1 - 15
- 16 - 30
- 31 - 45
- 46 or more

- Village
- Lease Sale 193 Area
- Lease Blocks Under Stipulations 4, 5 & 7

Lease Owner
- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Sighting data obtained from Mineral Management Service Bowhead Whale Aerial Survey Project Historical Database, 1979-2007.

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BOWHEAD WHALE SIGHTINGS IN THE CHUKCHI SEA 1979-2007
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.4-6

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Life History

Bowhead whales are large whales that use baleen to filter the water for food sources, primarily copepods and euphausiids (L. G. Lowry 1993). Energy requirements, especially for migration, are high. Thus, bowhead whales must find areas with above-average concentrations of zooplankton for feeding (L. G. Lowry 1993). Observations in the 1980s suggest that bowhead whales may feed opportunistically in the Chukchi Sea while they are migrating, but the feeding activity was not consistent (Ljungblad 1988) (Carroll 1987).

Bowheads are long-lived, slow-growing, late-maturing, and they reproduce infrequently (Zeh 1993) (Koski 1993). Females become sexually mature starting around age 15 (Koski 1993). At sexual maturity, females are 12.5–14 m (41–46 ft). Males mature later, around 17–27 years (IWC 2004).

Bowhead whale mating may start as early as January or February, but mostly occurs during their spring migration (Nerini 1984; Koski 1993). Gestation lasts 13–14 months (Nerini 1984). Calving starts in March and has been seen to occur until early August (Koski 1993). A single calf is born every 3–4 years. Bowhead whales have no known predators besides subsistence users and occasionally orcas. They have been documented to live past 100 years of age (J. J. George 2004).

Bowhead whales vocalize using low-frequency sounds. It is assumed that their hearing is most sensitive at the same frequencies that they use to vocalize. The frequency of their calls has been recorded as low as 35 Hz and as high as 5 kHz, although most calls range between 50–400 Hz (J. J. Burns 1993).

Abundance

The population of bowhead whales was severely depleted by commercial whaling in the 19th and early 20th centuries. Since the moratorium on commercial whaling, the population has replenished considerably, although they are still listed as endangered under the ESA. The most recent population estimate for the Western Arctic Stock of bowhead whales is 10,545 based on surveys conducted in 2001 (J. J. George 2004; B. A. Angliss 2009).

3.2.4.7 Fin Whale

The fin whale is designated as endangered under the ESA (1970), and while a draft recovery plan was published in 1998, no critical habitat designation has been proposed for the species.

Distribution

There are three stocks of fin whales worldwide. The Alaska Stock of fin whales ranges from the Gulf of Alaska into the southwestern Chukchi Sea in the north (B. A. Angliss 2009). Though little is known about the details of their migration routes, evidence from hydrophones off the coast of Alaska suggests that they follow a southbound migration in the winter and northbound in the summer (Moore et al. 1998; Watkins et al. 2000). They are considered extralimital in the Lease Sale 193 area and are not expected to be seen near Statoil’s proposed seismic activities. No fin whales were observed near the Burger prospect during surveys conducted in 1989, 1990, or 2008 (Brueggeman et al. 1990; Brueggeman et al. 1991; Brueggeman 2009). However, four were observed during joint monitoring surveys partially funded by Statoil conducted in 2008 (Funk 2009).

Life History

Fin whales are baleen whales that feed mostly on euphausiids, small schooling fish, and copepods. They are light grey in color and reach sexual maturity by age 12. The gestation period is thought to be slightly less than a year. Fin whales give birth to a single calf approximately every 2 years. Calves are weaned after 6 months. Fin whales are not taken for subsistence purposes in Alaska. It has been speculated that they may be prey for killer whales on occasion.

Like bowhead whales, fin whales vocalize using low-frequency calls typically in the range of 18–35 Hz (B. G. Patterson 1964). There have been no studies directly measuring the sound sensitivity of fin whales, but it is thought that their hearing is most sensitive to frequencies they use to vocalize.

Abundance
The worldwide abundance of fin whales is estimated at 120,000 (N. MMS 2008). There is no reliable abundance estimate for the Alaska stock of fin whales (B. A. Angliss 2009). A survey conducted in 1999–2000 estimated a population of 3,368 fin whales in the Bering Sea. However, this estimate is not reliable, because the entire extent of their range was not surveyed. It is thought that there are at least 5,200 fin whales in Alaska west of Kodiak (B. A. Angliss 2009).

3.2.4.8 Humpback Whale

The humpback whale is designated as endangered under the ESA (1970), but no critical habitat designation has been proposed for the species.

Distribution
Humpback whales are considered extralimital in the Chukchi Sea. They are not expected to be encountered near Statoil's proposed seismic survey activities. Their normal range extends north to the southern Chukchi Sea. In the summer, most humpback whales migrate to tropical waters. Five humpback whales were sighted in the Chukchi Sea during vessel-based marine mammal surveys in 2007, and one was sighted during surveys in 2008 that were partially funded by Statoil (Funk 2009). An observation of one humpback whale was reported by MMOs in the southern Chukchi Sea in 2006 (H. B. Patterson 2006), and six were reported during surveys in the southeastern Chukchi Sea in 2007 (Unpublished MMS MMO reports 2007). It is thought that the summer range of humpback whales is potentially expanding further north into the Chukchi Sea.

Life History
Humpback whales are baleen whales that feed mostly on euphausiids and other small organisms. They have been known to form feeding groups and cooperatively use a technique called bubble net feeding (MMS 2008). They are black and white in color and can be identified by their large pectoral flippers, which reach about a third of their body length. Data suggest that humpback whales can live for more than 100 years.

Male humpback whales vocalize long, complex songs during the breeding season, with frequencies typically ranging 25–5,000 Hz (Payne 1970). No studies have directly investigated humpback whale hearing sensitivity. Humpback whales are not typically taken for subsistence purposes by Chukchi Sea villages.

Abundance
There is currently no reliable abundance estimate for humpback whales in Alaska, because surveys have not encompassed the entire extent of their range (B. A. Angliss 2009). No humpback whales were seen during surveys of the Burger Prospect in 1989 or 1990 (Brueggeman et al. 1990; Brueggeman et al. 1991).

3.2.4.9 Pacific Walrus

On September 10, 2009, the USFWS, responding to a listing petition submitted by the Center for Biological Diversity and settlement agreement following resulting litigation, published a 90-day notice that the petition presents substantial scientific or commercial information indicating that listing the subspecies may be warranted. Under the court-ordered deadline, the USFWS must submit a 12-month finding by September 10, 2010.

Pacific walruses occur seasonally from Bristol Bay to Point Barrow (Bering and Chukchi Seas), with most animals migrating northward during spring and returning south during the fall. Migrations are directly related to the seasonal advance and retreat of the sea ice (Fay 1982, Alaska Department of Fish and Game [ADF&G] 2009). Walruses are found in waters less than 200 m (656 ft) deep along the pack ice margin where ice concentrations are less than 80 percent (Fay 1982). This ice-covered, shallow, continental shelf is important for walrus, as they utilize this for rest and for calves incapable of deep or long-term diving (MMS 2007). Walrus use floating sea ice for birthing, nursing, resting, isolation from predators, and for passive transport to new feeding areas (USFWS 2009). Therefore, walrus can be expected in shallow waters near the coast, on shelf pack ice, and also offshore on unconsolidated ice.

Life History

Walruses are long-lived animals with low reproduction rates. Females reach sexual maturity at 4–9 years of age and give birth to one calf every 2 or more years. Males become fertile at 5–7 years of age and reach complete maturity at approximately age 15. Walruses can live up to the age of 40. Walruses inhabit pack ice of the Bering Sea in winter and breed between January and March, with implantation of the embryo delayed until June or July. Calving occurs on the sea ice in April–May, approximately 15 months after mating. Calves are weaned after 2 years or more after birth (Fay 1982).

Walruses feed on benthic macroinvertebrates and prefer to forage in areas less than 80 m (262 ft) deep (Fay 1982). In Bristol Bay, 98 percent of satellite locations of tagged walruses were in water depths less than or equal to 60 m (197 ft) (Jay, C.V.; Hills, S. 2005). Walruses most commonly feed on bivalve mollusks (clams), but they also will feed on other benthic invertebrates (e.g., snails, shrimp, crabs, and worms). Some walruses have been reported to prey on marine birds and small seals (MMS 2007).

Seasonal Distribution

Because walrus are limited by water depth and ice conditions, their distribution varies seasonally (USFWS 2009). Segregation by gender also accounts for distribution characteristics as they migrate over vast areas of the Bering and Chukchi seas (Fay 1982). In May, adult females and young move northward into areas of unconsolidated pack ice within 100 km (62 mi) of the leading pack ice edge of the Chukchi Sea. By July, large groups of up to several thousand walruses can be found along the edge of the pack ice between Icy Cape and Point Barrow. Adult males generally travel to coastal haulouts in Bristol Bay and the Gulf of Anadyr in spring (Jay, C.V.; Hills, S. 2005). When pack ice is not available, walruses will haul out to rest on land haulout sites in the eastern Chukchi Sea, including Cape Thompson, Cape Lisburne, and Icy Cape. By August, walruses are found farther offshore, with the majority of concentrations to the northwest of Barrow. The Chukchi Sea west of Barrow is generally considered the eastern extent of the main summer range of the walrus.

In October, as the pack ice advances, large herds are found along the leading edge of the pack ice. In winter they continue to follow the advancing pack ice through the Bering Straits (MMS 2007).

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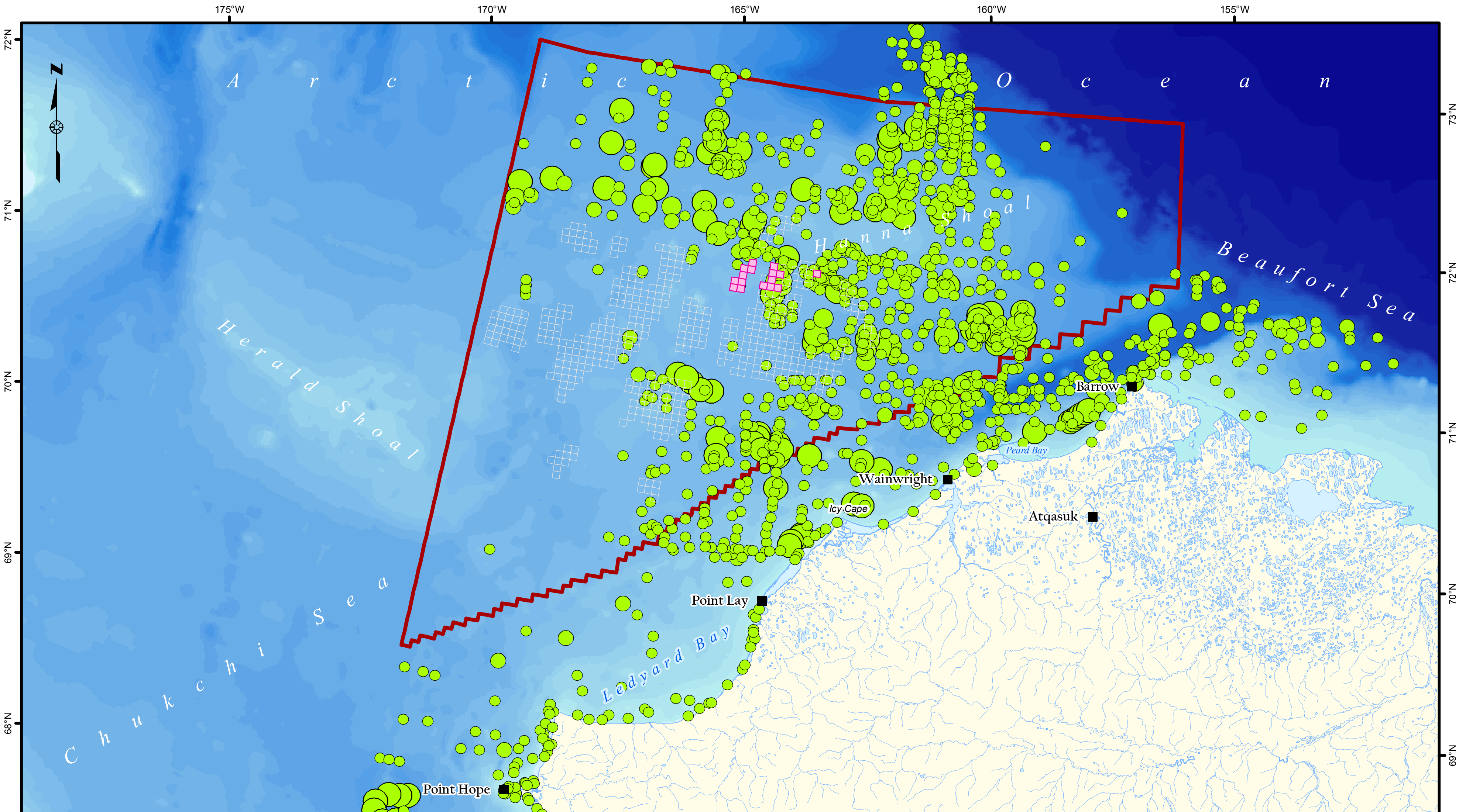

Walrus

Total number counted in sighting:

- 1 - 25
- 26 - 50
- 51 - 75
- 76 - 100

Village

Lease Sale 193 Area

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area

Sighting data obtained from Mineral Management Service Bowhead Whale Aerial Survey Project Historical Database, 1979-2007.

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PACIFIC WALRUS SIGHTINGS IN THE CHUKCHI SEA 1979-2007

Statoil 2010 Chukchi Marine Seismic Survey Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.4-7

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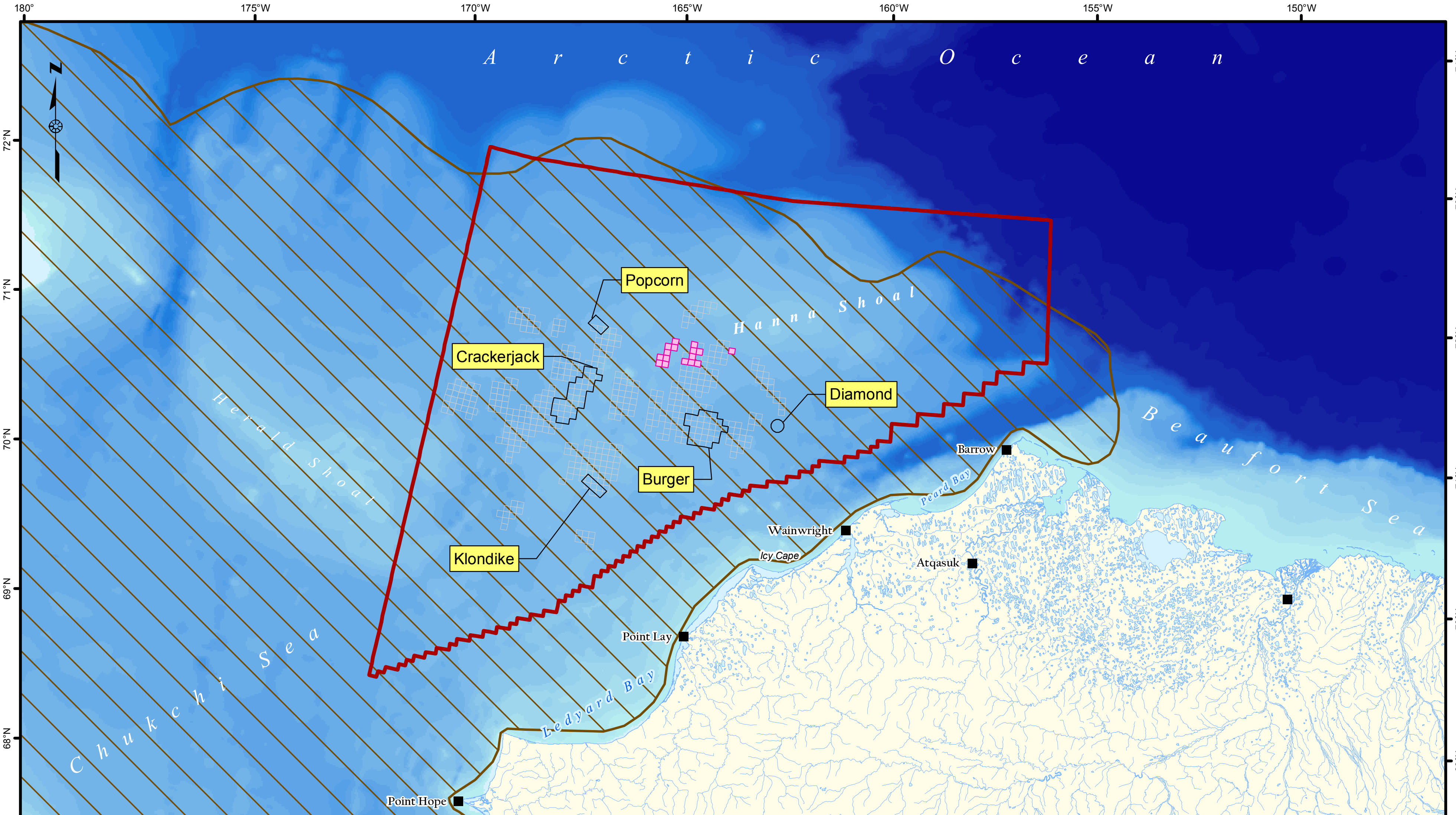

Prospect

Lease Sale 193 Area

Lease Owner

Statoil

All Other

Pacific Walrus Distribution

Village

NAD83, Alaska Albers Equal Area

NOTE: Pacific Walrus distribution derived from:
http://ak.audubon.org/birds-science-education/atlas-chukchi-and-beaufort-seas-draft

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WALRUS DISTRIBUTION AND HABITAT IN LEASE SALE 193 AREA

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 25 50 100 Miles

FIGURE: 3.2.4-8

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3.2.4.10 Marine Mammal Surveys within the Statoil Project Area

In 1989, 1990, and 1991, Brueggeman et al. (1990, 1991, and 1992) conducted marine mammal surveys during the open water season at prospect sites (Klondike, Burger, Popcorn, Crackerjack, and Diamond Prospects) within the Lease Sale 193 area to assess effects of potential drilling operations on walrus. In 1989, large numbers of walrus moved through the project area, and a small number of walrus summered in open water within all prospects surveyed. The spring migration corresponded to the northward retreat of the pack ice as it passed through the Klondike Prospect, the only prospect surveyed during the spring ice retreat.

The pack ice remained north of the project area when the surveys began in late June of 1990. Most walrus were in the marginal ice between Popcorn and Burger Prospects (162°–165°W longitude). Small numbers of walrus were observed near the Crackerjack Prospect in late September swimming southward of the pack ice, considerably ahead of the pack ice (J. Brueggeman 2009).

In 1991, when surveys were conducted at Crackerjack and Diamond Prospects, walrus movements through the prospects were transitory and associated with the retreat of the pack ice, as reported in previous years. The Crackerjack prospect appeared to be on the western edge of the main walrus concentration during the northward migration, summer-early fall feeding period, and southward migration. Conversely, walrus were numerous in the region of the Diamond Prospect during the northward and southward migrations. The Diamond Prospect is closely associated with Hanna Shoal, a region of relatively shallow water presumed to be an important walrus feeding ground when pack ice is present in (J. Brueggeman 2009; MMS 2008).

In summary, the occurrence of walrus in the project area is transitory with the highest occupancy dependent on the time and duration of pack ice in that area. Small numbers of walrus occurred in the seismic survey area after the sea ice moved north, carrying most of the walrus to more northern feeding grounds. The likelihood of encountering a walrus in or near Statoil's current prospect areas will depend largely upon ice conditions at the time of exploration activity. See Table 3.2.4-2 for summary of sightings for 1989, 1990, and 1991 surveys.

TABLE 3.2.4-2 Walruses Sighted within Prospects near the Statoil Project Area 1989–1991

	Klondike	Burger		Popcorn		Crackerjack		Diamond
Marine Mammal	**1989**	**1989**	**1990**	**1989**	**1990**	**1990**	**1991**	**1991**
Pacific walrus	4,858	19	534	85	33	22	14,593	34,097

Source: Brueggeman 1990, 1991, 1992

Statoil's project occurs in Lease Sale Area 193. Shell vessel and aerial surveys took place between 2006 and 2008 in the Lease Sale 193 area during the open water season. Table 3.2.4-3 shows walrus sightings during Shell vessel and aerial surveys.

TABLE 3.2.4-3 Number of Pacific Walrus Sightings from Shell Vessels and Aerial Surveys in the Chukchi Sea, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	129	381
2007	350	177
2008	92	197

Source: Funk 2009

Marine mammal surveys were conducted by CPAI and Shell at the Klondike and Burger Prospects survey area in the Chukchi Sea during the 2008 open water season. Walrus were fairly concentrated in their spatial and temporal distribution during this survey. At Klondike, walrus were recorded during a small proportion (17 percent) of the total survey days, with all but one occurring after September 24. No more than ten animals were seen on any given survey day. At Burger, however, walrus were observed on over a third of the survey days. The daily numbers were consistently below ten animals, except for one day (September 13) when there were over 900 walruses observed. At both sites most walrus were primarily observed in the northern halves of each survey area (J. Brueggeman 2009). Table 3.2.4-4 shows walrus sightings in the Lease Sale 193 area during Shell surveys.

TABLE 3.2.4-4 Walrus Sightings and Numbers at Lease Sale 193 Prospect Areas

Klondike		Burger		Other		Total	
Sightings	Number	Sightings	Number	Sightings	Number	Sightings	Number
8	24	39	940	1	1	48	965

Source: J. Brueggeman 2009

Over the past decade, the numbers of walruses at coastal haulouts in Bristol Bay, along the coast of Kamchatka, and in the Bering Strait and Gulf of Anadyr have steadily declined, which may indicate a declining walrus population (Smirnov et al. 2004). According to Smirnov et al. (2004) and others, efforts must be made to improve the protection and monitoring of the most vulnerable Pacific walrus habitats, their coastal haulouts (MMS 2007). Recent trends in seasonal sea ice breakup have resulted in seasonal sea ice retreating beyond the continental shelves and over deep Arctic Ocean waters. This trend poses adaptive challenges for the walrus population (Tynan and DeMaster 1997). Funk et al. (2009) reported large numbers of walrus were hauled out on the Alaska side of the Chukchi Sea in 2007 when sea ice was north of the OCS.

On September 8, 2009, USFWS announced a finding on a petition to list the Pacific walrus as threatened or endangered under the ESA and to designate critical habitat. USFWS found that the petition presents scientific information indicating that listing a subspecies may be warranted and is soliciting information regarding the status of the Pacific walrus for review (USFWS 2009).

Population Size and Status

The size of the Pacific walrus population has never been known with certainty. Between 1975 and 1990, aerial surveys were carried out by the United States and Russia producing population estimates ranging from 201,039–234,020 animals; however, these estimates are considered minimum values and are not suitable for detecting trends in population size (Gilbert et al. 1992). Efforts to survey the

Pacific walrus population were suspended after 1990 due to unresolved problems with survey methods (Gilbert et al. 1992).

In 2006, available walrus sea ice habitat averaged 668,000 sq km (415,076 sq mi), and the area surveyed equaled approximately 318,204 sq km (197,723 sq mi). The number of Pacific walrus within the surveyed area was estimated at 129,000, with 95 percent confidence limits of 55,000–507,000 individuals. As this estimate does not account for areas that were not surveyed, some of which are known to have had walrus present, it is negatively biased to an unknown degree (USFWS 2010), which provides assurance that walrus population size was greater than the estimate (NMFS 2005).

Current Population Trend

The estimate for 2006 of about 129,000 walruses is biased low because some areas known to be important to walrus were not surveyed due to poor weather conditions, such as the area south of Nunivak Island, St. Lawrence Island, and Cape Navarin, where large aggregations of walrus have been documented (Fay 1982; Burn et al. 2009; USFWS 2010).

Earlier estimates of walrus population size are also likely to be negatively biased since they did not adjust for walrus in the water, a proportion of the population that may be as high as 0.65–0.87 (Jay, Farley, and Garner 2001). Considering this, more surveys will be required to verify any trends in population size and to quantify such changes.

3.2.5 Marine and Coastal Birds

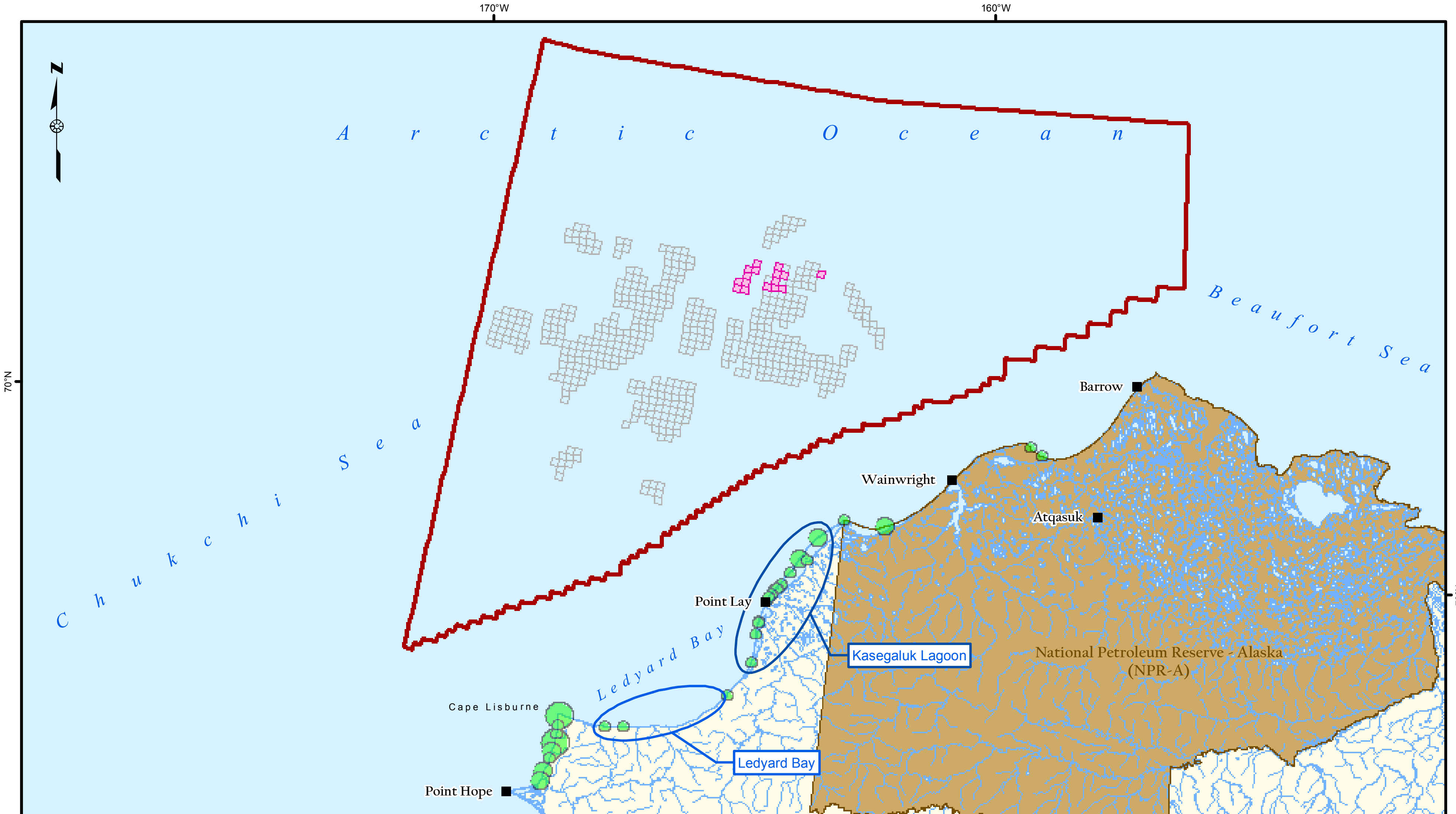
The Chukchi Sea and adjacent onshore areas are important habitat for a wide variety of birds. Most of the birds that use the Arctic area are migrants and use the coastal areas for breeding and nesting. Vessel-based and remote sensing studies have found that these migrants use the coastal and offshore waters to forage and molt (Divoky 1987; Hatch et al. 2000). The North Pacific Seabird Colony Database (USFWS 2006) has records of 34 seabird colonies along the northeastern Chukchi Sea coast between Point Hope and Barrow. Table 3.2.5-1 identifies the abundance of each seabird species found in these colonies.

TABLE 3.2.5-1 Abundance of Various Bird Species in Coastal Chukchi Sea Colonies

Species	Number of Birds in Colonies by General Location					
	Peard Bay	Akoliakatat Pass	Icy Cape	Kasegaluk Lagoon	Ledyard Bay	Cape Lisburne
Pelagic cormorant *(Phalacrocorax pelagicus)*	-	-	-	-	33	238
Common eider *(Somateria mollissima)*	-	442	62	914	-	-
Glaucous gull *(Larus hyperboreus)*	-	10	2	234	40	168
Black-legged Kittiwake *(Rissa tridactyla)*	-	-	-	-	-	18,100
Arctic tern *(Sterna paradisaea)*	50	42	6	62	10	-
Common murre *(Uria aalge)*	-	-	-	-	-	77,500
Thick-billed murre *(Uria lomvia)*	-	-	-	-	-	147,500
Black guillemot *(Cepphus grylle)*	-	-	-	-	9	198
Tufted puffin *(Fratercula cirrhata)*	-	-	-	-	3	40
Horned puffin *(Fratercula corniculata)*	4	-	-	-	-	1,869
Total Birds	54	494	70	1,210	95	245,613

(Source: Adapted from North Pacific Seabird Colony Database [USFWS 2006])

Spring migration for some birds starts with the ice lead openings; many sea birds and sea ducks will closely follow open leads that typically form along the edges of landfast ice. By late fall, most birds migrate south before the formation of sea ice.



Known Colonies and Number of Birds Observed:

- 0 - 100 Birds
- 101 - 1000 Birds
- 1000 or more Birds

- Village
- Lease Sale 193 Area
- National Petroleum Reserve - Alaska
- Sensitive Habitat Area

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Seabird Colony Data Source: *Beringian Seabird Catalog*, USFWS 2000, Anchorage, AK

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SEABIRD COLONIES ALONG THE CHUKCHI SEA COASTLINE

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE:
0 20 40 80
Miles

FIGURE:
3.2.5-1

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3.2.5.1 Cliff-Nesting Birds

Several species of cliff-nesting seabirds inhabit the Chukchi Sea and coastal areas, for foraging, nesting, or both. The status and biology of these birds are not always known. Cliff-nesting birds are often long-lived and have a low reproductive rate. Thus, they are not quick to rebound in population size and are slow to recover from catastrophic events. Cliff-nesting seabirds are often monitored since they are considered early indicators of a deteriorating ecosystem (Iverson et al. 2007). Figure 3.2.5-1 is a map of seabird colonies identified by the USFWS (2006) along the Chukchi Sea coast between Point Hope and Barrow.

Common murre *(Uria aalge)* and thick-billed murre *(U. lomvia)* breed as far north as Cape Lisburne. Approximately 100,000 murres nest at Cape Lisburne (USFWS 2004). Murre numbers have decline by 50 percent at Cape Thompson in the southern Chukchi, while the murre population more than doubled at Cape Lisburne between 1976 and 1995 (Fadely et al. 1989; Roseneau 1996). Horned puffin (Fratercula corniculata), tufted puffin *(F. cirrhata),* and the black-legged kittiwake *(Rissa tridactyla)* are found to breed in colonies at Cape Lisburne and Cape Thompson.

3.2.5.2 Bering Sea Breeders and Summer Residents

Several bird species are known to use the project area in the Chukchi Sea during the summer months (Divoky 1987). These species include the northern fulmar *(Fulmaris glacialis),* short-tailed shearwater *(Puffinus tenuirostris),* parakeet auklet *(Cyclorrhynchus psittacula),* least auklet *(Aethia pusilla),* and crested auklet *(A. cristatella).* None of these species is known to nest north of the Bering Strait (Roseneau and Herter 1984; MMS 2007b).

Northern fulmars and short-tailed shearwaters do not breed on the Chukchi Sea coast, though they are found in the project area during the summer and fall. These individuals are non-breeders or failed breeders foraging on pelagic fish, or euphausiids, and amphipods. Their numbers represent a small portion of total numbers present in Alaskan coastal and marine waters during this time period (Divoky 1987; Gould 1983).

The auklet species listed above are not known to nest north of the Bering Strait. They have been recorded in very large numbers (Divoky 1987) at times when there was an unusual amount of water flowing into the Chukchi Sea from the Bering Sea (MMS 2007b), temporarily increasing zooplankton availability, a key prey species for auklets. Divoky (1987) has estimated that during a typical year there may be as many as 100,000 total auklets in the Chukchi Sea. The current status of all these species in the project area is unknown (MMS 2007b).

3.2.5.3 High Arctic-Associated Seabirds

Small numbers of the black guillemot *(Cepphus grille)* breed in the Alaska Chukchi Sea (about 500 breeding pairs) (Roseneau and Herter 1984), and fewer than 2,000 breeding individuals are found in Alaska’s coastal areas and offshore islands (Divoky et al. 1974; Divoky 1987). However, the pelagic population in Alaska is estimated to be around 70,000 (Divoky 1987). Black guillemots winter in Bering Sea pack ice (Kessel and Gibson 1978; Kessel 1989).

Black guillemots are associated with sea ice throughout their lifetime and feed extensively on Arctic cod found near the sea ice edge (Divoky 1987). Their diet can also vary by season and geographic range to include crustaceans and other invertebrates (Cairns 1987). Once foraging trips become too long as sea ice recedes over the course of a season, there is evidence that black guillemots begin feeding on other fish species (Friends of Cooper Island 2005).

Arctic terns *(Sterna paradisaea)* have been found in fairly large numbers in Kasegaluk Lagoon (Johnson et al. 1992). Arctic terns arrive in the Chukchi Sea in May after migrating from the Antarctic (Williamson et al. 1966). This species may be rare in pelagic waters of the Chukchi Sea, with most sightings recorded within 40 km (25 mi) of the shore. In this area, Arctic terns generally feed on arctic cod, sand lance, euphausiids, mysid shrimp, and amphipods (Divoky 1983; Roseneau and Herter 1984).

Arctic terns breed and nest in colonies on marine spits and small islands. The hatching and fledging of chicks happen relatively quickly due to the short season and energetic demands. Juveniles are able to fly within approximately 50 days from egg-laying, depending on the amount of predator disturbance (Bianki 1967; Boekelheide 1980; Cullen 1956). Arctic terns depart by mid-September and likely follow the coast over waters no deeper than 20 m (66 ft) (Divoky 1987).

3.2.5.4 Tundra-Breeding Migrants

The glaucous gull and three species of jaegers (pomarine jaeger *[Stercorarius pomarinus]*, parasitic jaeger *[S. parasiticus]*, and long-tailed jaeger [*S. longicaudus])* are found in the Chukchi Sea near the project area in spring until late September (Divoky 1987).

Glaucous gulls generally breed inland around freshwater lakes, though they will also breed and nest in colonies on the coast near other seabirds (Divoky 1987; Sowls et al. 1978). Migrants begin to arrive on the Chukchi Sea coast in April when the spring ice lead system is open (Swartz 1966). Egg-laying is in mid-June, with the juveniles fledging as soon as 72 days later in late August (Denlinger 2006; Roseneau and Herter 1984). In late summer and early fall, non-breeders and sub-adults join the breeding population that can be found as far as 70 km (43 mi) offshore in the Chukchi Sea between Ledyard Bay and Point Barrow (Divoky 1987; Dau and Larned 2005). Glaucous gulls are predators as well as scavengers. While they will feed on Arctic cod, sand lance, and herring, the largest concentrations are usually seen near carcasses of marine mammals and where murre chicks and eggs are abundant (Swartz 1966; Roseneau and Herter 1984).

Surveys conducted by Divoky (1987) found that all three species of jaegers were abundant in the Chukchi Sea from the beginning of summer until late September. Roseneau and Herter (1984) have concluded that the pomarine jaeger is the most abundant of the three. Jaegers winter at sea in the Southern Hemisphere and arrive in the northeastern Chukchi Sea in late May. The only significant amount of time they spend on land is during breeding and nesting. Lemmings and voles compose a large amount of the prey of long-tailed and pomarine jaeger at this time (Maher 1970; de Korte and Wattel 1988), while the parasitic jaeger feeds primarily on the eggs and chicks of other smaller birds (Maher 1974; Taylor 1974). Non-breeding birds are found in offshore waters, commonly along the ice front, where they pirate fish from other birds or capture their own by seizing them at the surface. The density of these birds offshore may depend on the breeding success on the tundra (Divoky 1987). Fall migration begins in late August and is complete by late September (Roseneau and Herter 1984).

3.2.5.5 Waterfowl

Waterfowl include mergansers, ducks, geese, and swans. Table 3.2.5-2 contains a list of species commonly found in the marine and coastal areas of the Chukchi Sea and summarizes the global distribution of each of these waterfowl species and its distribution in Alaska. While many of these species are usually found in nearshore areas of the Chukchi Sea, surveys in the project area by Divoky (1987) recorded low densities of ducks and eiders.

TABLE 3.2.5-2 Summarized Distribution of Abundant Waterfowl Species Found in the Northeastern Chukchi Sea

Common and Scientific Name	Worldwide	Alaska/Northeastern Chukchi Sea
Red-breasted merganser *(Mergus serrator)*	Resident over much of North America and Eurasia; winters in ice-free protected marine waters	Nests throughout Alaska, nests on tundra along Chukchi; uses coastal waters for rearing broods, feeding, migration; winters in ice-free marine waters, Aleutians and south
Northern pintail *(Anas acuta)*	Northern North America and Eurasia; winters in Africa, Central America, and southern United States and Eurasia	Nests throughout Alaska, nests on tundra along Chukchi; uses coastal waters for rearing broods, feeding, migration; winters in southern United States and Central America
Greater scaup *(Aythya marila)*	Holarctic, circumpolar; winters in coastal waters of southern United States, Mexico, Japan, China	Nests across much of western and northern Alaska, including Chukchi coastline; utilizes Chukchi Sea coastal waters for molting, staging, migration
Surf scoter *(Melanitta perspicillata)*	Nests in northern North America; winters in coastal waters of the Atlantic and Pacific	Nests mostly in boreal forest; uses coastal waters along Chukchi Sea for molting, staging, migration
Black scoter *(Melanitta nigra)*	Nests in northern Eurasia and North America; winters in coastal waters	Nests on tundra Bristol Bay to Canada, nests along Chukchi coast; and uses coastal waters for molting, staging, migration
White-winged scoter *(Melanitta fusca)*	Nests in northern Eurasia and North America; winters in coastal waters	Nests in forested interior; uses coastal waters along Chukchi Sea for molting, staging, migration
Long-tailed duck *(Clangula hyemalis)*	Circumpolar, winters in northern marine waters; North Slope nesters; winters in the Sea of Okhotsk, Japan	Nests in western and interior Alaska, North Slope, including northeastern Chukchi coastline; uses nearshore and offshore waters for molting, staging, migration; winters offshore Russian Far East
Common eider *(Somateria mollissima)*	Circumpolar, winters in northern marine waters	Nests across western Alaska, North Slope, including northeastern Chukchi coastline; winters in Bering Sea, Sea of Okhotsk
King eider *(Somateria spectabilis)*	Circumpolar in the high arctic; winters in northern marine waters	Nests across the North Slope; uses Chukchi Sea for molting, staging, migration; winters in the Bering Sea, Bristol Bay, Gulf of Alaska, Sea of Okhotsk
Lesser snow goose *(Chen caerulescens)*	Breeds in northeast Siberia, northern North America; winters in the United States, Japan	Nests regularly at only two locations, one is at Kukpowruk River delta; stages and molts along Chukchi, especially Kasegaluk Lagoon
Greater white-fronted goose *(Anser albifrons)*	Holarctic, breeds across Eurasia and North America; winters in southern United States, Mexico, and southern Eurasia	Nests Yukon-Kuskokwim Delta, Cook Inlet, North Slope; stages and molts along Chukchi Sea
Canada goose *(Branta canadensis)*	Breeds northern North America, winters southern U.S.	Nests across much of Alaska; found in low numbers in Kasegaluk Lagoon when staging

TABLE 3.2.5-2 Summarized Distribution of Abundant Waterfowl Species Found in the Northeastern Chukchi Sea

Common and Scientific Name	Worldwide	Alaska/Northeastern Chukchi Sea
Pacific black brant *(Branta bernicula nigricans)*	Nests in Alaska, Canada, and Siberia; winters in Baja Mexico	Nests on North Slope and Yukon-Kuskokwim Delta; up to 45 percent of population stages in Kasegaluk Lagoon
Tundra swan *(Cygnus columbianus)*	Nests in Alaska, Canada, and northern Eurasia; winters east coast of North America	Nests on the North Slope, including Chukchi coast; uses Kasegaluk Lagoon and other nearshore

(Source: Distribution summarized from The Birds of North America species accounts [Poole 2005])
Note: Spectacled and Steller's eiders are discussed in Section 3.2.4.

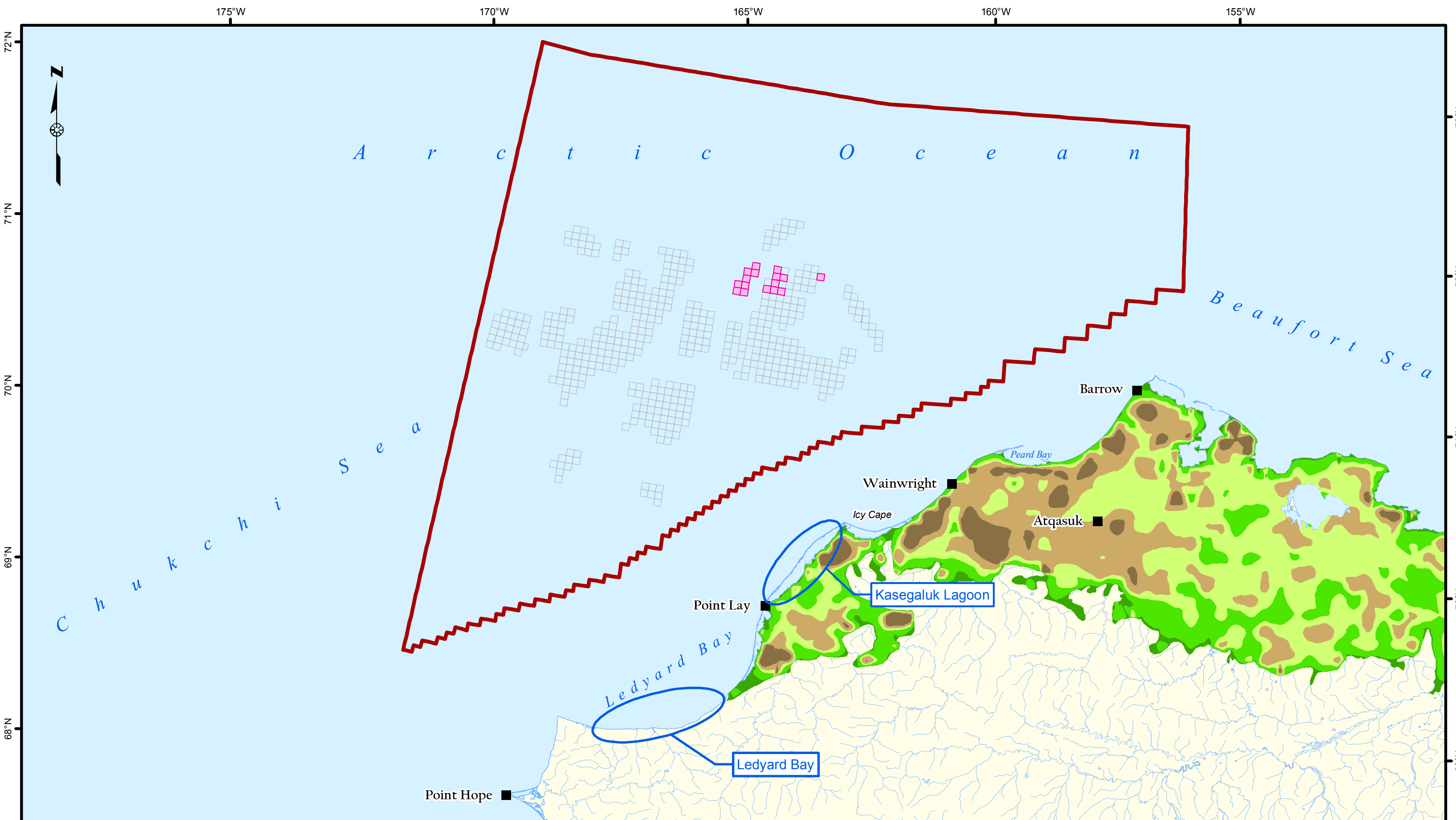
Long-Tailed Duck

Telemetry studies (U.S. Geological Survey [USGS] 2009) indicate long-tailed ducks from the North Slope winter in ice-free waters of the Sea of Japan, Sea of Okhotsk, and Kamchatka Peninsula in Asia. At least several hundred thousand migrate into or through the northeastern Chukchi Sea.

Spring migration commences along the lead system in mid-May and continues through June (Roseneau and Herter 1984). Long-tailed ducks nest on the tundra near shallow waterbodies across the North Slope, including along the northeastern Chukchi Sea coastline (Figure 3.2.5-2). A clutch of 6–8 eggs takes 24–29 days to incubate, and the ducklings can fly within an additional 35–40 days (Sea Duck Venture 2003). At that time, they move to marine habitats, where the female undergoes a molt during which she is flightless. Males and non-breeding females move to these molting areas and molt prior to breeding females. The molting, which takes place in lagoons and other shallow waters, continues through July and August, after which the birds utilize coastal waters to feed and stage for the fall migration. Known molting areas include Peard Bay, Kasegaluk Lagoon, and Ledyard Bay. While flocks typically remain within the 20 m (66 ft) nearshore isobath, surveys (Divoky 1987) have documented their presence in pelagic waters near the Hanna Shoal.

Fall migration begins in early September, with few long-tailed ducks remaining on the Chukchi Sea coast after mid-October (Roseneau and Herter 1984). Fall migration is concentrated, with the birds forming large flocks. Lehnhausen and Quinlan (1981) estimated that 186,000 long-tailed ducks migrated past Icy Cape between August 22 and September 20, 1981. In the marine environment they feed primarily on invertebrates, with key food items being mysid shrimp, gammarid amphipods, isopods, and mollusks (Johnson and Richardson 1981).

Long-tailed ducks are one of the most abundant nesting ducks on the North Slope, second in numbers only to the northern pintail. Survey data indicate that the U.S. and Canadian breeding population of long-tailed ducks has declined by about 80 percent since 1957; however, the population seems to have stabilized since the 1990s (Sea Duck Venture 2004). Over the past 16 years (1992–2007), aerial surveys of the North Slope population of long-tailed ducks have shown a significant decline (Larned et al. 2007).



Long-Tailed Duck Densities:

- Low
- Medium Low
- Medium
- Medium High
- High

- Village
- Lease Sale 193 Area
- Sensitive Habitat Area

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Bird Density data source: U.S. Fish and Wildlife Service, Arctic Coastal Plain Survey 1993-2005

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LONG-TAILED DUCK DENSITIES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.5-2

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King Eider

Due to the remoteness of their habitats, the life history of King eiders, and eiders in general, is not well known (Petersen et al. 2006; Suydam et al. 2000). The King eiders that breed on the Chukchi Sea coast have been tracked throughout the non-breeding season by satellite telemetry, which has shown that they migrate to offshore areas in the Bering Sea (Phillips 2005; Powell et al. 2005). The diet of King eiders consists primarily of mollusks, gammarid amphipods, and isopods (Roseneau and Herter 1984) they obtain by diving to depths of 55–60 m (180–200 ft) or more (Suydam 2000).

King eiders begin arriving on the North Slope through the Chukchi Sea in mid-May. Males and females pair up prior to spring migration (Suydam et al. 2000). As with seabirds and other ducks, the spring lead system is a large factor in determining when King eiders are able to migrate into the area (Barry 1986). Recent satellite tracking (Powell et al. 2005; Oppel et al. 2008) has documented Ledyard Bay as an important staging area during this time. Aerial surveys have shown King eiders do not utilize coastal areas with great frequency during the breeding season (Dau and Larned 2005), but instead nest far inland near Atqasuk (Figure 3.2.5-3) (Larned et al. 2005). Nests are usually located close to freshwater lakes (Powell et al. 2005).

Three–four eggs are laid in mid-June to mid-August, and hatching occurs from mid-July to late August (Roseneau and Herter 1984). The males depart the nesting areas at the onset of incubation and migrate to the molting areas, while breeding females and their young move to the sea when they fledge. Primary molting areas are located along the Chukotka Peninsula in Russia (Sea Duck Venture 2004; Oppel et al. 2008), but molting also occurs in Peard Bay and northern Kasegaluk Lagoon. The molt migration occurs through the Chukchi Sea, starting in early July with the males and increasing in August with the females (Roseneau and Herter 1984).

Springer et al. (1982) estimated that 50,000 eiders passed Cape Lisburne each day in late July of 1980. These large-scale movements continue until early October, and some birds remain as long as there is open water, sometimes as late as mid-November (Bailey 1948). The timing of fall migration may be linked to productivity on the breeding grounds (Hepp 1984; Dugger 1997). Divoky (1987) reported that eiders were common along the 20 m (66 ft) depth contour, but small numbers were observed much further offshore after September 22.

The population of King eiders has dramatically declined in recent times: from 1953–1976, the population appeared to be stable but declined by 56 percent from approximately 802,556 birds in 1976 to about 350,835 in 1996 (Suydam et al. 2000).

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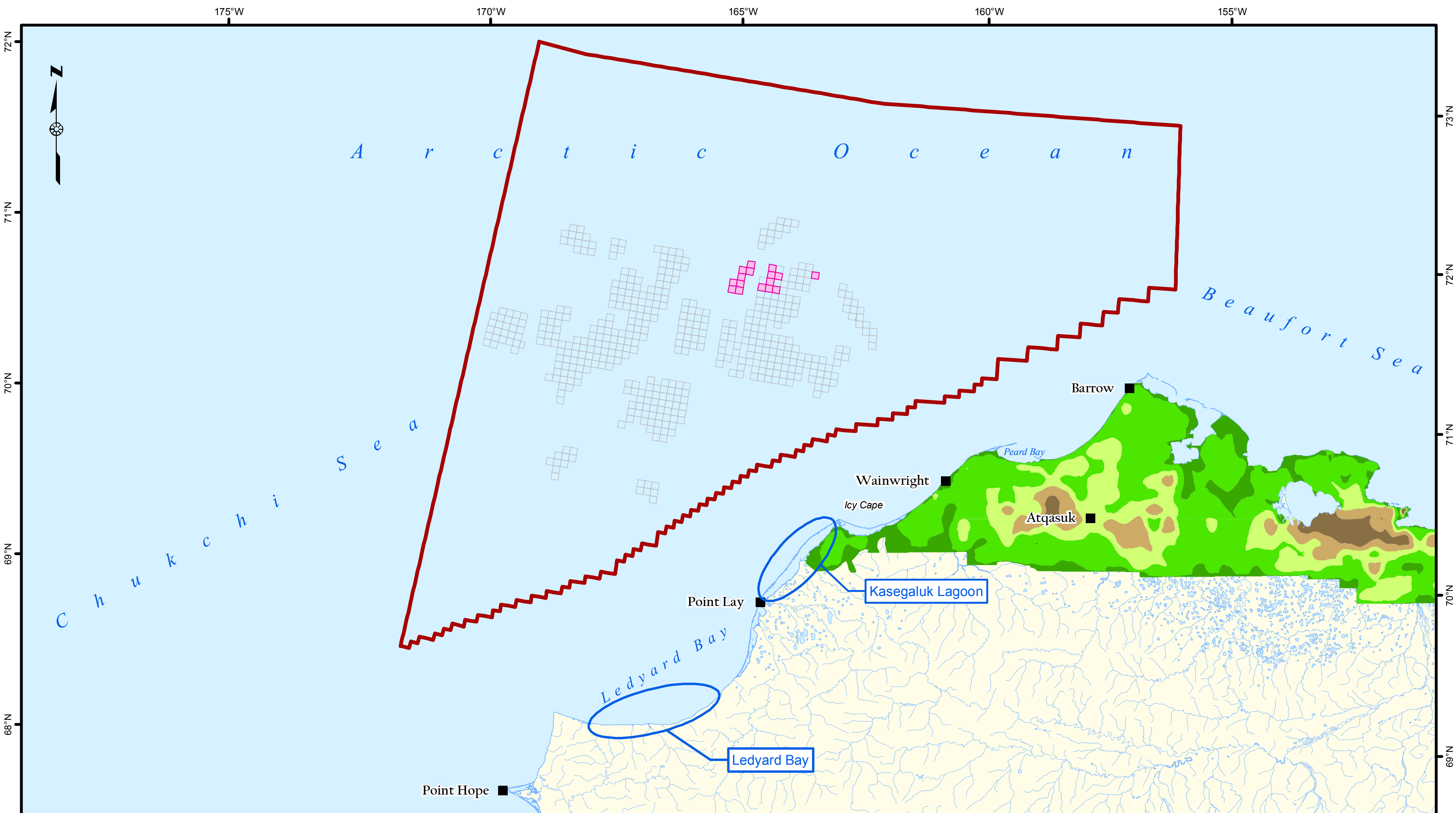

King Eider Densities:

- Low
- Medium Low
- Medium
- Medium High
- High

- Village
- Lease Sale 193 Area
- Sensitive Habitat Area

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Bird Density data source: U.S. Fish and Wildlife Service, *Arctic Coastal Plain Survey* 1993-2005

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KING EIDER DENSITIES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.5-3

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Common Eider

Common eiders migrate to the North Slope by mid-May, through the Chukchi Sea following the open ice lead system along the coast (Roseneau and Herter 1984). Their offshore distribution is not well known in the Chukchi Sea, but information from the King eider studies by Oppel et al., mentioned above, has been applied to common eiders. Thus, it is thought that Ledyard Bay is also an important spring staging area for common eiders prior to the breeding season (MMS 2007). Most common eiders then move to the Beaufort Sea coast and arctic Canada to breed, though a small portion remains on the Chukchi Sea coast.

Common eiders nest on barrier islands and spits along the coast of the Chukchi Sea (Johnson and Herter 1989). The diet of this species consists primarily of mussels, clams, sea urchins, starfish, and crabs, which are obtained by diving. The birds typically feed in water depths of 3–20 m (10–66 ft) (Sea Duck Joint Venture 2004). The USFWS has conducted extensive surveys for nesting common eiders along the Chukchi Sea coast and found that the Kasegaluk Lagoon and Peard Bay are the most heavily used areas (Dau and Larned 2005).

Female common eiders have very high nesting-site fidelity (Sea Duck Joint Venture 2004) and nest in dense colonies on barrier islands along the coast. The time from egg-laying to fledging is 84–91 days total. After hatching, the juveniles are reared in marine waters close to the nesting site, where the female begins her molt (Sea Duck Joint Venture 2004; Peterson and Flint 2002). Once the molt is complete, common eiders will group in coastal protected waters and then begin their fall migration in late September and October. The path of migration is very similar to that of King eiders (Divoky 1987).

Common eider production can fluctuate with ice conditions (Dau and Larned 2005) and predation rates from Arctic fox *(Alopex lagopus)* and glaucous gulls (Noel et al. 2002). The common eider population declined dramatically by 53 percent from approximately 156,081 in 1976 to about 72,606 in 1996 (Suydam et al. 2000).

Lesser Snow Goose

Monitoring of lesser snow geese populations on the North Slope has increased in intensity over the past 10 years due to an increase in the size of existing colonies (Ritchie and Rose 2008). Recent publications and evidence show that the population near the village of Point Lay may have grown by an order of magnitude since monitoring began there almost two decades ago (Suydam, NSB, personal communication in Ritchie and Rose 2008; Ritchie et al. 2000). The greater white-fronted geese are much more common in the region and nest within 30 km (19 mi) of the Chukchi Sea coast. Up to 4,200 greater white-fronted geese have been observed in the Kasegaluk Lagoon area (MMS 2007b).

Pacific Black Brant

Pacific black brant are colonial nesters and prefer to nest in scattered locations on offshore spits, barrier islands, or on islands in river deltas away from terrestrial predators (Johnson and Herter 1989). Brant densities across the Chukchi Sea coast are surveyed annually by the USFWS (Figure 3.2.5-4). They are not known to nest in large numbers near the Chukchi Sea coastline, but heavily use adjacent coastal waters Kasegaluk Lagoon (Johnson 1993). Aerial surveys have indicated positive growth on the North Slope over the past 16 years (1992–1997) (Larned et al. 2007). However, this trend is suspect as surveys may include non-breeders or failed breeders from western Alaska.

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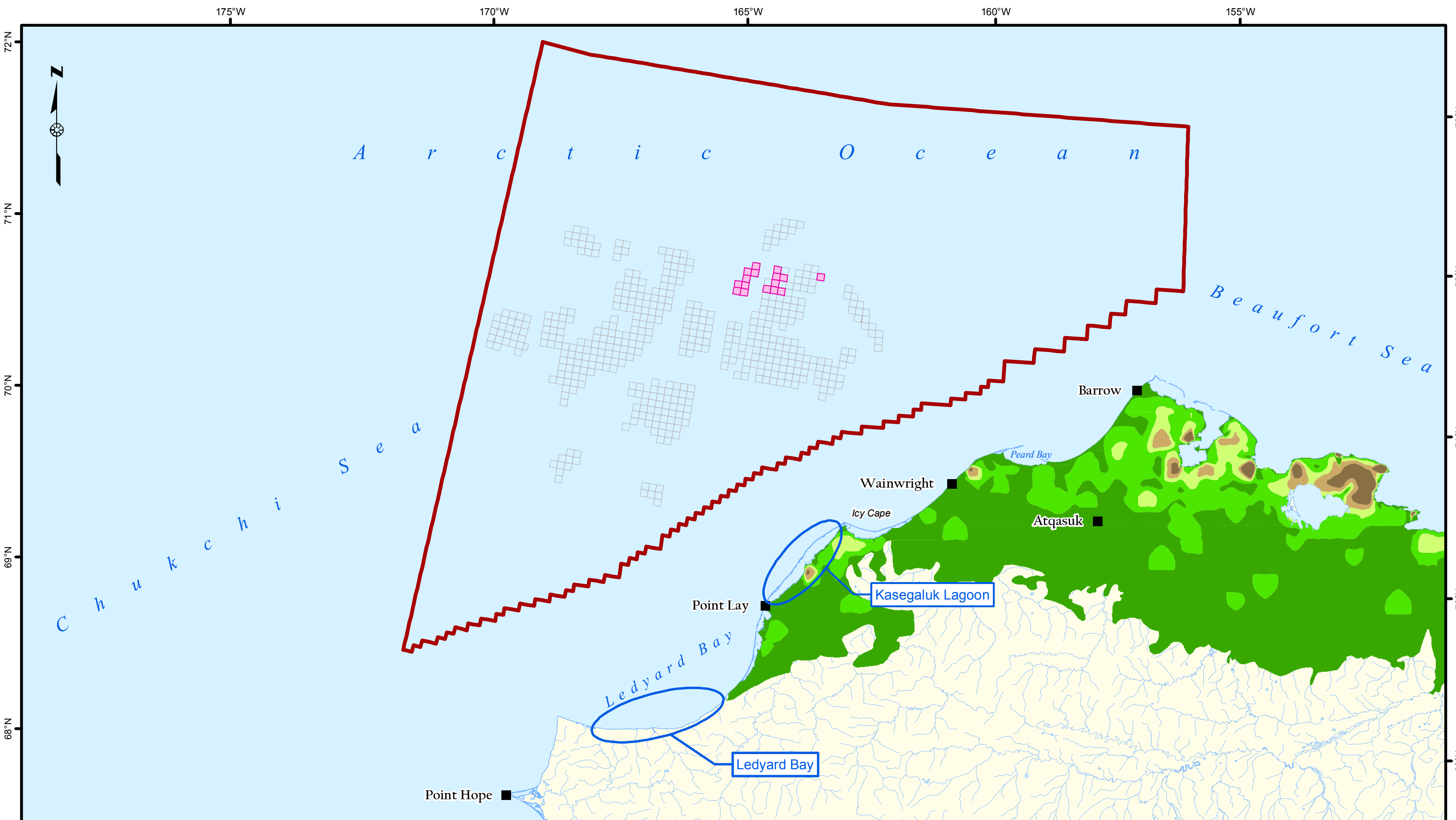

NAD83, Alaska Albers Equal Area.
Bird Density data source: U.S. Fish and Wildlife Service, *Arctic Coastal Plain Survey* 1993-2005

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PACIFIC BLACK BRANT DENSITIES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.5-4

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Tundra Swans

Tundra swans are known to nest in Kasegaluk Lagoon. The North Slope population index for this species was 10,174 in 2006, which was slightly higher than the average over the past two decades. There is evidence that the North Slope population is undergoing a significant increase (Mallek et al. 2007).

Loons

There are three loon species found in the offshore and coastal habitats of the Chukchi Sea, about 70 miles from the project area. These are the Pacific loon *(Gavia pacifica),* the red-throated loon *(G. stellata),* and the yellow-billed loon *(G. adamsii).* Discussions of life history and abundance information about Pacific and red-throated loons are discussed below, while more comprehensive information about the yellow-billed loon was provided earlier in Section 3.2.4.

Red-Throated Loons

Red-throated loons nest across northern North America and Eurasia. In Alaska, they nest primarily in coastal areas from southeastern Alaska to Canada. Red-throated loons generally nest in small, shallow wetlands, apparently due to competition with the larger and more abundant Pacific loons. Red-throated loon nesting occurs mostly within about 20 km (12 mi) of the coast (Larned et al. 2007). This species feeds its young almost exclusively on marine species (Madsen 1957; Palmer 1962) and is considered to be more marine-associated than the Pacific loon. Most red-throated loons that breed in Alaska migrate back to East Asia to winter. The density of nesting red-throated loons across the North Slope has been documented by the USFWS (Figure 3.2.5-5). These surveys indicate that the red-throated loon population has generally increased on the Arctic Coastal Plain since 1986, with a 2006 population index of 5,142 (Mallek et al. 2007).

Pacific Loons

Pacific loons nest in northern Canada, Alaska, and parts of Siberia. They nest throughout much of Alaska and are commonly found across the Arctic Coastal Plain, including areas along the northern Chukchi Sea coastline. Pacific loons winter in marine environments along the western coast of North America from Alaska to Mexico (Weber 1978; Kessel 1989). Recent indices of population size have shown a dramatic increase over the relatively stable numbers from previous aerial survey results (Larned et al. 2007; Lysne et al. 2004; Dau and Larned 2006, 2007, 2008).

Total numbers of loons in the area are unknown but probably number in the tens of thousands, with most passing through the project area offshore to lands further north and east on the North Slope and Canadian Arctic Slope.

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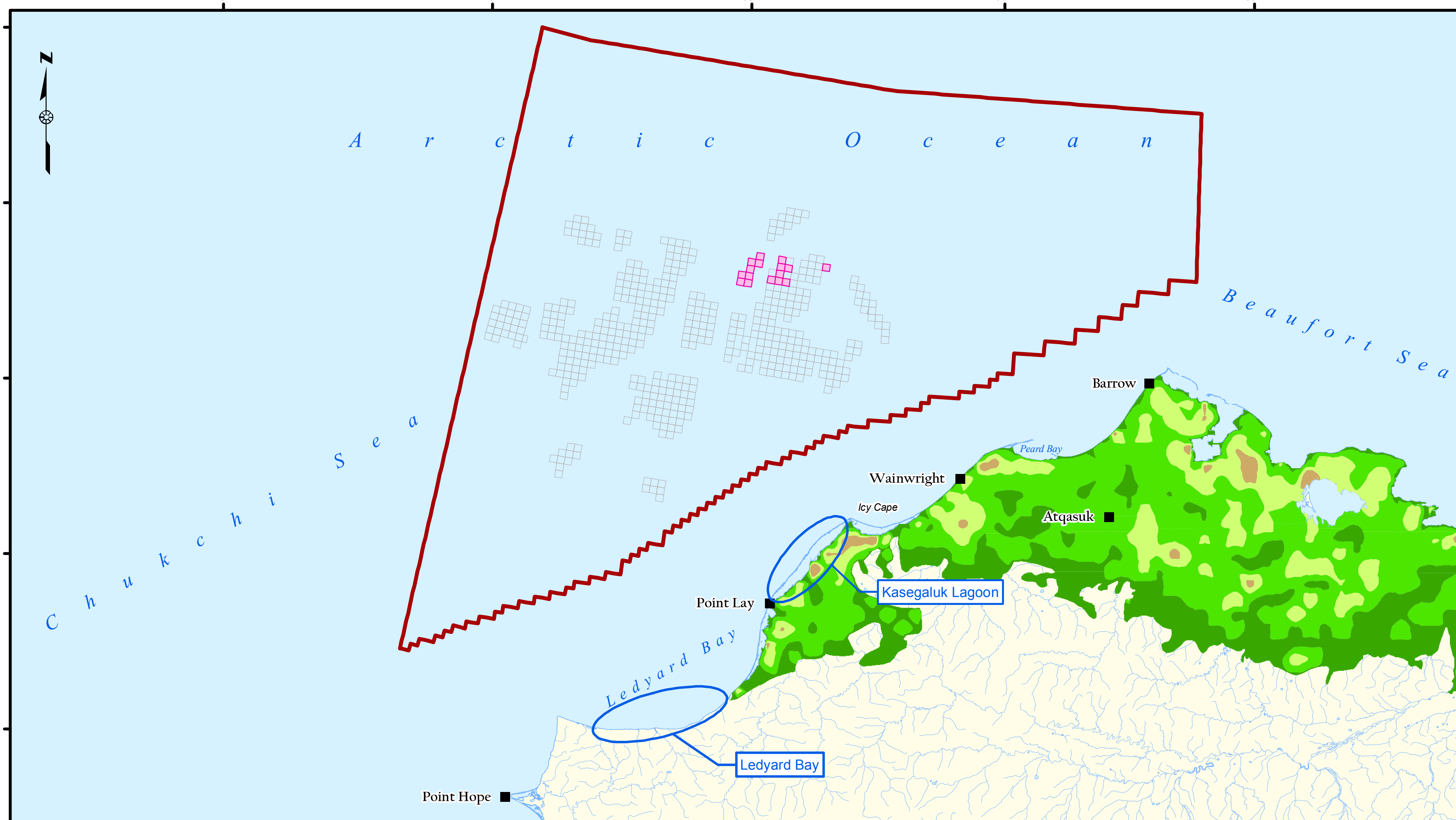

Red-Throated Loon Densities:

- Low
- Medium Low
- Medium
- Medium High
- High

- Village
- Lease Sale 193 Area
- Sensitive Habitat Area

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Bird Density data source: U.S. Fish and Wildlife Service, Arctic Coastal Plain Survey 1993-2005

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RED-THROATED LOON DENSITIES
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.5-5

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3.2.5.6 Shorebirds

Shorebirds often rely on coastal areas, such as beaches, barrier islands, lagoons, and mudflats, because these areas serve as important habitat for foraging. Some of the most common shorebirds on the North Slope are dunlin *(Calidris alpine),* semipalmated sandpiper *(C. pusilla),* pectoral sandpiper *(C. malanotos),* red phalarope *(Phalarpopus fuliacaria),* bar-tailed godwit *(Limosa lapponica baueri),* buff-breasted sandpiper *(Tryngites subruficollis),* and American golden-plover *(Pluvialis dominica).* Recently, many species of shorebirds have been of large concern due to falling populations.

Troy (2000) listed 16 shorebird species that routinely use the North Slope and another 20 that occur as migrants, vagrants, or rare breeders. A 1998–2004 North Slope-wide study (Johnson et al. 2007) of the distribution of shorebirds documented a total of 19 species breeding in the area. Generally, shorebirds are present on the North Slope from May to mid-August. These species nest on the tundra, but many move to the Chukchi Sea coastline to use intertidal habitats for feeding and staging prior to and during migration. These shores provide productive shorebird habitat that is used for foraging and replenishing fat reserves after breeding and prior to southward migration. Information on the worldwide and Alaska distribution of shorebirds found on the Alaska North Slope is summarized below in Table 3.2.5-3.

Shorebirds are likely to remain in the high use areas of the Kasegaluk Lagoon and Peard Bay, but previous surveys of the project area (Divoky 1987) have recorded some shorebirds offshore in the project area.

TABLE 3.2.5-3 Distribution of Shorebirds that Commonly Nest on the Alaska North Slope

Common and Scientific Name[1]	Worldwide Distribution [2]	Alaska Distribution[3]
Black-bellied plover *(Pluvialis squatarola)*	Pan-arctic breeding; winters in South America and Pacific islands	Nesting common in the Yukon-Kuskokwim Delta, uncommon on the Arctic Coastal Plain, rare in the Southwest and Northwest
American golden-plover *(Pluvialis dominica)*	Nests North America; winters in South America	Nesting common in the Northwest and Arctic Coastal Plain, uncommon in the Yukon-Kuskokwim Delta
Semipalmated plover *(Charadrius semipalmatus)*	Nests northern Alaska and northern Canada; winters along coasts North and South America	Nesting common in the southwest, uncommon in the Northwest and on the Arctic Coastal Plain
Whimbrel *(Numenius pheopus)*	Nests northern Eurasia, northern and central Alaska and Canada; winters India, Africa, southern United States, northern South America	Nesting uncommon in the Northwest, rare in the Southwest, Yukon-Kuskokwim Delta, and Arctic Coastal Plain
Bar-tailed godwit *(Limosa lapponica)*	Nests northern Eurasia, western North Alaska; winters tropical Asia, Africa, Australia	Nesting common in the Yukon-Kuskokwim Delta, uncommon in the Northwest, and rare on the Arctic Coastal Plain
Ruddy turnstone *(Arenaria interpres)*	Nests northern Eurasia, northern Alaska and Canada; winters Africa, Australia, southern United States, South America	Nesting uncommon in the Yukon-Kuskokwim Delta, Northwest, and Arctic Coastal Plain
Sanderling *(Calidris alba)*	Nests northern North America, Eurasia; winters coasts of Africa, South America, Australia	Nesting uncommon on the Arctic Coastal Plain[4]

TABLE 3.2.5-3 Distribution of Shorebirds that Commonly Nest on the Alaska North Slope

Common and Scientific Name[1]	Worldwide Distribution [2]	Alaska Distribution[3]
Semipalmated sandpiper *(Calidris pusilla)*	Nests northeastern Siberia, arctic North America; winters Pacific and Atlantic coasts to South America	Nesting abundant in the Yukon-Kuskokwim Delta and on the Arctic Coastal Plain, common in the Northwest
Western sandpiper *(Calidris mauri)*	Nests in northeastern Asia and northwestern North America; winters Pacific and Atlantic coasts	Nesting abundant in the Yukon-Kuskokwim Delta, common in the Northwest, uncommon in the Southwest, and rare on the Arctic Coastal Plain
White-rumped sandpiper *(Calidris fuscicollis)*	Nests in northern Alaska, Canada; winters in South America	Nesting uncommon on the Arctic Coastal Plain
Baird's sandpiper *(Calidris bairdii)*	Nests northeastern Asia and northern North America; winters in South America	Nesting uncommon on the Arctic Coastal Plain, rare in the Yukon-Kuskokwim Delta
Pectoral sandpiper *(Calidris melanotos)*	Nests eastern Siberia, northern Alaska and Canada, winters South America, Australia	Nesting abundant on the Arctic Coastal Plain, uncommon in the Northwest, and rare in the Yukon-Kuskokwim Delta and in the southwest
Dunlin *(Calidris alpina)*	Circumpolar in holarctic; winters in sourthern United States, Mexico, Europe, southern Asia, northern Africa	Nesting abundant in the Yukon-Kuskokwim Delta and on the Arctic Coastal Plain, and common in the southwest and northwest
Stilt sandpiper *(Calidris himantopus)*	Nests from northern Alaska to Hudson Bay; winters in South America	Nesting common on the Arctic Coastal Plain
Buff-breasted sandpiper *(Tryngites subruficollis)*	Nests northeastern Siberia, northern Alaska and Canada; winters in southern South America, Australia	Nesting uncommon on the Arctic Coastal Plain
Long-billed dowitcher *(Limnodromus scolopaceus)*	Nests northeastern Asia, northcentral North America; winters western and southern United States, Central America	Nesting uncommon in all areas in Alaska
Wilson's snipe *(Gallinago delicata)*	Nests northern North America; winters northwestern and central United States to northern South America	Nesting common in the southwest, Yukon-Kuskokwim Delta, and northwest United States, rare on the Arctic Coastal Plain
Red-necked phalarope *(Phalaropus lobatus)*	Circumpolar in holarctic; winters at sea off South America, Africa, Australia	Nesting abundant in the Yukon-Kuskokwim Delta, common in the southwest, northwest, and on the Arctic Coastal Plain
Red phalarope *(Phalaropus fulicarius)*	Circumpolar in holarctic; winters at sea off South America and Africa	Nesting abundant on the Arctic Coastal Plain, common in the Yukon-Kuskokwim Delta, and uncommon in the northwest United States

[1]Species list based on results of 1998-2004 surveys reported by Johnson et al. (2007)
[2] Worldwide distributions summarized from World Bird Guide (2009)
[3]Alaska nesting distribution summarized from Bowman (2004)
[4]Sanderling nesting distribution summarized from USFWS (2008)

Estimates of the North American population of the common shorebird species on the North Slope are provided below in Table 3.2.5-4.

TABLE 3.2.5-4 Shorebird Populations Nesting across the Alaskan North Slope

Common Name	North American Population	Percent of Population in Alaska		
		Breeding	Migration	Winter
Black-bellied plover	50,000	100	100	<5
American golden-plover	200,000	25–50	25–50	0
Semipalmated plover	150,000	>25	>25	0
Whimbrel	26,000	>80	>80	0
Bar-tailed godwit	80,000–120,000	100	100	0
Ruddy turnstone	65,000	>35	35	<1
Sanderling	300,000	<10	<10	<5
Semipalmated sandpiper	2,000,000	>25	>25	0
Western sandpiper	3,500,000	>95	100	0
White-rumped sandpiper	1,120,000	<5	<5	0
Baird's sandpiper	300,000	5–15	5–15	0
Pectoral sandpiper	500,000	30–50	>70	0
Dunlin	750,000	100	100	<5
Stilt sandpiper	820,000	5–10	5–10	0
Buff-breasted sandpiper	30,000	<25	<30	0
Long-billed dowitcher	400,000	>80	>90	0
Wilson's snipe	2,000,000	25–50	25–50	0
Red-necked phalarope	2,500,000	20–40	20–40	0
Red phalarope	1,250,000	60	60	0

(Source: Alaska Shorebird Conservation Plan [Alaska Shorebird Working Group 2008])

3.2.6 Marine Mammals

This section summarizes the information on marine mammal abundance and distribution in the Chukchi Sea and, where available, near Statoil's proposed seismic survey area. The Chukchi Sea is a rich environment, home to many marine mammals such as whales, porpoises, seals, walruses, and polar bears. Table 3.2.6-1 lists these marine mammals, their scientific name, and their status under the MMPA and the ESA. Many of these animals are important as subsistence resources for the nearby villages of Point Hope, Point Lay, Wainwright, and Barrow.

Cetaceans (whales and dolphins) that are common in the area include bowhead whales *(Balaena mysticetus),* gray whales *(Eschrichtius robustus),* beluga whales *(Delphinapterus leucas),* and harbor porpoises *(Phocoena phocoena).* Some uncommon cetaceans that have been sighted in the Chukchi

Sea include fin whales *(Balaenoptera physalus),* minke whales *(Balaenoptera acutorostrata),* humpback whales *(Megaptera novangliae),* and killer whales *(Orcinus orca).* All marine mammals are protected under the MMPA, which is discussed in more detail in Section 2.0 Regulatory Framework. Bowhead whales, fin whales, and humpback whales are listed as endangered under the ESA (see Section 3.2.4).

Pinnipeds that occur in the Chukchi Sea and are likely to be sighted near Statoil's seismic survey area are ringed seals *(Phoca hispida),* spotted seals *(Phoca largha),* ribbon seals *(Phoca fasciata),* bearded seals *(Erignathus barbatus),* and Pacific walruses *(Odobenus rosmarus divergens).* The status of bearded and ringed seals is under review by the NMFS, and status of the Pacific walruses by USFWS. NMFS plans to make their determination by November 2010 whether the seal species warrant listing under ESA as a threatened or endangered species, and USFWS plans to publish their determination for the Pacific walrus in the Federal Register by September 2010.

Polar bears are also regular inhabitants in the Chukchi Sea and may be encountered in water or on ice near the Statoil seismic survey area. Polar bears are listed as threatened under the ESA. Critical habitat areas have been proposed for polar bears by the USFWS. Public comments regarding the proposed designation are being collected for review by the USFWS.

More information regarding marine mammal species that are listed as endangered or threatened under the ESA is provided in Section 3.2.4, Threatened and Endangered Species. Walruses are also discussed in Section 3.2.4.

TABLE 3.2.6-1 The Habitat, Abundance (in Alaska or North Chukchi Sea, if available), and Conservation Status of Marine Mammals Inhabiting the Proposed Survey Area

Species	Abundance	Habitat	ESA[1]	IUCN[2]	CITES[3]
Pinnipeds					
Bearded seal *(Erignathus barbatus)*		Pack ice, Open water	In review for listing	LC	–
Alaska population	250,000–300,000[9]				
Eastern Chukchi Sea population	4,863[10]				
Spotted seal *(Phoca largha)*		Pack ice, Open water, Coastal haulouts	Not listed	DD	–
Alaska population	~59,214[11]				
Eastern and Central Bering Sea	101,568[12]				
Ringed seal *(Phoca hispida)*		Landfast and pack ice, open water	In review for listing	LC	–
Bering/Chukchi Sea stock	230,673[13]				
Beaufort Sea stock	326,500[14]				
Ribbon seal *(Histriophoca fasciata)*	90,000–100,000[15]	Pack ice, open water	Not listed	DD	–

TABLE 3.2.6-1 The Habitat, Abundance (in Alaska or North Chukchi Sea, if available), and Conservation Status of Marine Mammals Inhabiting the Proposed Survey Area

Species	Abundance	Habitat	ESA[1]	IUCN[2]	CITES[3]
Pacific walrus *(Odobenus rosmarus divergens)*	129,000[16]	Pack ice, open water, coastal haulouts	In review for listing	DD	–
Baleen Whales					
Bowhead Whale (Balaena mysiticetus)		Pack ice, coastal	Endangered	LR-cd	I
Bering-Chukchi-Beaufort Stock	11,800[6]				
Gray whale *(Eschrichtius robustus)*		Coastal, lagoons	Not listed	LC	I
Southern Chukchi Sea and Northern Bering Sea	488[7]				
North Pacific population	20,110[8]				
Minke whale (*Balaenoptera acutorostrata*)	Small Numbers	Shelf, coastal	Not listed	LC	I
Fin whale (*Balaenoptera physalus*)	Rare in Chukchi	Slope, mostly pelagic	Endangered	EN	I
Humback whale (*Megaptera novaeangliae*)		Shelf, coastal	Endangered	LC	I
North Pacific population	Rare				
Toothed Whales					
Beluga whale (*Delphinapterus leucas*)		Offshore, coastal, Ice edges	Not listed	NT	II
Beaufort Sea stock	39,258[4]				
Eastern Chukchi Sea stock	3,710[5]				
Killer whale (*Orcinus orca*)	Rare	Widely distributed	Not listed	DD	II
Harbor Porpoise *(Phocoena phocoena)*		Coastal, inland waters, shallow offshore waters	Not listed	LC	II
Bering Sea stock	48,215[5]				
Fissipeds					
Polar Bear (*Ursus maritimus*)		Pack ice, open water, coastal	Threatened	VU	–
Southern Beaufort Sea stock	1,526[16]				
Chukchi/Bering Seas stock	Unknown				

TABLE 3.2.6-1 The Habitat, Abundance (in Alaska or North Chukchi Sea, if available), and Conservation Status of Marine Mammals Inhabiting the Proposed Survey Area

Species	Abundance	Habitat	ESA[1]	IUCN[2]	CITES[3]

[1]U.S. Endangered Species Act.
[2] IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Codes for IUCN classifications: EN = Endangered; LR = Lower Risk (cd = conservation dependent); NT = Near Threatened; LC = Least Concern; DD = Data Deficient; VU = Vulnerable.
Category descriptions can be found at http://www.iucnredlist.org/apps/redlist/static/categories_criteria_3_1#categories
[3]Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2004).
[4] IWC 2000, Angliss and Allen 2009.
[5] Angliss and Allen 2009.
[6] 2004 Population estimate from photo-identification data (Koski et al. 2009).
[7] Southern Chukchi Sea and northern Bering Sea (Clark and Moore 2002).
[8]North Pacific gray whale population (Rugh 2003 *in* Keller and Gerber 2004); see also Rugh et al. (2005).
[9] Bering-Chukchi Sea population (Angliss and Allen 2009).
[10]Eastern Chukchi Sea population (National Marine Mammal Laboratories [NMML], unpublished data).
[11]Alaskan population (Rugh et al. 1995, cited in Angliss and Allen 2009).
[12] Eastern and Central Bering Sea (Boveng et al. 2009).
[13] Average Bering/Chukchi Sea population (Bengtson et al. 2005).
[14] Alaskan Beaufort Sea population estimate (Amstrup 1995).
[15] Burns, J.J. 1981a.
[16]USFWS 2010.

MMS conducted aerial surveys (BWASP) between 1987–2007 to investigate the use of the Chukchi Sea by bowhead whales during fall migration. Starting in 2007, the surveys were supported by MMS and conducted by USFWS. While the study focus is the bowhead whale, distribution data are collected on all observed marine mammals. Data from these surveys are utilized in the following discussions of the distribution of marine mammals in the Lease Sale 193 Area. Variation in survey efforts across the Chukchi Sea should be taken into consideration when interpreting figures created using BWASP data; equal levels of survey effort were not given to all areas in the Chukchi Sea. Coastal areas between Wainwright and Barrow received the most survey effort.

3.2.6.1 Pinnipeds

The seals in the Chukchi Sea are sometimes called ice seals, because they have their pups on the sea ice. The CBD filed requests to the NMFS under the ESA to list the four ice seal species in the Chukchi Sea (ringed, spotted, ribbon, and bearded seals) as threatened or endangered. In 2008, NMFS decided that ribbon seal stocks in Alaska do not warrant listing under the ESA. In 2009, they decided that spotted seal stocks in Alaska also do not warrant listing under the ESA. Ringed seal and bearded seal stocks in Alaska are still under review.

Because seals and walruses are dependent upon sea ice habitat, their presence and abundance in Statoil's project area depends upon the presence of ice during the time of the surveys.

Ringed Seal

The ringed seal is currently in review for listing under the ESA. In May 2008, the CBD filed a petition to list the seal due to global warming-related habitat loss, and subsequently filed suit against NMFS for failing to make a 12-month finding within the deadline set by the ESA. As part of a settlement agreement, NMFS agreed to issue the 12-month finding for the ringed seal by November 1, 2009. NMFS has not yet published the required finding.

Distribution

Ringed seals are the most widespread and common seal in the Arctic Ocean. They are associated with sea ice and typically remain with the ice throughout the year (B. A. Angliss 2009; Bengston 2005). Their range encompasses both the Alaskan Beaufort Sea and the Chukchi Sea and can reach as far south as Bristol Bay in Alaska in years with extensive ice coverage. Ringed seals prefer shorefast ice until it disappears for the summer. They tend to prefer large floes greater than 48 m (160 ft) in diameter and are often found on the interior ice pack where the sea ice coverage is greater than 90 percent (Simpkins 2003). Ringed seals are known to follow the advance and retreat of the pack ice edge (J. Burns, Remarks on the Distribution and Natural History of Pagophilic Pinnipeds in the Bering and Chukchi Seas 1970), but little else is known about their migration (B. A. Angliss 2009). Ringed seals sightings recorded during BWASP surveys in the Chukchi Sea are shown on Figure 3.2.6-1.

Life History

Ringed seals are the smallest of the pinnipeds found in Alaska, rarely exceeding 1.5 m (5 ft) and 68 kilogram (kg) (150 pounds [lbs]). They are grey in color, with black spots. In Alaska, ringed seals mostly eat Arctic cod, saffron cod, and crustaceans (Eley 1994).

Ringed seals overwinter on pack and shorefast ice (Bengston 2005). They create breathing holes in the newly formed ice and maintain them throughout the year by scraping the sides using nails on their foreflippers (T. M. Smith 1981). The seals excavate subnivean lairs above some of the holes to give birth and nurse their pups between March and April. Nursing lasts 4–6 weeks, during which time the pups stay in the lairs. The lairs protect the pups against hypothermia and predation by Arctic foxes and polar bears (T. G. Smith 1991).

Abundance

Ringed seal surveys conducted in the Chukchi Sea in 1999 and 2000 found densities higher at nearshore locations and estimated the Chukchi population at 252,488 animals in 1999 and 208,857 in 2000 (Bengston 2005). This is a minimum population estimate, because the entire range of the stock was not surveyed. The density of ringed seals is dependent upon the availability of food, ice conditions, and water depth. Bengston et al. found that seal density was higher in nearshore fast and pack ice and lower in offshore pack ice (Bengston 2005).

During vessel-based surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 893 ringed seals were observed by MMOs between 2006 and 2008 (see Table 3.2.6-2). It is often difficult to identify the species of a seal during surveys, especially when they are swimming in the water, because they can look very similar to one another. Because of their close resemblances in certain conditions, there were many seals that were considered “unidentified” during these surveys. The unidentified seal counts were not included in the results listed in the tables in this section. Since there were approximately 1,300 seals that were considered “unidentified,” the numbers reported for each species could be significantly altered, especially for ringed and spotted seals, which are fairly similar in size. During aerial surveys, ringed and spotted seals were counted as one category for this reason.

TABLE 3.2.6-2 Ringed Seal Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys (Ringed and Spotted Seals)
2006	585	781
2007	99	678
2008	209	853

Source: (Funk 2009)

Large concentrations of ringed seals are not expected to be encountered near the proposed seismic survey areas in the northern Chukchi Sea during Statoil's seismic activities, as these seals are generally found in association with the ice front that would be avoided during this project. There will, however, likely be some seals swimming in the open water near the project activities (Quakenbush 1988).

Spotted Seal

The spotted seal is currently in review for listing. In May 2008, the CBD filed a petition to list the seal due to global warming-related habitat loss, and subsequently filed suit against NMFS for failing to make a 12-month finding within the deadline set by the ESA. As part of a settlement agreement, NMFS agreed to issue the 12-month finding for the spotted seal by October 15, 2009. On October 20, 2009, NMFS published a proposed rule and 12-month finding for the spotted seal. NMFS determined that the spotted seal exists as three distinct population segments (DPS) within its range: the southern DPS (located in Liadong Bay and Peter the Great Bay in the Yellow Sea and Sea of Japan); the Okhotsk DPS (located in the Tatar Straight, southwest Sea of Okhotsk, and northeast Sea of Okhotsk), and the Bering DPS (located in Karaginsky Bay, the Gulf of Anadyr, and the east Bering Sea). NMFS determined that the southern DPS, which is located entirely in waters outside of U.S. jurisdiction, is likely to become endangered throughout all or a significant portion of its range and proposed that it be listed as a threatened species. Because the southern DPS' habitat is outside of the U.S., no critical habitat can be designated. NMFS determined that the other two DPS of the spotted seal did not warrant listing under the ESA. The proposed rule designating the southern DPS as threatened and finding that the Okhotsk and Bering DPS' do not warrant listing, were open for public comment until December 21, 2009.

Distribution

Spotted seals are typically seen in coastal areas and in open water far offshore in the Chukchi Sea during the summer months (LGL 2004). They migrate with the ice edge and follow it south into the Bering Sea in the winter (Quakenbush 1988; L. K. Lowry 1998; Simpkins 2003). They are typically seen hauled out on sand spits and in bays and lagoons in the Chukchi and Bering Seas; however, they have been seen as far east as the Colville River Delta (Rugh 1997; L. K. Lowry 1998). Spotted seals sightings recorded during BWASP surveys in the Chukchi Sea are shown in Figure 3.2.6-1.

Large concentrations of spotted seals are not expected to be encountered during the Statoil project, as these seals are generally found in coastal areas during the summer months after the ice edge has retreated. There will, however, likely be some seals swimming in the open water near project activities (Quakenbush 1988).

Life History

Spotted seals are intermediate in size (bigger than ringed seals, smaller than bearded seals) and light-colored, with dark spots covering their body. They typically weigh between 81–109 kg (180–240 lbs) (ADF&G 1994). In the Chukchi Sea, they eat mostly schooling fish and crustaceans. Unlike ringed seals, spotted seals give birth on the ice surface and are considered annually monogamous (Tikhomirov 1961; J. Burns 2002). There are still uncertainties surrounding the breeding behavior of spotted seals, since most of it occurs underwater (Boveng 2009).

Abundance

An early estimate of the size of the world population of spotted seals was 335,000–450,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Burns et al. 1973, cited in Angliss and Allen 2009). During vessel-based surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 262 spotted seals were observed by MMOs in the Chukchi Sea between 2006 and 2008 (see Table 3.2.6-3). As stated, sightings of ringed and spotted seals during aerial surveys were included in one category due to the difficulty in distinguishing between the species from the air.

TABLE 3.2.6-3 Spotted Seal Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys (ringed and spotted seals)
2006	189	781
2007	26	678
2008	47	853

Source: (Funk 2009)

There is not a reliable abundance estimate for spotted seals in Alaska (B. A. Angliss 2009). The most current estimate is 59,000, based on a study by the ADF&G in which four spotted seals were fitted with satellite transmitters. They estimated the amount of time the seals spent hauled out versus in the water and applied a correction factor to the then most recent estimate of 4,145. After applying the correction factor, they estimated the population in Alaska was 59,214 (L. K. Lowry 1994).

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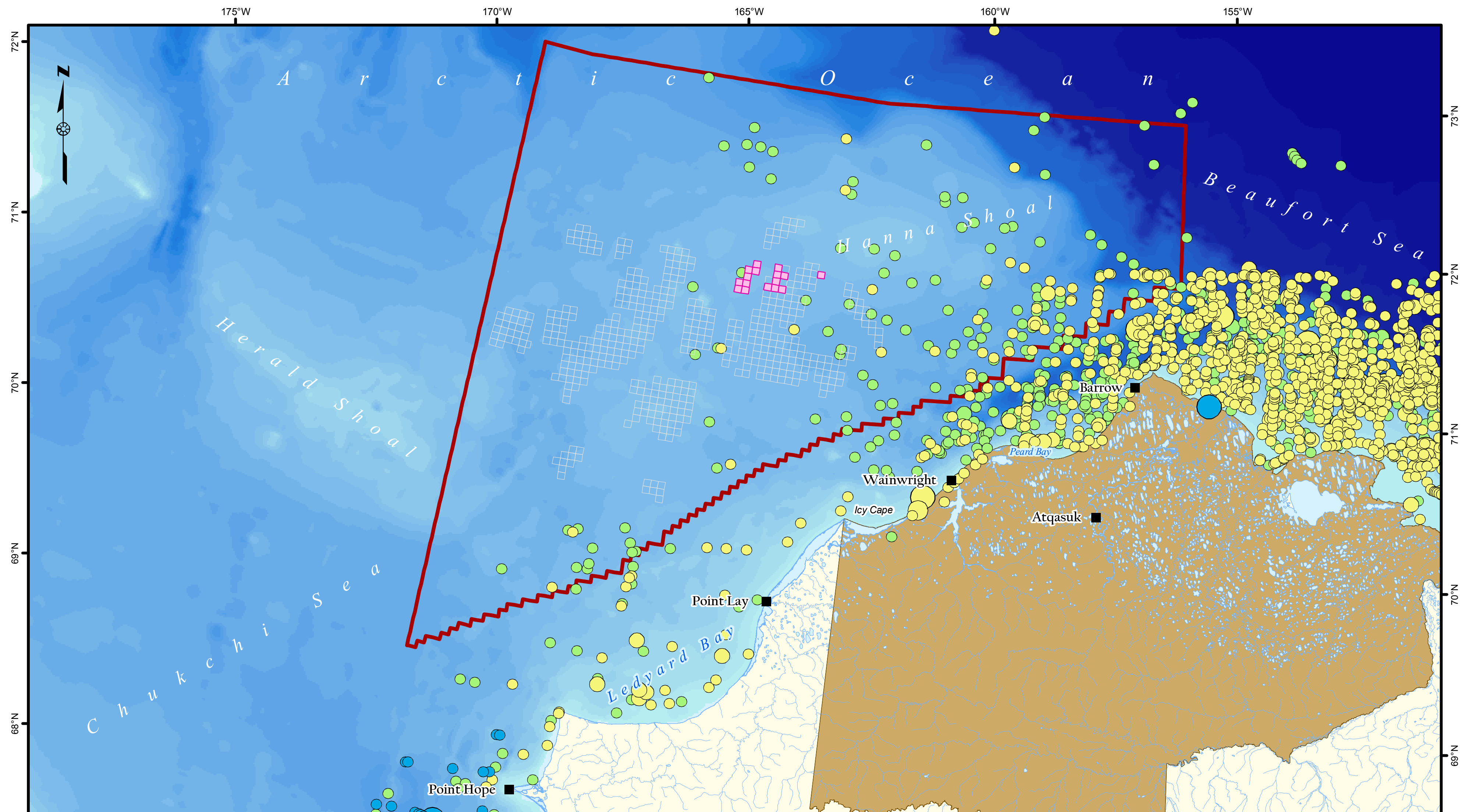

Spotted Seal

Total number counted in sighting:

- 1 - 2
- 3 or more

Ringed Seal

Total number counted in sighting:

- 1 - 5
- 6 - 10
- 11 - 15
- 16 or more

Bearded Seal

Total number counted in sighting:

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20

- Village
- Lease Sale 193 Area
- National Petroleum Reserve - Alaska

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Sighting data obtained from Mineral Management Service Bowhead Whale Aerial Survey Project Historical Database, 1979-2007.

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RINGED, SPOTTED, AND BEARDED SEAL SIGHTINGS IN THE CHUKCHI SEA 1979-2007
Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.6-1

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In the Chukchi Sea, Kasegaluk Lagoon is an important area for spotted seals. Spotted seals haul out in the area from mid-July until freezeup in late October or November. Frost and Lowry (1993) reported a maximum count of about 2,200 spotted seals in the lagoon during aerial surveys. No spotted seals were recorded along the shore south of Pt. Lay. Based on satellite tracking data, Frost and Lowry (1993) reported that spotted seals at Kasegaluk Lagoon spent 94 percent of the time at sea. Extrapolating the count of hauled-out seals to account for seals at sea would suggest a Chukchi Sea population of about 36,000 animals.

Ribbon Seal

The ribbon seal is currently the subject of ongoing litigation regarding a listing petition. In December 2007, the CBD filed a petition to list the seal due to global warming-related habitat loss. NMFS denied the seal ESA protection in December 2008, and the CBD filed suit in September 2009.

Distribution

The only stock of ribbon seals in U.S. waters is the Alaska stock (B. A. Angliss 2009). They range from Bristol Bay through the Chukchi Sea. Ribbon seals use the northern pack ice from March–early May until the ice recedes (J. Burns 1994). Little is known about their habitat use during the rest of the year, but it is thought that many migrate into the Chukchi Sea for the summer (Kelly 1988).

It is not likely that a large number of ribbon seals would be encountered in Statoil’s project area during seismic activities because there will not be many haulout locations for the seals to use, being that the project area is far offshore and away from the pack ice edge. However, a few seals are likely to be present in open water in or near the project area during seismic activities. Ribbon seals appeared to be relatively rare in the northern Chukchi Sea during recent vessel-based surveys in summer and fall of 2006–2007, with only three sightings among 1,778 sightings of seals identified to species (Haley et al. 2009b). Thus ribbon seals are expected to be rare in the proposed survey area in the Chukchi Sea.

Life History

Ribbon seals are intermediate in size, similar to spotted seals. Their appearance is unique as adults have light-colored ribbon shapes wrapped around their dark bodies. They also have large, dark eyes and a uniquely shaped windpipe. The purpose of the difference in their windpipe shape compared to other seals is unknown, but it may function to produce unique underwater vocalizations (J. Burns 1994).

Ribbon seals reach sexual maturity between the ages of 2 and 6. Pups are born on the ice surface between April and May. Ribbon seals nurse their pups for 3–4 weeks during the mating season.

Abundance

During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of four ribbon seals were observed by MMOs between 2006 and 2008 (see Table 3.2.6-4). There were many unidentified pinnipeds that were not included in this count that may have been ribbon seals. The latest estimate of the ribbon seal population in the Bering Sea is 90,000–100,000 (J. Burns 1981). There is no current reliable estimate of the ribbon seal population.

TABLE 3.2.6-4 Ribbon Seal Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	1	0
2007	0	0
2008	1	2

Source: Funk 2009

Bearded Seal

The bearded seal is currently in review for listing. In May 2008, the CBD filed a petition to list the seal due to global warming-related habitat loss, and subsequently filed suit against NMFS for failing to make a 12-month finding within the deadline set by the ESA. As part of a settlement agreement, NMFS agreed to issue the 12-month finding for the bearded seal by November 1, 2009. NMFS has not yet published the required finding.

Distribution

Bearded seals, the largest of the ice seals, are distributed throughout the Chukchi Sea. Bearded seal sightings recorded during BWASP surveys in the Chukchi Sea are shown in Figure 3.2.6-1. They are found in areas with ice platforms over water depths less than 200 m (656 ft), where they can easily access the seafloor, although they are also seen swimming in open water (J. Burns 1981). They generally avoid regions of continuous thick shorefast ice (J. K. Burns 1979). They migrate throughout the year, following the pack ice edge south into the Bering Sea in the winter and north into the Chukchi and Beaufort Seas in areas with high ice coverage in the summer (J. Burns 1981; Simpkins 2003).

Life History

Bearded seals are the largest of the northern seals, weighing up to 340 kg (750 lbs). Their color ranges from light brown to dark brown and sometimes silvery grey. They are easily distinguishable from other seals in the area because of their large size and their uniquely long whiskers (J. J. Burns 1994).

The female gives birth to a single pup, weighing around 34 kg (75 lbs). Pupping occurs on drifting ice floes from late March through May (Kovacs 1996). Pups are typically weaned when they are around 24 days old (Kovacs 1996). Bearded seals are benthic feeders. They mainly feed on or in seafloor sediments including crabs, shrimp, and clams(Kelly 1988; Reeves 1992).

Abundance

As is common with most seals, there are no reliable estimates of the bearded seal population in the Chukchi Sea (B. A. Angliss 2009). Early estimates of the Alaskan population range from 250,000–300,000 (Popov 1976; J. Burns 1981). Results of more recent surveys conducted between May and June of 1999 and 2000, showed densities of .07 and .14 seals per sq km (.03 and .05 seals per sq mi) (Bengston 2005). There is currently no correction factor available to account for bearded seals not seen because they are in the water. Reiser et al. (2009) reported bearded seal densities ranging from 0.01–0.03 seals per sq km in the summer and fall, respectively, during vessel-based surveys in the Chukchi Sea. These densities were lower than those reported by Bengtson et al. (2005) but are not directly comparable, because the latter densities were based on aerial survey counts of seals on ice in late May and early June.

Bearded seal densities in the pack ice of the northern Chukchi Sea appear to be low; only three bearded seals were observed during a survey that passed through the proposed Statoil seismic survey area in early August of 2005 (Haley and Ireland 2006). During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 866 bearded seals were observed by MMOs between 2006 and 2008 (see Table 3.2.6-5).

TABLE 3.2.6-5 Bearded Seal Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	258	105
2007	54	51
2008	120	278

Source: Funk 2009

During the time of their seismic activities, Statoil may encounter bearded seals during the open water season; however, the number of bearded seals is expected to be small, especially since the operations will specifically avoid ice-front areas where bearded seals concentrate.

3.2.6.2 Cetaceans

Cetaceans that could be present in the Chukchi sea near Statoil's seismic operations include bowhead whales, humpback whales, fin whales, beluga whales, harbor porpoises, killer whales, minke whales, and gray whales. As stated, bowhead whales, humpback whales, and fin whales were discussed in Section 3.2.4, Threatened and Endangered Species.

Little is known about hearing in cetaceans or about what frequency ranges they use in vocalizations for specific functions because they are difficult to study (NOAA 2009; NRC 2005; NRC 2003). There have been no direct studies on the hearing capabilities of baleen whales (NOAA 2009). Most baleen whale calls are low frequency, below 1 kHz, but some bowhead whale songs can reach frequencies up to 4,000 Hz. However, most bowhead calls are between 50–400 Hz (NOAA 2009). Toothed whales have relatively poor hearing below 1 kHz and exceptionally good hearing at and above 5Hz. Most toothed whales have functional hearing from 150 Hz–160 kHz (Southall et al. 2007).

Harbor Porpoise

Distribution

The harbor porpoise is a small, coastal porpoise generally found in shallow waters. The Bering Sea stock, which ranges east to Point Barrow (R. J. Suydam 1992), occurs most frequently in waters less than 100 m (328 ft) in depth (Waite n.d. *in* B. A. Angliss 2009). During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 62 harbor porpoises were observed by MMOs between 2006 and 2008 (see Table 3.2.6-6). Harbor porpoises are unlikely to occur in significant numbers within the seismic acquisition area as the seismic transects will occur well offshore in water depth averaging approximately 250 m (820 ft).

TABLE 3.2.6-6 Harbor Porpoise Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	20	0
2007	16	1
2008	25	0

Source: (Funk 2009)

Life History
Harbor porpoises are small, dark grey cetaceans, reaching approximately 1.9 m (6.2 ft). Females are slightly larger than the males. They can travel alone, in pairs, or in groups of up to ten individuals. Harbor porpoises feed mostly on fish (MarineBio 2010).

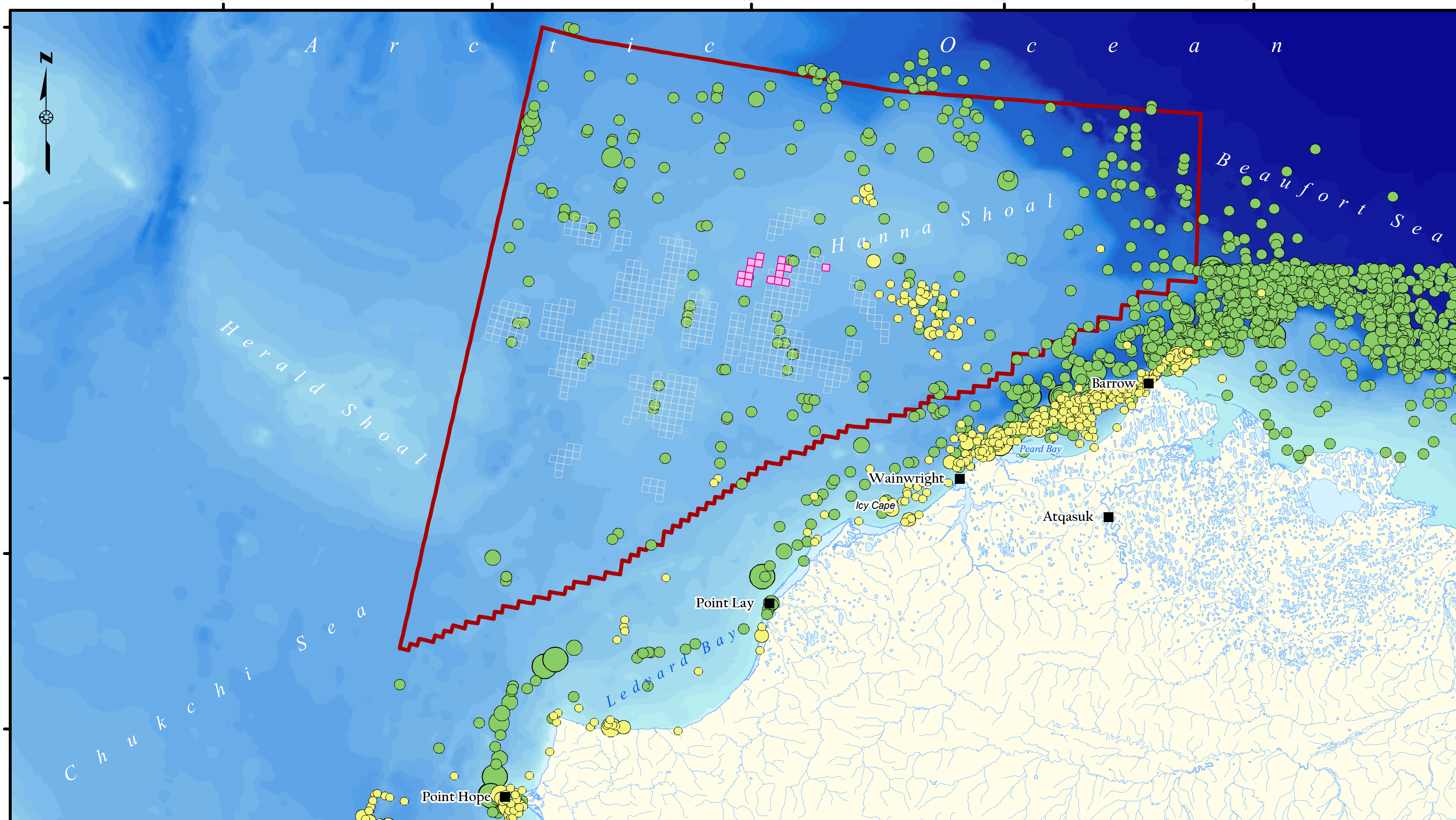
Sexual maturity is reached around 4 years. Gestation lasts about 11 months, and calves are usually born every 2 years. Calves are weaned around 8 months of age (MarineBio 2010).

Abundance
The most recent abundance estimate for the Bering Sea stock, based on aerial surveys conducted by National Marine Mammal Laboratories (NMML) in Bristol Bay, is about 48,000 animals (B. A. Angliss 2009). These estimates are considered conservative but are higher than an earlier estimate of about 11,000 (Dahlheim 2000).

Beluga Whale

Distribution
There are five stocks of beluga whales in Alaska (O'Corry-Crowe 1997; (B. A. Angliss 2009). The only stocks that may be encountered during Statoil's proposed seismic activities are the Eastern Chukchi and Beaufort Sea stock.

The belugas migrate along open leads north from their wintering grounds in the Bering Sea during the spring (April–May) (H. B. Braham 1984; W. C. Richardson 1995) and return in the fall along the southern pack ice edge in their annual migration back to Bering Sea wintering areas in September (Richard 1998). Migration generally occurs in deeper water along the ice front (Hazard 1988; Clarke 1993; Miller 1998). Much of the Chukchi Sea stock aggregates in Kasegaluk Lagoon from late June to mid-July, probably for breeding and molting (R. K. Suydam 2005). During this time, the village of Point Lay conducts its subsistence hunt of the belugas. Beluga whale sightings recorded during BWASP surveys in the Chukchi Sea are shown in Figure 3.2.6-2.



Beluga Whale

Total number counted in sighting:

- 1 - 25
- 26 - 50
- 51 - 75
- 76 - 100

Gray Whale

Total number counted in sighting:

- 1 - 5
- 6 - 10
- 11 - 15
- 16 or more

- Village
- Lease Sale 193 Area

Lease Owner

- Statoil
- All Other

NAD83, Alaska Albers Equal Area.
Sighting data obtained from Mineral Management Service Bowhead Whale Aerial Survey Project Historical Database, 1979-2007.

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BELUGA WHALE AND GRAY WHALE SIGHTINGS IN THE CHUKCHI SEA 1979-2007

Statoil 2010 Chukchi Marine Seismic Survey
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.2.6-2

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Belugas in Kasegaluk Lagoon were captured and tagged in order to track their movements during several summers between 1998 and 2002 (R. K. Suydam 2005). After leaving Kasegaluk Lagoon around mid-July, most of the tagged whales traveled northeast toward Barrow. Previous to the study, it was thought that belugas spent the summer in warm, coastal waters. The study results, however, showed consistent use of deep, offshore, ice-covered waters during the summer (R. K. Suydam 2005). During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 973 beluga whales were observed by MMOs between 2006 and 2008 (see Table 3.2.6-7).

TABLE 3.2.6-7 Beluga Whale Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	0	370
2007	0	579
2008	2	22

Source: (Funk 2009)

Life History

Beluga whales are medium-sized, toothed cetaceans. At birth, they are dark grey but lighten in color as they age. By age 5 or 6 they are usually white. They have a large melon on their head that aids in echolocation to find prey in muddy waters. They feed primarily on schooling fish (L. Lowry 1994).

Sexual maturity is reached by around age 5 for females and slightly later for males. Gestation lasts about 14.5 months before a single calf is born, usually tail first (L. Lowry 1994). Mating occurs during early spring, and calves are born between May and July. Calves are not weaned until after they reach about 3 years of age (Krasnova 2005).

Abundance

Small numbers of belugas may be encountered during the early (July) phase of the seismic surveys in the eastern Chukchi Sea; however, the majority of the migration will have passed, while local whales may concentrate at inshore breeding lagoons. Migrating belugas might be encountered, especially if seismic surveys extend into the fall. However, the seismic efforts will avoid the ice conditions favored by this species.

The eastern Chukchi Sea population is estimated at 3,710 animals (Angliss and Allen 2009). This estimate was based on surveys conducted in 1989–1991. Survey effort was concentrated on the 170 km- (106 mi-) long Kasegaluk Lagoon, where belugas are known to occur during the open water season. The actual number of beluga whales recorded during the surveys was much lower. Correction factors to account for animals that were underwater and for the proportion of newborns and yearlings that were not observed due to their small size and dark coloration were used to calculate the estimate. The calculation was considered to be a minimum population estimate for the eastern Chukchi stock because the surveys on which it was based did not include offshore areas where belugas are also likely to occur. This population is considered to be stable. It is assumed that beluga whales from the eastern Chukchi stock winter in the Bering Sea (Angliss and Allen 2009).

Although beluga whales are known to congregate in Kasegaluk Lagoon during summer, evidence from a small number of satellite-tagged animals suggests that some of these whales may subsequently range into the Arctic Ocean north of the Beaufort Sea. Suydam et al. (2005) put satellite tags on 23 beluga whales captured in Kasegaluk Lagoon in late June and early July 1998–2002. Five of these whales moved far into the Arctic Ocean and into the pack ice to 79–80°N. These and other whales moved to areas as far as 1,100 km (684 ft) offshore between Barrow and the Mackenzie River delta, spending time in water with 90 percent ice coverage.

During aerial surveys in nearshore areas (i.e., approximately 37 km [23 mi] offshore) of the Chukchi Sea in July–November 2006 and 2007 and July–October 2008, peak beluga sighting rates were recorded in July, and the lowest monthly sighting rates were recorded in August and September (Thomas et al. 2009). Beluga sighting rates and number of individuals were generally highest in waters 25–35 km (16–22 mi) offshore. The largest single groups, however, were sighted at locations within 5 km (3 mi) from shore.

Gray Whale

Distribution

The eastern Pacific or California gray whale population, like all large whale populations, was once hunted to near extinction, but has since recovered significantly from commercial whaling. The Pacific gray whale stock (D. A. Rice 1971) ranges from the Bering, Chukchi, and Beaufort Seas (in summer) to the Gulf of California (in winter) (Nelson 1993). Gray whales have also been documented foraging in waters off Southeast Alaska, British Columbia, Washington, Oregon, and California (D. A. Rice 1971; Berzin 1984; Darling 1984; Quan 2000; Calambokidis 2002; D. Rice 1981). Most of the eastern north Pacific population makes a round-trip annual migration of more than 8,000 km (4,320 nm) from Alaska waters to Baja California in Mexico (Nelson 1993). During most of this migration, they remain within sight of land (Nelson 1993). From late May to early October, the majority of the population concentrates in the northern and western Bering Sea and the Chukchi Sea. Gray whale sightings recorded during BWASP surveys in the Chukchi Sea are shown on Figure 3.2.6-2.

Gray whales are considered common summer residents in the nearshore waters of the eastern Chukchi Sea, and occasionally are seen east of Point Barrow in late spring and summer, as far east as Smith Bay (Green et al. 2007). On wintering grounds, mainly along the west coast of Baja California, gray whales utilize shallow, nearly land-locked lagoons and bays (D. A. Rice 1981). From late February to June, the population migrates back to arctic and subarctic seas (D. A. Rice 1971). During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 477 gray whales were observed by MMOs between 2006 and 2008 (see Table 3.2.6-8).

TABLE 3.2.6-8 Gray Whale Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	25	43
2007	32	185
2008	79	113

Source: (Funk 2009)

Gray whales occur fairly often near Point Barrow, but historically only a small number of gray whales have been sighted in the Beaufort Sea east of Point Barrow. Hunters at Cross Island (near Prudhoe Bay) took a single gray whale in 1933 (Maher 1960). Only one gray whale was sighted in the central Alaskan Beaufort Sea during the extensive aerial survey programs funded by MMS and industry from 1979–1997. However, during September 1998, small numbers of gray whales were sighted on several occasions in the central Alaskan Beaufort (Miller et al. 1999; Treacy 2000). More recently, a single sighting of a gray whale was made on August 1, 2001, near the Northstar production island (Williams and Coltrane [eds.] 2002). Several gray whale sightings were reported during both vessel-based and aerial surveys in the Beaufort Sea in 2006 and 2007 (Jankowski et al. 2008; Lyons et al. 2008) and during vessel-based surveys in 2008 (Savarese et al. 2009). Several single gray whales have been seen farther east in the Canadian Beaufort Sea (Rugh and Fraker 1981; LGL Ltd., unpublished data), indicating that small numbers must travel through the Alaskan Beaufort during some summers. In recent years, ice conditions have become lighter near Barrow, and gray whales may have become more common there and perhaps in the Beaufort Sea. In the springs of 2003 and 2004, a few tens of gray whales were seen near Barrow by early to mid-June (LGL Ltd and NSBDWM, unpublished data). However, no gray whales were sighted during cruises north of Barrow in 2002 or 2005 (Harwood et al. 2005; Haley and Ireland 2006).

Gray whales routinely feed in the Chukchi Sea during the summer. Moore et al. (2000b) reported that, during the summer, gray whales in the Chukchi Sea were clustered along the shore primarily between Cape Lisburne and Point Barrow and were associated with shallow, coastal shoal habitat. In autumn, gray whales were clustered near shore at Point Hope and between Icy Cape and Point Barrow, as well as in offshore waters northwest of Point Barrow at Hanna Shoal and southwest of Point Hope. Thomas et al. (2009) reported that gray whale sighting rates and abundance were greater in the 0–5 km (0–3 mi) offshore band in 2006 and in the 25–30 km (16–19 mi) band in 2007 and 2008 during aerial surveys of the nearshore area of the eastern Chukchi Sea. They suggested that the difference in gray whale distribution in 2006 vs. 2007 and 2008 may have been because of differences in food availability and perhaps ice conditions.

Small numbers of gray whales could be encountered during the proposed seismic survey in the Chukchi Sea in 2010. Although they are most common in portions of the Chukchi Sea close to shore, gray whales may also occur in offshore areas of the Chukchi Sea, particularly over offshore shoals.

Life History

Gray whales are baleen whales that are mottled grey in color and have no dorsal fin. Their baleen is different from other baleen whales in that it is short, stiff, and light in color. They use this specialized baleen and their uniquely shaped mouths to suction sediments from the seafloor and filter out their prey (K. Frost 1994). During the summer in the Chukchi Sea, gray whales feed on benthic animals, mainly amphipods, on or near the ocean floor (Nelson 1993). They can be identified easily from the air, because they leave behind large mud clouds while feeding on the seafloor.

Hanna Shoal is a major feeding ground for gray whales (Nelson 1993). For this reason, Statoil may encounter gray whales during their seismic activities.

Gray whales concentrate in shallow lagoons to give birth. A single calve is born between December and February after a 13-month gestation period. Female gray whales are known for being protective of their young (K. Frost 1994).

Abundance

The Pacific gray whale population was estimated at about 19,000 ,based on surveys conducted in central California in 2000–01 and 2001–02. Population may have declined from earlier estimates, possibly due to the populations reaching carrying capacity (B. A. Angliss 2009).

Minke Whale

Distribution

The Alaska stock of minke whales ranges from near the equator north to the Chukchi Sea (Leatherwood 1982). They have been seen penetrating ice in the Chukchi Sea during summer (Leatherwood 1982). The minke whales seen in the Chukchi are thought to migrate south to California during the fall (Dorsey 1990).

No minke whales were observed at the Burger Prospect during surveys in 1989 or 1990, and one whale was seen in the Popcorn prospect in 1990. During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of 16 minke whales were observed by MMOs between 2006 and 2008 (see Table 3.2.6-9).

TABLE 3.2.6-9 Minke Whale Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	3	0
2007	3	0
2008	10	0

Source: (Funk 2009)

Life History

Minke whales are the smallest of the baleen whales in North American waters. They are dark grey on top and light grey on their underside. They filter water using baleen to feed on plankton and small fish. Females are, on average, larger than males (Kennedy 2009).

Sexual maturity is reached around age 6, and a single calf is born every 1–2 years after a gestation period of about 10 months. Calves nurse for about 6 months. Minke whales are thought to live to around age 50 (Kennedy 2009).

Abundance

Provisional estimates of Minke whale abundance based on surveys in 1999 and 2000 are 810 and 1,003 whales in the central-eastern and southeastern Bering Sea, respectively. These estimates have not been corrected for animals that may have been submerged or otherwise missed during the surveys, and only a portion of the range of the Alaskan stock was surveyed.

Minke whales range into the Chukchi Sea but are not likely to occur in the Beaufort Sea. The level of Minke whale use of the Chukchi Sea is unknown. Leatherwood et al. (1982, in Angliss and Allen 2009) indicated that Minke whales are not considered abundant in any part of their range, but that some individuals venture north of the Bering Strait in summer. Reiser et al. (2009) reported eight and five Minke whale sightings in 2006 and 2007, respectively, during vessel-based surveys in the Chukchi Sea; and Haley et al. (2009a) reported 26 Minke whale sightings during similar vessel-based surveys in the Chukchi Sea in 2008. Small numbers of Minke whales could be encountered during the proposed exploratory activities in the Chukchi Sea in 2010.

Killer Whale

Distribution

Killer whales are found throughout the world's oceans and seas, from the equator's more tropical waters to the cooler waters in the high latitudes. They are most common in cooler coastal waters of both hemispheres, but appear in greatest numbers within 800 km (432 nm) from continental coasts (Mitchell 1975).

Killer whales are considered rare in the Chukchi Sea. A few of these whales have been sighted near Point Barrow. Sightings, whale carcasses, and scar patterns found on harvested bowhead indicate that some killer whales do exist in the Arctic Ocean (J. L. George 1994).

Life History

Adult killer whales generally reach 8.2 m (27 ft) in length. They are mostly black in color, with large white patches under the jaw and behind each eye. A grey or white "saddle patch" is most often found behind the dorsal fin. Both males and females have dorsal fins, but the male's is much taller, sometimes reaching 1.8 m (6 ft) (Zimmerman 1994).

Killer whale populations in Alaska are divided into resident and transient pods. Resident pods are thought to feed mainly on fish, while transient pods feed mainly on other marine mammals. Killer whales feed cooperatively, sometimes in large groups (Zimmerman 1994).

Killer whales are long-lived and slow reproducing. It is unknown how long they live, but it is thought that they may at least reach 34 years. Sexual maturity is reached between 10 and 16 years. These whales give birth to a single calf every 3–8 years after a gestation period of 15–16 months. (Zimmerman 1994).

Abundance

During vessel-based and aerial surveys conducted in the Chukchi Sea with partial funding from Statoil, a total of three killer whales were observed by MMOs between 2006 and 2008 (see Table 3.2.6-10). MMOs onboard industry vessels did not record any killer whale sighting in the Beaufort Sea in 2006–2008 (Savarese et al. 2009).

TABLE 3.2.6-10 Killer Whale Sightings in the Chukchi Sea, Alaska, 2006–2008

Year	Sightings from Vessel Surveys	Sightings from Aerial Surveys
2006	2	0
2007	1	0
2008	0	0

Source: (Funk 2009)

Of the eight killer whale stocks recognized in the Pacific, the trans-boundary Alaska resident stock, found from southeastern Alaska to the Chukchi Sea (B. A. Angliss 2009) is the only stock that could possibly be encountered by Statoil's seismic operations. The NMML began killer whale studies in 2001 in Alaskan waters west of Kodiak Island, including the Aleutian Islands and Bering Sea. Line-transect surveys were conducted in July and August in 2001–2003. Based on surveys conducted by the NMML, the Alaska resident stock comprises a minimum estimate of 1,123 killer whales (B. A. Angliss 2009).

George et al. (1994) reported that they and local hunters see a few killer whales at Point Barrow each year. Killer whales are more common southwest of Barrow in the southern Chukchi Sea and the Bering Sea. Approximately100 animals have been identified in the Bering Sea (ADF&G 1994). The number of killer whales likely to occur in the Chukchi Sea during the proposed activity is unknown.

3.2.7 Terrestrial Mammals

Among the terrestrial mammals that occur in the Chukchi Sea area, caribou, muskox, and grizzly bear are the species most likely to be affected by development. Of these three, caribou regularly use coastal areas of the Chukchi Sea in summer and, therefore, are the only terrestrial mammmal species potentially affected by activities associated with this project (MMS 2007).

3.2.7.1 Caribou

Barren-ground caribou *(Rangifer tarandus groenlandicus)* are the most prolific, large terrestrial mammals occurring along the coast of the Chukchi Sea. One large and two smaller caribou herds use habitats of Alaska's Arctic plain in the project area: the Western Arctic, the Central Arctic, and the Teshekpuk Lake herds (MMS 2007).

Population Status and Range

The Western Arctic herd (WAH) is the largest in the state and ranges over approximately 225,308 sq km (140,000 sq mi) in northwestern Alaska from the Chukchi coast east to the Colville River, and from the Beaufort coast south to the Kobuk River, with a population estimated above 300,000 (Dau 2005). Emigration and immigration between herds can occur and change population estimates. Sutherland (2005) estimated that local residents harvest approximately 14,700 WAH caribou annually. The Teshekpuk Lake Caribou Herd (TCH) is found primarily within the NPR-A, with its summer range extending between Barrow and the Colville River. The TCH was estimated at 45,166 caribou in 2002 (Carroll 2007). The Central Arctic Herd (CAH) has grown from an estimated 5,000 animals in 1975 to about 31,857 animals in 2002 (Lenart 2005). The CAH's range extends from the Itkillik River east to the Canning River, and from the Beaufort coast south into of the Brooks Range. Its summer range extends from just west of the Colville River and eastward along the coast to the Katakturuk River. It often overlaps with the WAH and TCH herds on summer and winter range to the west (Lenart 2005).

Migration

Caribou have distinct phases of activities that include spring migration, calving, post-calving aggregation, fall migration, rutting, and wintering. Caribou migrate seasonally between their calving areas and summer and winter ranges to take advantage of seasonally available forage resources. The caribou diet shifts seasonally, depending on the availability of forage. In general, the winter diet of caribou characteristically consists of lichens and mosses, with a shift to vascular plants during the spring (Thompson and McCourt 1981).

Spring migration of parturient females to calving grounds begins in late March (Hemming 1971). Bulls and non-parturient females migrate later. Calving occurs in early June for North Slope caribou, where females typically have one calf per year (Valkenburg 1999). Migrating north of the tree line, caribou leave the range of the wolf packs, which generally remain on the caribou winter range, in the mountain foothills, or along the tree line during the wolf pupping season (Heard and Williams 1991; Bergerud 1987). The WAH calving area is inland on the NPR-A. The TCH's central calving area generally is located on the east side of Teshekpuk Lake and near Cape Halkett, adjacent to Harrison Bay. The CAH generally calves within 30 km (19 mi) of the Beaufort coast between the Itkillik and Canning rivers.

In late August and early September, males come into rut for the breeding season, the time that caribou again begin to migrate (Valkenburg 1999). By winter, most caribou have migrated inland from the Chukchi Sea coast.

Summer Distribution and Insect-Relief Areas

In the postcalving period (July through August), caribou attain their highest degree of aggregation. During calving and postcalving periods, cow and calf groups are most sensitive to human disturbance. Members of the WAH may be found in continuous herds numbering in excess of tens of thousands of individuals, and portions of the WAH may be found throughout their summer range. Insect-relief areas become important during late June to mid-August during the insect season (Lawhead 1997). For insect relief, caribou use various coastal and upland habitats such as sandbars, spits, river deltas, barrier islands, foothills, snow patches, and sand dunes, where stiff breezes prevent insects from alighting on the caribou. Members of the TCH generally aggregate close to the coast for insect relief.

Caribou aggregations move frequently from insect-relief areas along the arctic coast (the CAH, WAH, and especially the TCH) and in the mountain foothills (some aggregations of the WAH) to and from green foraging areas.

Winter-Range Use and Distribution

The WAH caribou generally reach their winter ranges located south of the Brooks Range in early to late November and remain on the range through March (Hemming 1971). During winters of heavy snowfall or severe ice crusting, caribou may overwinter within the mountains or on the Arctic Coastal Plain (Hemming 1971).

The TCH winter in the Teshekpuk Lake area, in the Brooks Range, within the range of the WAH, and some travel as far south as the Seward Peninsula (Bente 2000). The CAH overwinters primarily in the northern foothills of the Brooks Range (Roby 1980).

3.2.7.2 Brown Bear

Brown bear or grizzly bear *(Ursus arctos)* distributions are influenced by a combination of factors, which includes patterns of calving caribou. On the North Slope, brown bears are at the northern extent of their distribution and typically occur at relatively low densities. Brown bears, in general, are most abundant in the foothills and mountains of the Arctic Coastal Plain (Carroll 2007).

Life History

Brown bears consume a wide variety of food that includes vegetation, salmon, moose, and caribou (Eide and Miller 1994). Brown bears in the western Brooks Range use food sources such as the WAH caribou, beach-cast marine mammal carcasses, and to some degree, seasonal salmon and char runs that occur in major Chukchi coast drainages.

Bears on the North Slope enter dens primarily in the last 2 weeks of September through early November and emerge from the dens in mid-April to early June, with adult males entering dens the latest and emerging the earliest (Shideler and Hechtel 2000). Brown bear dens occur in pingos, banks of rivers and lakes, sand dunes, and steep gullies in uplands (Shideler and Hechtel 2000).

Abundance and Distribution

An estimated 60–70 bears or approximately four per 1,000 sq km (621 sq mi) currently inhabit the central North Slope Coastal Plain (Shideler and Hechtel 2000). In the presence of anthropogenic food sources, brown bear density in the Prudhoe Bay area increased to six bears per 1,000 sq km (15 bears per 1,000 sq mi) (Stephenson 2003). These bears have very large home ranges of 201–13,880 sq km (125–8,625 sq mi) and travel up to 50 km (31 mi) per day (Shideler and Hechtel 2000).

Overall in unit 26A, bear populations are estimated at 1,007, with 81 in the coastal plain, 666 in the foothills, and 260 in the mountains (Carroll 2007), with an estimated density of 29.5 bears per 1,000 sq km (621 sq mi) (Carroll 2007). Densities by habitat zone are estimated at 0.5–23 bears/1,000 sq km (621 sq mi) on the coastal plain, 10–30 bears per 1,000 sq km (621 sq mi) in the foothills, and 10–20 bears per 1,000 sq km (621 sq mi) in the mountains (Carroll 2007).

3.2.7.3 Muskoxen

Indigenous populations of muskoxen *(Ovibos moschatus)* were extirpated in the 1800s in northern Alaska (T. Smith 1989). Muskoxen were reintroduced into the Arctic National Wildlife Refuge (ANWR) in 1969 and in the Kavik River area (between Prudhoe Bay and the Refuge) in 1970; they were reintroduced west of the NPR-A near Cape Thompson in 1970 and 1977 (T. Smith 1989). The reintroductions to the east established the ANWR population, which grew rapidly and expanded both east and west of the Refuge (Garner and Reynolds 1986).

Muskoxen extend west of Prudhoe Bay in northern NPR-A, in the Itkillik Hills south of Kuparuk, all the way to the Colville River. The most important habitats for muskoxen appear to be riparian, upland shrub, and moist sedge-shrub meadows (Johnson et al. 1996). Muskoxen generally do not migrate but will move in response to seasonal changes in snow cover and vegetation. They use riparian habitats along the major river drainages on the Arctic Slope year-round. Calving takes place from about April–early June (Garner and Reynolds 1987). Distribution of muskoxen during the calving season, summer, and winter are similar, with little movement during winter (Reynolds 1992).

3.3 Socioeconomic Resources

3.3.1 Traditional Knowledge

Traditional Knowledge, also known as indigenous knowledge and traditional ecological knowledge, is the collective knowledge possessed by a community and passed down from generation to generation for hundreds, if not thousands, of years. This knowledge is the product of the relationship a particular culture has with its environment, based on experience and adaptation over a long period of time. It can be ecological in nature, pertaining to the plants and animals within an ecosystem, and their respective relationships to each other and to the people who use them. It can also be environmental, such as information regarding snow, ice, and weather conditions (Hansen and VanFleet 2003; Miraglia 1998).

Traditional Knowledge is more than a tool that people use to survive and thrive in their environment; it is a way of life (Alaska Native Science Commission [ANSC] 2009). While rooted in the past, the term "traditional" is not meant to imply that the information is old, but rather based on tradition and "created in a manner that reflects the traditions of communities, therefore not relating to the nature of the knowledge itself, but to the way in which that knowledge is created, preserved, and disseminated" (Hansen and VanFleet 2003:3). Traditional Knowledge is a living system that can be altered to reflect changing environmental conditions, cultural values, and spiritual or philosophical views, among other things. Contemporary Traditional Knowledge incorporates non-traditional information, such as science, resulting in a modern, holistic way of existing with one's natural environment (ANSC 2009).

In northern Alaska, Traditional Knowledge serves to inform hunters when particular animals should be hunted, as well as how to treat the spirits of those animals (Panikpak Edwardsen 1980). It is used as a way to teach children what their community expects of them. It is used to predict the weather, assess the safety of ice, and govern the use of resources (ANSC 2009; McNabb 1990). Iñupiaq[2] knowledge is usually transmitted orally through songs, stories, and dance. It cannot be separated from the Iñupiat people who own it; it is their history, maintained in the present, advising their future.

3.3.2 Community Profiles

Chukchi Sea communities that may be affected by Statoil's project include Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue. Barrow, Wainwright, Point Lay, and Point Hope are within the NSB; Kivalina and Kotzebue in the NWAB. This section summarizes the NSB and NWAB governments and the six villages listed above (Figure 3.3.2-1).

3.3.2.1 North Slope Borough

In land mass, the NSB is the largest borough in the State of Alaska and encompasses 230,509 sq km (89,000 sq mi). It extends across the top of Alaska from Point Hope on the Chukchi Sea to the

[2] Forms of Iñupiaq and Iñupiat used in this document are those employed and taught in *North Slope Iñupiaq Grammer* by Edna Ahgeak MacLean (1986). Iñupiaq refers to one individual of northern Alaskan Eskimo heritage. Iñupiat referrers to two or more people of northern Alaskan Eskimo heritage. Iñupiaq also (1) refers to the language of the Iñupiat, and (2) is an adjective used to identify something(s) associated with Iñupiat or Iñupiaq. For example, Iñupiaq culture or Iñupiaq words.

Canadian border and from the Brooks Range to the Arctic Ocean (NSB 2005). Fewer than 7,600 residents inhabit eight villages. The villages are Kaktovik, Nuiqsut, Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, Point Lay, and Point Hope. Kaktovik is in the Alaska Wildlife Refuge, and Atqasuk is in the NPR-A.

The North Slope geographic area includes three regions with different climate, drainage, and geological characteristics: the Arctic Coastal Plain, the Brooks Range Foothills, and the northern portion of the Brooks Range. Arctic Slope Regional Corporation (ASRC), one of thirteen Alaska Native regional corporations, encompasses the North Slope and has substantial land and mineral rights.

The Iñupiat are the predominant inhabitants of eight villages in the region. Iñupiat have lived in the region for centuries and have actively traded with Canadian Natives (Alaska Department of Commerce, Community, and Economic Development [ADCCED] 2007). Vital to the Iñupiaq culture throughout the region are traditional whaling and other subsistence hunting, fishing, trapping, and gathering activities (NSB 2005).

The NSB government is funded by oil tax revenues; it provides public services to all of its communities and is the primary employer of local residents. North Slope oil field operations provide employment to over 5,000 non-residents, who rotate in and out of oil worksites from Anchorage, other areas of the state, and the lower 48 states. Census figures are not indicative of this transient worksite population (ADCCED 2007).

Air travel provides the only year-round access, while land transportation provides seasonal access. The Dalton Highway provides road access to Prudhoe Bay, although it is restricted during winter months. “Cat-trains” (a train of sleds, cabooses, etc., pulled by a Caterpillar™ tractor, used chiefly in the north during winter to transport freight) are sometimes used to transport freight overland from Barrow during the winter.

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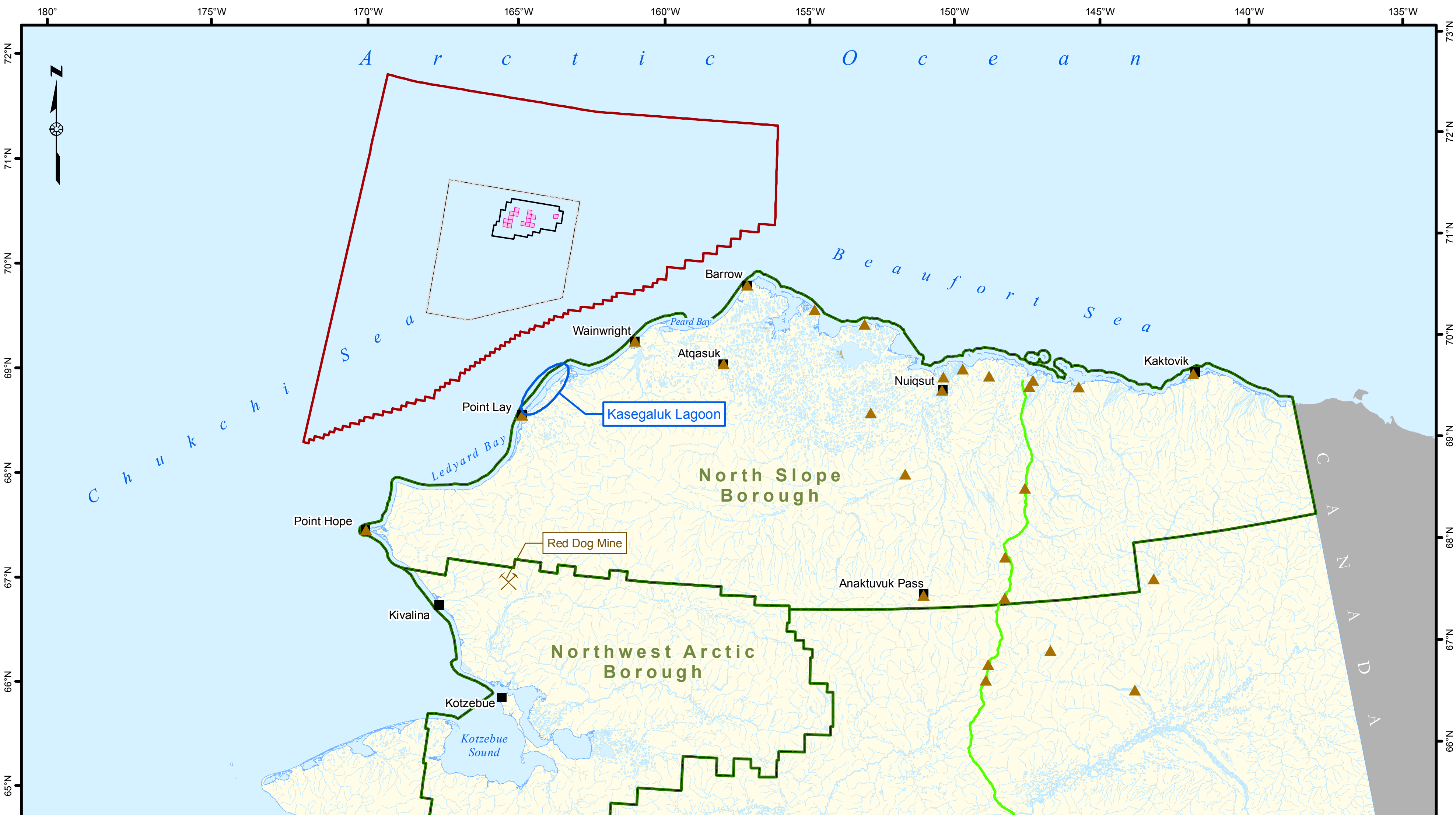

Statoil Leases	Lease Sale 193 Area	Airport
3D Seismic Survey	TAPS	Village
Permit Area	Borough	

NAD83, Alaska Albers Equal Area

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

HUMAN ENVIRONMENT
Statoil
Environmental Evaluation Document

SCALE: 0 35 70 140 Miles

FIGURE: 3.3.2-1

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Barrow

Barrow is the largest community on the North Slope. It is also the northernmost community in the United States. Barrow sits on the Chukchi Sea coast, 16 km (10 mi) south of Point Barrow and 1,170 air-km (725 air-mi) from Anchorage. Barrow receives about 12.7 cm (5 inches) of precipitation and 50.8 cm (20 inches) of snow a year. Temperatures range from -48.9°–25.6°C (-56°–78°F), with a summer average of 4.4°C (40°F) (ADCCED 2009).

It is the NSB seat and the economic and transportation hub of the borough. The city of Barrow takes its name from neighboring Point Barrow, named after Sir John Barrow of the British Admiralty in 1825 (ADCCED 2009; ASRC 2009; NSB 2009a; University of Arkansas 2007).

Barrow in the Past

Traditionally called Ukpiabvik, Barrow and the surrounding area have a rich history. The Birnirk archaeological site, just a few miles from Barrow, dates from 500–900 A.D., and was a small village whose residents were among the earliest whale and seal hunters of Alaska's Arctic coast (NPS 2009). The village of Nuvuk (meaning *tip* or *point*) was located at Point Barrow. The cemetery at Nuvuk dates from at least 1,200 years ago (PolarTREC 2009), and the village was inhabited until the mid-1940s when the last of its residents moved to Barrow (Brower 2004).

Recent important, historical factors influencing the area include 19th–20th century commercial whaling, 20th century fur trade, and military activities. A refuge station and whaling and trading post were built in Cape Smyth—present-day Browerville, Barrow (Bockstoce 1986; Brower 2004). In 1881, the U.S. Army established a meteorological and magnetic research station near the community (ADCCED 2009; University of Arkansas 2007). Responding to Cold War threats and fears, the U.S. military constructed server Distant Early Warning (DEW) stations in Alaska between 1953 and 1969 (U.S. Department of the Air Force [USAF] 1999). Construction of the DEW Line station at Point Barrow and exploration of the NPR-A in the mid 1900s brought many people into the area (ADCCED 2009; ASRC 2009; NSB 2009a; University of Arkansas 2007).

Modern-Day Barrow

The City of Barrow was incorporated in 1958, and the NSB was formed in 1972 (ADCCED 2009). Today, piped water and a sewage system connect many houses in Barrow, and a majority of people heat their houses with natural gas. The Barrow Utilities and Electric Cooperative supplies electricity, natural gas, water, and sewer services to residents. Two companies deliver water, and the NSB provides trash-removal services. The Barrow and Browerville fire stations serve Barrow (ADCCED 2009; ASRC 2009).

The city has four hotels, many restaurants, a bank, two grocery stores, and several convenience stores. Communication into and within the city includes telephone, mail, public radio, cable television, and the internet (ASRC 2009; NSB 2009a).

Ukpeagvik Inupiat Corporation (UIC) is the village corporation and owns approximately 652 sq km (252 sq mi) of land in the area.

Just over 4,000 people live in Barrow. In 2008, the U.S. Census Bureau estimated the population at 4,010 (U.S. Census Bureau 2009a), and the State of Alaska estimated 4,054 (ADCCED 2009). Figure 3.3.2-2 shows Barrow's population trend from 1939–2008. This graph shows that Barrow's population grew relatively steadily until recently.

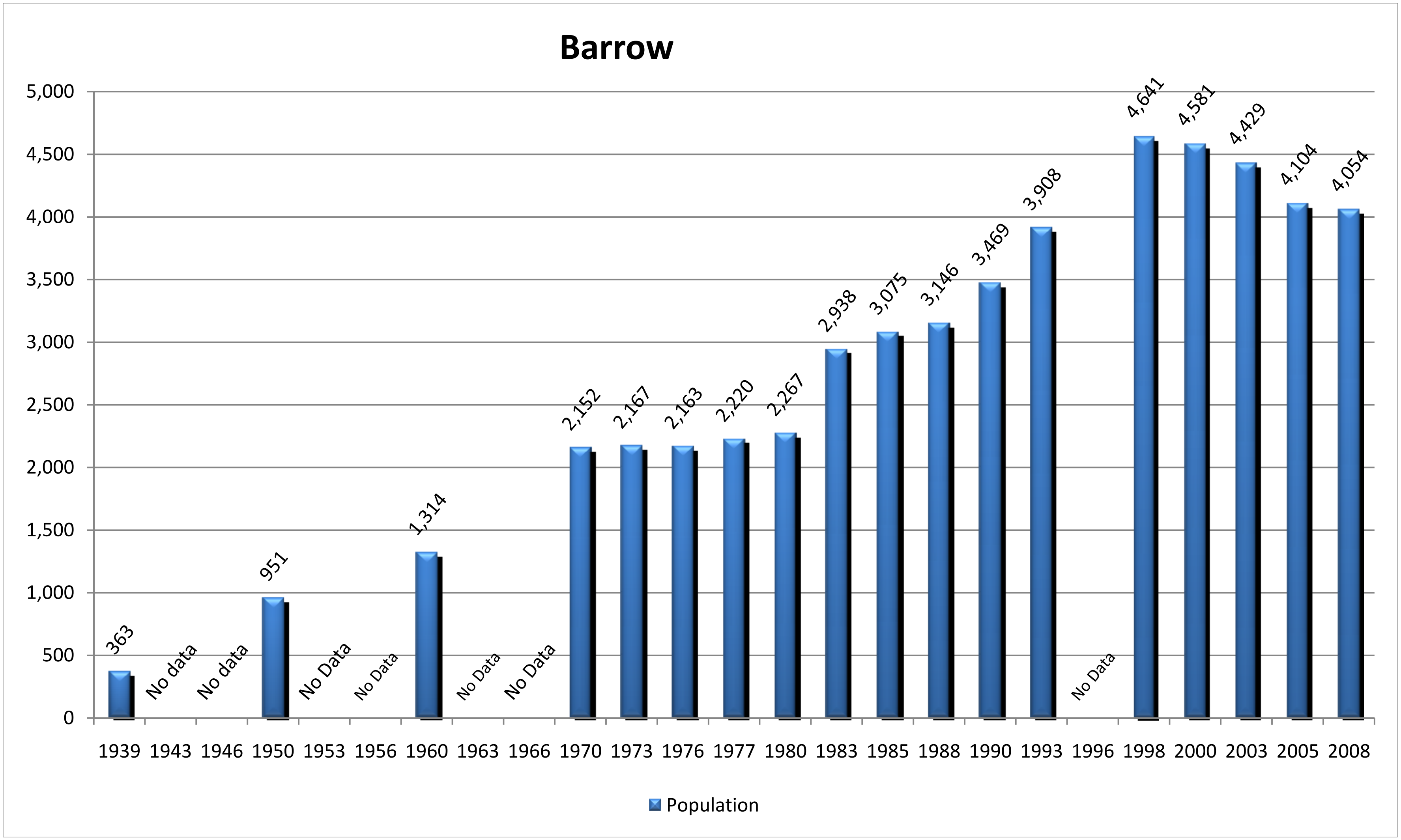
Most recent published detailed population data on Barrow are from the 2000 U.S. Census and the 2003 NSB Census (ADCCED 2009; NSB 2005; Shepro, Maas, and Callaway 2003; U.S. Census Bureau 2009). The data demonstrated that Barrow's population is relatively young compared to the rest of the United States. Table 3.3.2-1 shows the age distributions for Barrow, Alaska, and the U.S. for 2000.

TABLE 3.3.2-1 Barrow Age Distribution Compared with that of Alaska and the United States

Age Category	Barrow 2000*	Alaska 2000*	U.S. 2000*
19 years and younger	39%	33%	29%
20–34 years	20%	21%	21%
35–54 years	32%	33%	29%
55 years and older	8%	13%	21%

Note: This table only uses data from 2000 in order to make an adequate comparison.
Notes: *Percent of total population depicted
Source: U.S. Census Bureau 2009a

Figure 3.3.2-2 Barrow Population from 1939–2008



Sources: (ADCCED 2007, NSB 2005, Shepro, Maas and Callaway 2003, U.S. Census Bureau 2009a and U.S.Census Bureau 2009b)
Note: In cases where both the U.S. Census Bureau ADCCED had estimates for the same year, estimates from ADCCED were used because assumptions are that the Alaska department works closer and more often with local Alaska communities than the U.S. Census Bureau.

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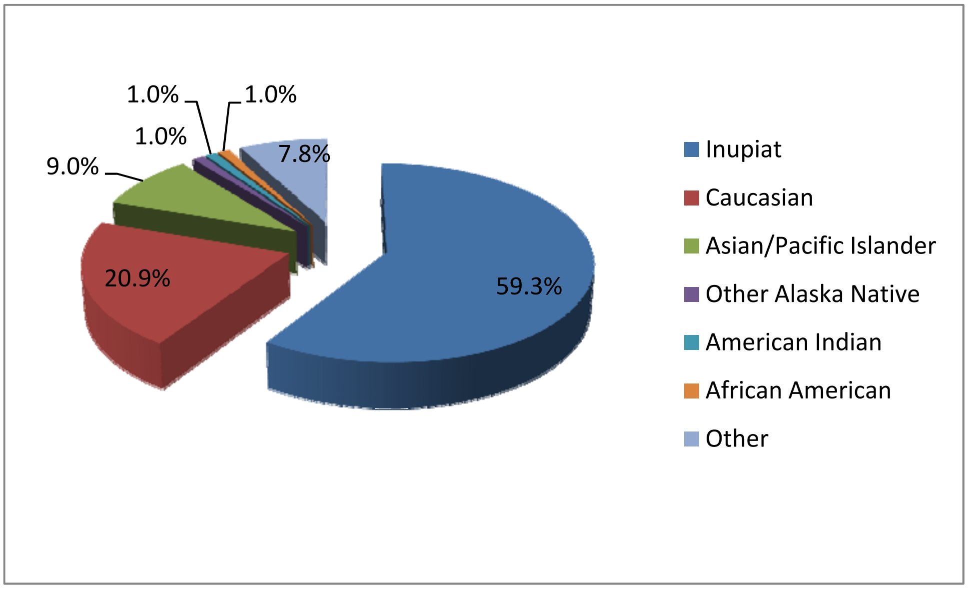
The majority of the people in Barrow are Iñupiat, approximately 59 percent. The other 41 percent are a diverse ethnic makeup. Figure 3.3.2-3 depicts the ethnic makeup of Barrow in 2003.

Figure 3.3.2-3 Ethnic Makeup of Barrow in 2003



Source: Data used to generate this chart came from Shepro et al. 2003.

Wainwright

Located approximately 116 km (72 mi) southwest of Barrow, Wainwright sits on a Chukchi Sea coast eroded by waves (NSB 2009b). Wainwright receives about 12.7 cm (5 inches) of precipitation and 30.5 cm (12 inches) of snow a year. Temperatures range from -48.9° to 26.7°C (-56°–80°F) (ADCCED 2009). Given its modern name in 1826 after Lt. John Wainwright, the village's traditional name is Olgoonik (ADCCED 2009; University of Arkansas 2007).

Residents identify closely with the sea and the coastal environment. The name they use for themselves, *Tagiumiut,* means *people of the sea* (NSB 2005).

Wainwright in the Past

Generations of Iñupiat have lived in and used the region around Wainwright. Archaeologists have found sites in the region containing material culture associated with the Birnirk tradition or culture (OHA 2009)—a tradition attributed to sites from the Barrow area south to Nome, and as far west as the northern coast of northeast Asia (Anderson 1998). Archaeologists estimate that Birnirk sites date from 1,300–1,000 years before present (B.P.[3]) (Reuther and Williams 2004).

Later prehistoric and early historical sites in the area range from ephemeral, likely short-term, sites to village sites. Russian Naval officer Lieutenant Lavernty Zagoskin first recorded the village of Kilimantavi (archaeological site designation WAI-002), approximately 22 km (14 mi) from Wainwright, in 1842–1844. This village was later recorded in the 1890 Census and is thought to have been occupied until 1904. The 1890 Census reported another village in the area, Kunmeum, meaning *near Wainwright Inlet* (OHA 2009).

[3] Radiocarbon or carbon-14 dating provides the age of materials using the decay rate of naturally occurring radioisotope carbon-14 in organic materials. Uncalibrated dates are reported in radiocarbon years B.P., which is defined as AD 1950. Radiocarbon dating can be used to date materials as old as approximately 60,000 years.

The present village of Wainwright was settled in 1904. The Alaska Native Service built a school and began providing medical and other services in this location. These actions stimulated settlement (ADCCED 2009; University of Arkansas 2007).

As with Barrow, the U.S. built a DEW Auxiliary Station near Wainwright in 1953 (USAF 1999). Five miles west of Wainwright, the installation and individuals stationed there undoubtly had some effect on the village. Other factors influencing Wainwright's past include reindeer herding, oil and gas exploration, and military activities.

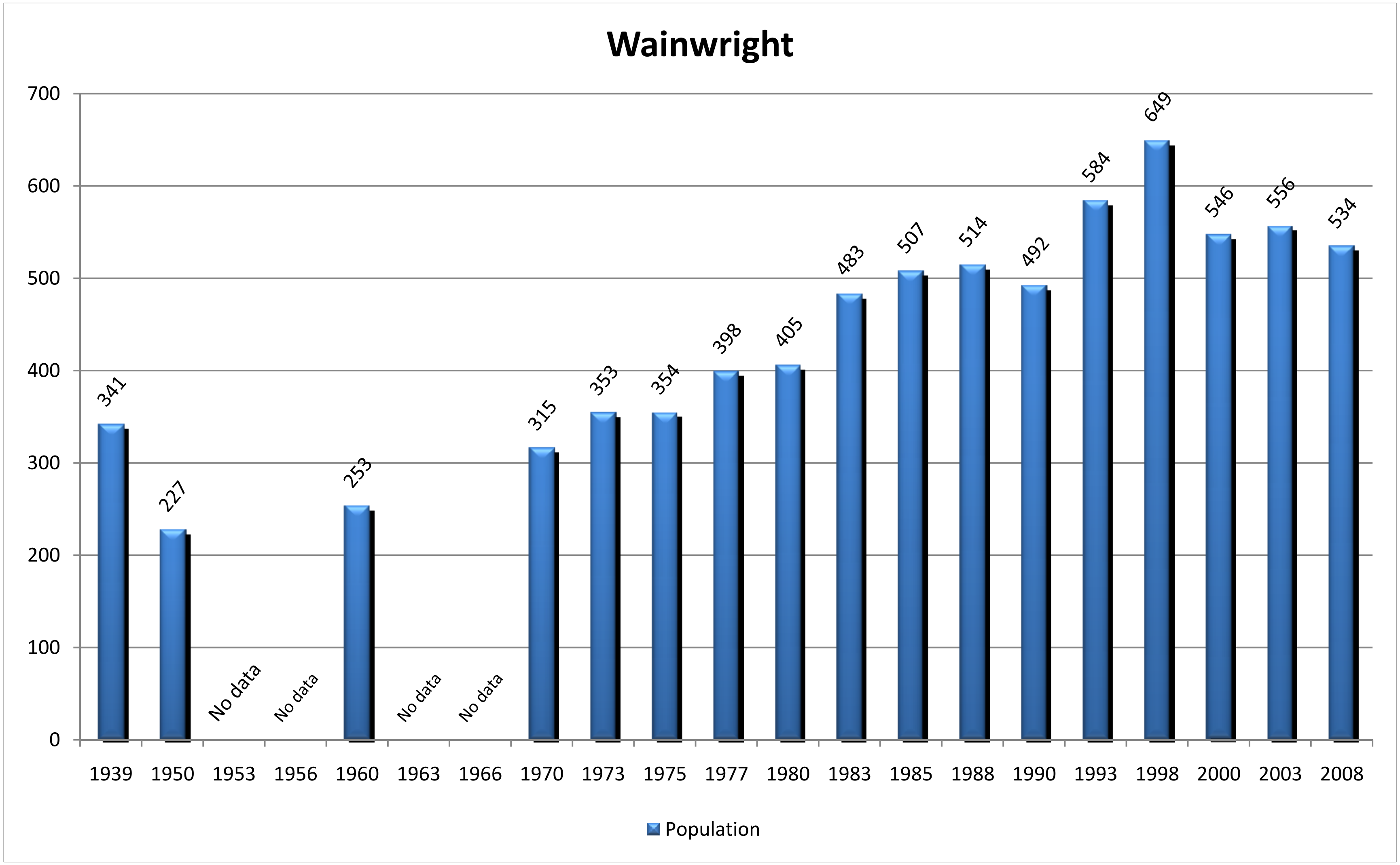
Modern Wainwright

The City of Wainwright was incorporated in 1962. Today the NSB provides all the utilities for the city. The NSB obtains water from Merekruak Lake and trucks it to the city where it treats, stores, and delivers it to household tanks (ADCCED 2009). This water and sewage system was built in 1998, and by 2003 approximately 94 percent of the households had flush toilets that connected to the sewer system. The NSB Power and Light System provides electricity to the village, generating it from diesel fuel. Approximately 97 percent of the households use diesel fuel to heat their homes (NSB 2005).

Wainwright has a health clinic, police station, and a fire station. Pre-schoolers through twelfth graders attend the Alak School. Additionally, the Olgoonik Village Corporation runs a general store, one restaurant, and one hotel in the village (NSB 2005, 2009b).

Wainwright has just over 500 residents (ADCCED 2009). Figure 3.3.2-4 depicts Wainwright's population fom 1939–2008. This graph shows a steep decline in population between 1939 and 1950 and a steady increase until 1998, when the population declined again. Some have attributed this decline to a decline in jobs resulting from several large capital improvement projects coming to completion at this time (NSB 2005; Shepro et al. 2003).

Figure 3.3.2-4 Wainwright Population from 1939–2008



Sources: ADCCED 2009; NSB 2005; Shepro, Maas and Callaway 2003; U.S. Census Bureau 2009a, and U.S. Census Bureau 2009b

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Wainwright has a relatively young population; approximately 42 percent of the residents are 19 years of age or younger. This is greater than both the state's and the nation's percentage of population in the same age category. Table 3.3.2-2 shows a comparison of age distribution of Wainwright compared to the state and to the nation.

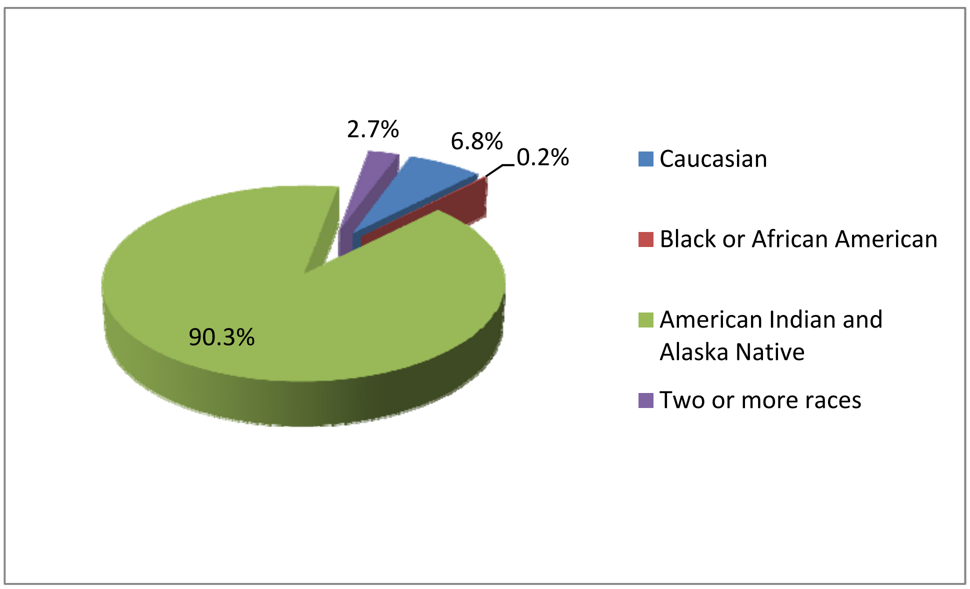
TABLE 3.3.2-2 Wainwright Age Distribution Compared with that of Alaska and the United States

Age Category	Wainwright 2000*	Alaska 2000*	U.S. 2000*
19 years and younger	42%	33%	29%
20–34 years	21%	21%	21%
35–54 years	24%	33%	29%
55 years and older	13%	13%	21%

Note: This table only uses data from 2000 in order to make an adequate comparison
Notes:*Percent of total population depicted
Sources: NSB 2005; Shepro et al. 2003; U.S. Census Bureau 2009a

The vast majority of Wainwright's population comprises Native Alaskans (U.S. Census Bureau 2009). According to the NSB, all or most of these residents are Iñupiat (NSB 2009b). Figure 3.3.2-5 depicts the ethnic makeup of Wainwright.

Figure 3.3.2-5 Ethnic Makeup of Wainwright in 2000



Source: ADCCED 2009

Point Lay

Located 240 km (150 mi) southwest of Barrow, Point Lay is the only unincorporated traditional village in the NSB. The village is protected from the Chukchi Sea by Kasegaluk Lagoon and sits on a coastal bluff. Kali is the Iñupiaq name for the village. It means *mound* and refers to the elevated ground on which the village sits (NSB 2005, 2009c). According to the NSB, Point Lay may be the last remaining village of the Kuukpaagruk (NSB 2009c), also spelled *Kukpowrk* (OHA 2009, USGS 2009).

Point Lay in the Past

The early Kuukpaagruk Iñupiat or Kukpaurungmiut lived along the coast and rivers in the area of present-day Point Lay. The Kukpaurungmiut lived in small groups and hunted and fished local resources. The mouth of the Kukpowruk River is approximately 1.2 km (0.8 mi) south of Point Lay. Both prehistoric and historic archaeological sites have been documented along this river, including the village of Kukpowruk (archaeological site designation XPL-001), which notable whaler and trader Charles D. Brower visited in the 1880s (Brower, 1994; OHA 2009; USGS 2009).

A number of archaeological sites are located closer to present-day Point Lay. Many of these have evidence dating from the turn of the 20th century (OHA 2009). Eventually, the people congregated in the location of the modern village. The population of the area began to grow in the 1920s when a trading post was established. A school was built in 1930. The original village of Kali sat on a barrier island. Residents moved from there to the banks of the Kokolik River before moving the village to its current location (NSB 2005, 2009c).

Like Barrow and Wainwright, Point Lay's location played a part in the Cold War. The U.S. military constructed a DEW Auxiliary Station on Kasegaluk Lagoon near Point Lay in 1955 (USAF 1999).

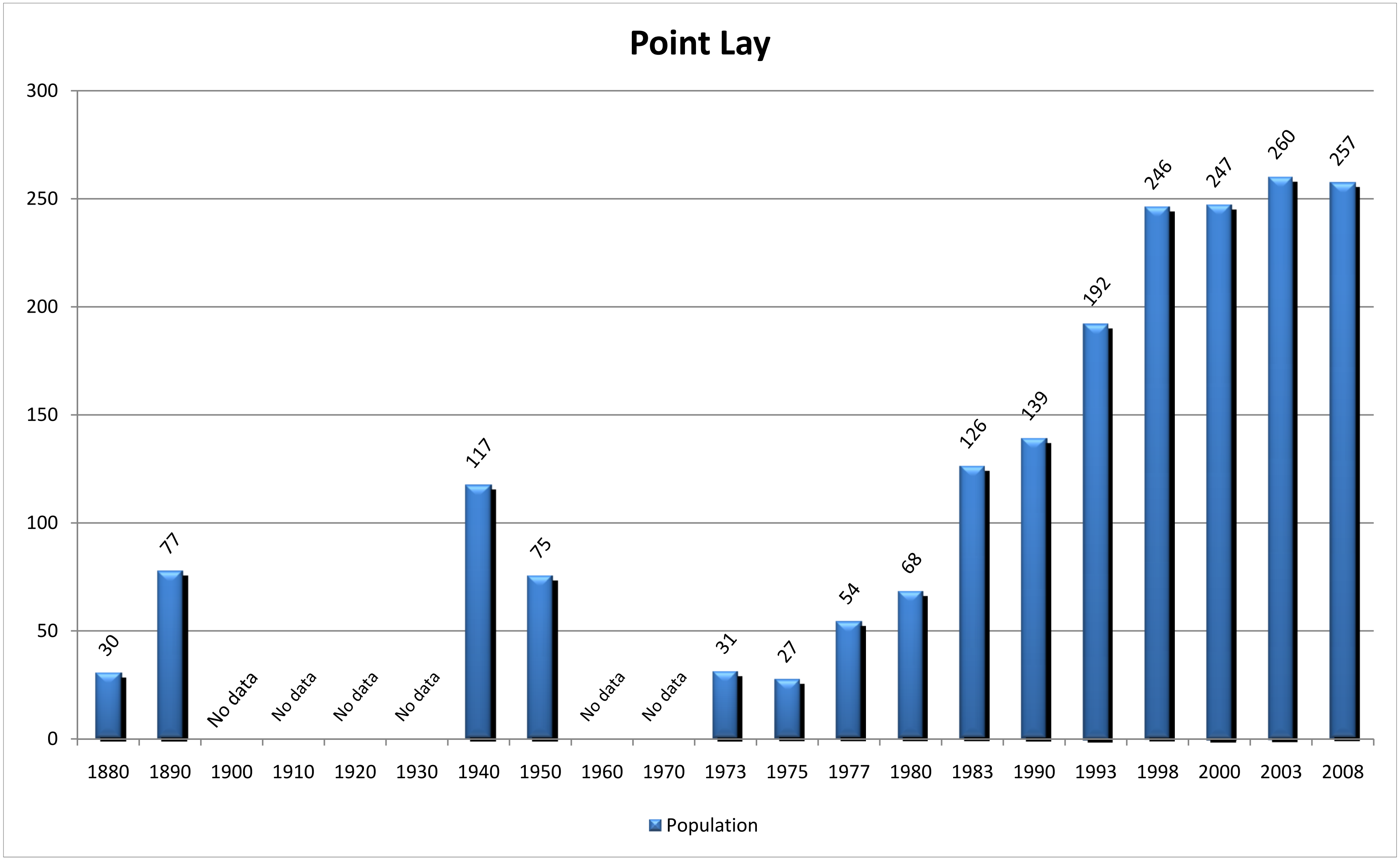
Modern-Day Point Lay

The NSB provides utilities for Point Lay. The Public Works Department maintains a water system that includes piped and hauled water and the sewage system. In 2003, approximately 60 percent of the households had flush toilets that were connected to the village sewage system (NSB 2005).

Most commonly, Point Lay residents heat their houses with diesel oil or a combination of diesel and electricity. The NSB Power and Light System generates electricity using diesel fuel (NSB 2005). The village has a health clinic, a school, a cultural center, a construction camp, a fire station, and a general store, which is run by the Native Village of Point Lay (NSB 2009c).

The State of Alaska estimates the current population of Point Lay at 257 (ADCCED 2009). Figure 3.3.2-6 shows population numbers of the village of Kali or Point Lay from1880–2008. There was a significant population number decrease after 1939. The community was abandoned circa 1960 and reestablished in 1973 (NSB 2005). From 1973–2003, the population generally grew steadily.

Figure 3.3.2-6 Point Lay Population from 1880–2008



Sources: ADCCED 2009; NSB 2005; Shepro et al. 2003; U.S. Census Bureau 2009a, 2009b

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Point Lay has a young population. Shepro et al. (2003) found that almost 56 percent of the people whose age was reported in 2003 were 19 years old or younger. This percentage has increased since 2000. Table 3.3.2-3 compares age groups in Point Lay, Alaska, and U.S. populations. In order to make an adequate comparison, only population numbers for the year 2000 are used. From this table it can be seen that Point Lay's population is considerably younger than that of Alaska in general and the U.S.

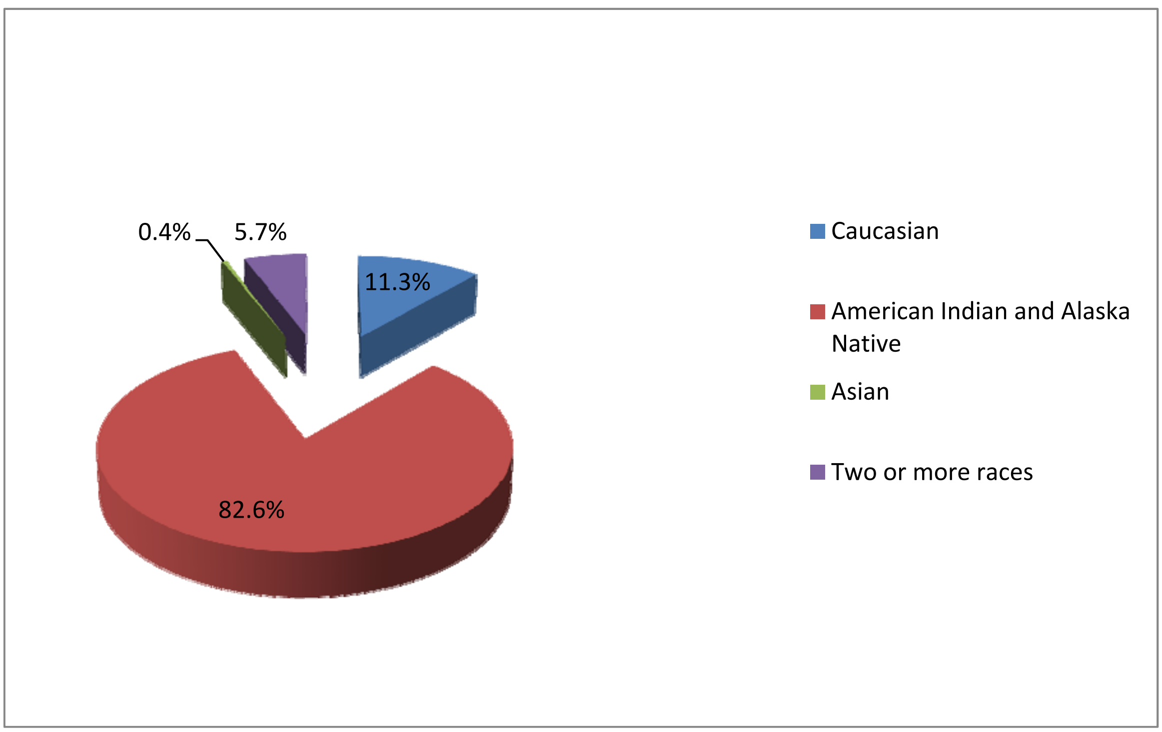
TABLE 3.3.2-3 Point Lay Age Distribution Compared with that of Alaska and the United States

Age Category	Point Lay 2000*	Alaska 2000*	U.S. 2000*
19 years and younger	49%	33%	29%
20–34 years	22%	21%	21%
35–54 years	18%	33%	29%
55 years and older	11%	13%	21%

Source: U.S. Census Bureau 2009a
Notes: This table only uses data from 2000 in order to make an adequate comparison
*Percent of total population depicted

The majority of the population in Point Lay identifies itself as Iñupiat. In 2003, Shepro et al. reported that 86.2 percent of the population identified itself as Inupiat and 13.8 percent as non-Inupiat. This result is consistent with the 2000 U.S. Census, which broke down ethnicity in more detail (Figure 3.3.2-7).

Figure 3.3.2-7 Ethnic Makeup of Point Lay



Source: ADCCED 2009

Point Hope

Point Hope is approximately 500 km (315 mi) southwest of Barrow. The village sits on a large gravel spit at the tip of the Tigara Peninsula, which is at the southwest point of the Lisburne Peninsula. This spit extends approximately 15 mi (24 km) into the sea. The Iñupiaq name for the village is Tikibaq, and the residents are Tikibabmiut. Like other Iñupiaq villages, past and present culture is "to a great extent, dependent on the capture of the bowhead whale" (Pulu et al. 1980).

Point Hope in the Past

The Tigara (*forefinger* [USGS 2009]) Peninsula is the longest continually inhabited location in the North Slope and perhaps in Alaska. Archaeological evidence shows that Tikibabmiut have inhabited this area for at least the last 2,500 years. Some of the more well-known archaeological villages are Old Tigara, New Tigara, Ipiutak, and Jabbertown (NSB 2005; NSB 2009d; University of Arkansas 2007; ADCCED 2009). The Ipiutak archaeological site was listed in the National Register in 1966. The site has been designated a National Historic Landmark. In 1979, the Ipiutak Archaeological District, which includes the Ipiutak site and other resources, was listed in the National Register (NPS 2008a, NPS 2008b).

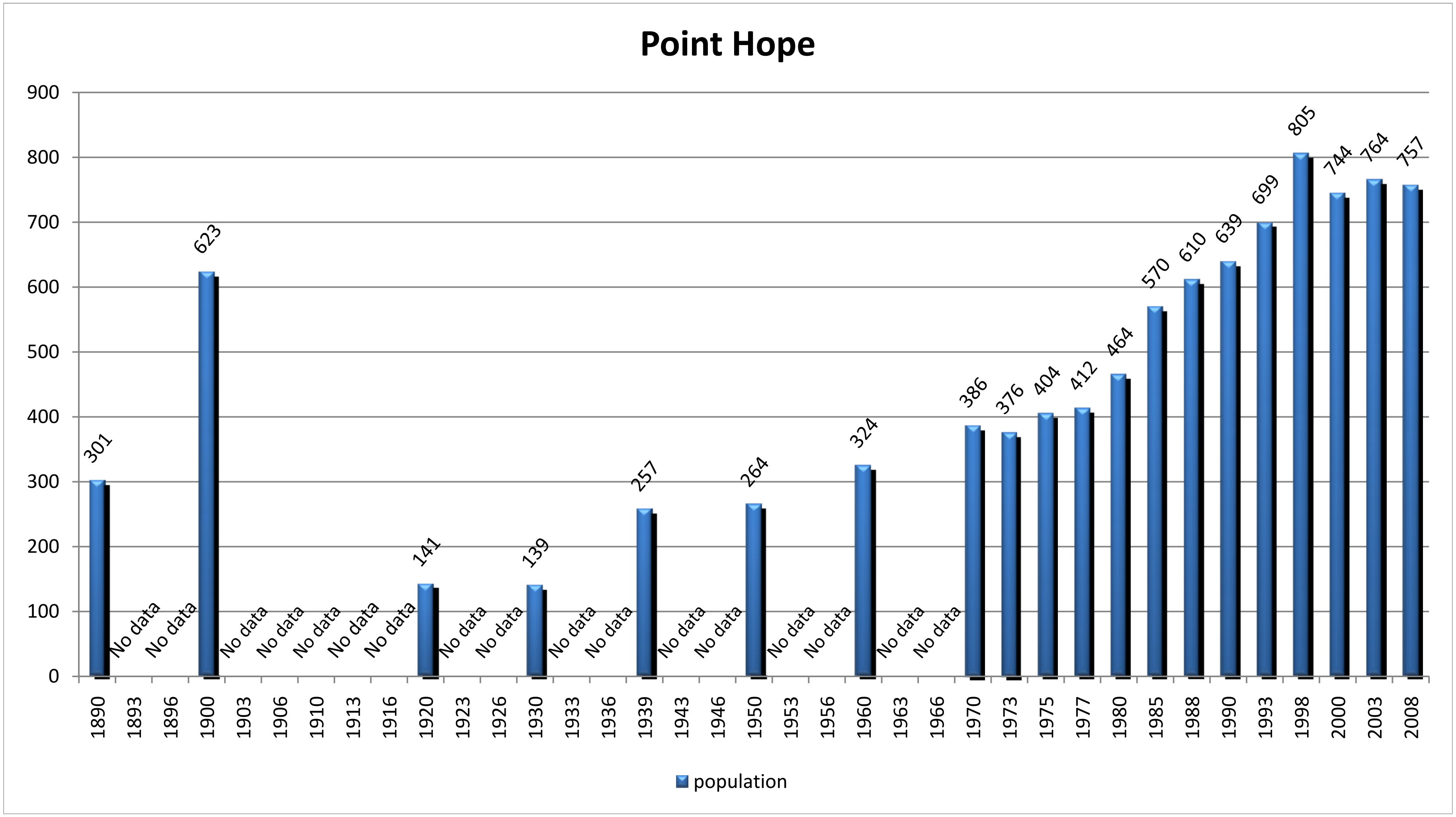
An influx of Euroamericans came to the area by 1848 to conduct commercial whaling activities. Many of the whalers employed local residents. In the 1880s, commercial whalers established shore-based whaling stations in northern Alaska. One of these was at Jabbertown. Commercial whaling ended in the early 1900s, and these stations were shut down (ADCCED 2009).

Modern-Day Point Hope

The NSB provides electricity, water and sewage services, and trash-removal services. The Public Works Department maintains a piped water system and provides a water haul system within the city. Most commonly, residents of Point hope heat their houses with diesel oil or a combination of diesel and electricity. The NSB Power and Light System generates electricity from diesel fuel (NSB 2005). The village has a health clinic, a school, a senior citizens' center, a fire station, and a general store, which is run by the Tikigaq Village Corporation (NSB 2009d).

In 2008, the State of Alaska certified the population at Point Hope as 713 (ADCCED 2009). Figure 3.3.2-8 depicts Point Hope's population from 1890–2008. This graph shows that the population more than doubled from 1890–1900, only to decrease as quickly from 1900–1910. This rise and fall in population corresponded with the shore-based commercial whaling stations. Point Hope's population continued to decline, stabilizing from 1920–1930. In 1939, the population began a steady increase, experienced a peak in 1998, and then a decrease. The population seems to have been relatively stable from 2000–2008.

Figure 3.3.2-8 Population of Point Hope from 1890–2008



Source: ADCCED 2009

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Like the other communities discussed thus far, Point Hope has a relatively young population. Shepro et al. (2003) found that almost 47 percent of the people whose age was reported in 2003 were 19 years old or younger. This is the same percentage the U.S. Census Bureau found in 2000 (U.S. Census Bureau 2009). Table 3.3.2-4 compares age groups in Point Hope, Alaska, and U.S. populations. In order to make an adequate comparison, only population numbers for the year 2000 are used. From this table it can be seen that Point Hope's population is considerably younger than that of Alaska and the U.S. in general.

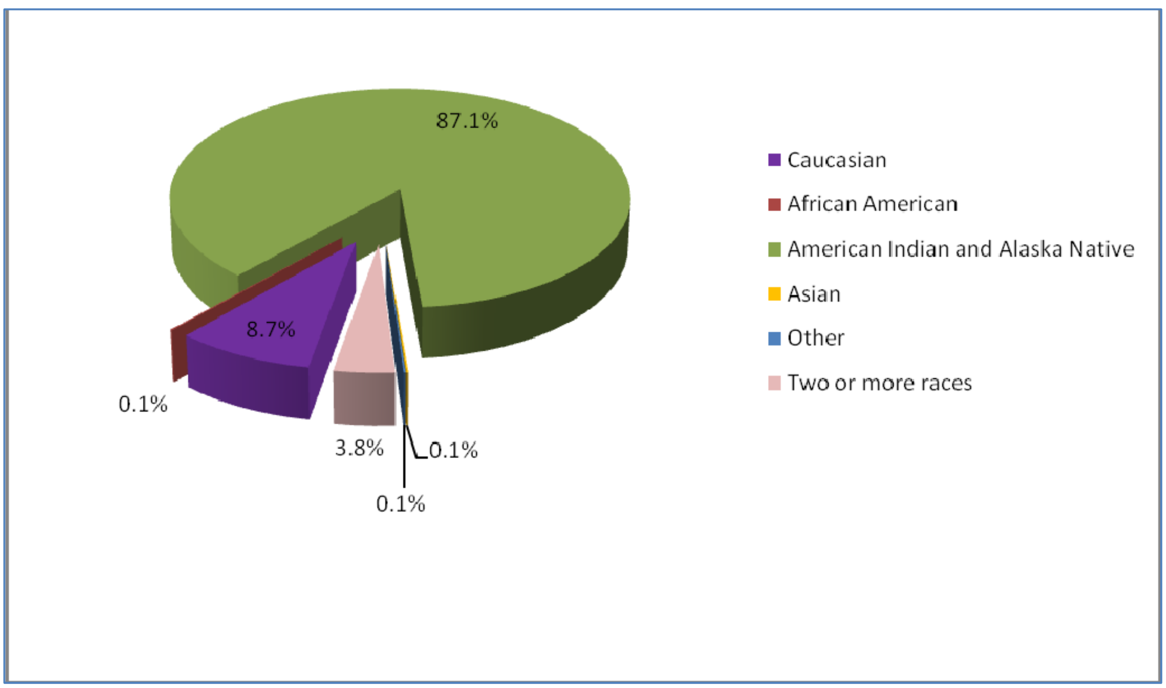
TABLE 3.3.2-4 Point Hope Age Distribution Compared with that of Alaska and the United States

Age Category	Point Hope 2000*	Alaska 2000*	U.S. 2000*
19 years and younger	47%	33%	29%
20–34 years	18%	21%	21%
35–54 years	25%	33%	29%
55 years and older	10%	13%	21%

Notes: *Percent of total population depicted
Sources: ADCCED 2009; NSB 2005; Shepro et al. 2003; U.S. Census Bureau 2009a

Most of the Point Hope residents identify themselves as Iñupiat. Shepro et al. (2003) noted that while over 90 percent of the Point Hope population was Iñupiat, the number of non-Iñupiat residents was on the rise. Figure 3.3.2-9 shows the ethnic make up of Point Hope in 2000.

Figure 3.3.2-9 Point Hope Ethnic Makeup in 2000



Source: U.S. Census Bureau 2009a

3.3.2.2 Northwest Arctic Borough

The NWAB is the second-largest borough in Alaska, by size, encompassing approximately 101,010 sq km (39,000 sq mi) along Kotzebue Sound and along the Wulik, Noatak, Kobuk, Selawik, Buckland, and Kugruk Rivers. It has a population of 7,407. The area has been occupied by Iñupiat for at least 10,000 years. Communities located within the Borough include Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Kotzebue, Noorvik, Selawik, and Shungnak and the unincorporated community of Noatak (ADCCED 2009).

Activities related to government, mining, health care, transportation, services, and construction contribute to the NWAB economy. The Red Dog Mine, 145 km (90 mi) north of Kotzebue, is the world's largest zinc and lead mine and provides 370 direct year-round jobs and over a quarter of the Borough's wage and salary payroll. The ore is owned by NANA Regional Corporation and leased to Teck Alaska Incorporated (formerly Teck Cominco), which owns and operates the mine and shipping facilities. Teck Alaska Incorporated, Maniilaq Association, the NWAB School District, Veco Construction (now owned by CH2M HILL), and Kikiktagruk Iñupiat Corporation are the borough's largest employers. The smaller communities rely on subsistence food-gathering and Native craft-making; 162 Borough residents hold commercial fishing permits (ADCCED 2009).

Kotzebue

Kotzebue sits on a sand spit at the end of the Baldwin Peninsula in Kotzebue Sound, north of the Seward Peninsula in Northwest Alaska. The community takes its name from Kotzebue Sound, which was named after Russian explorer Otto von Kotzebue who "discovered" the sound in 1818. The Iñupiat name for the community is Kikktagruk (ADCCED 2009; City of Kotzebue 2009).

Kotzebue in the Past

People have lived at the current site of Kotzebue (Kikktagruk) for at least 600 years (ADCCED 2009; OHA 2009). Prior to European contact, Kikiktagruk was the hub of Arctic trading routes. Its location on the coast and proximity to many river transportation routes made this a prime spot as a trading hub (ADCCED 2009). The Kotzebue Archaeological District consists of a number of sites within Kotzebue. Some of these sites include Old Kotzebue (KTZ-036), Intermediate Kotzebue (KTZ-030), and Kotzebue (KTZ-001) (OHA 2009).

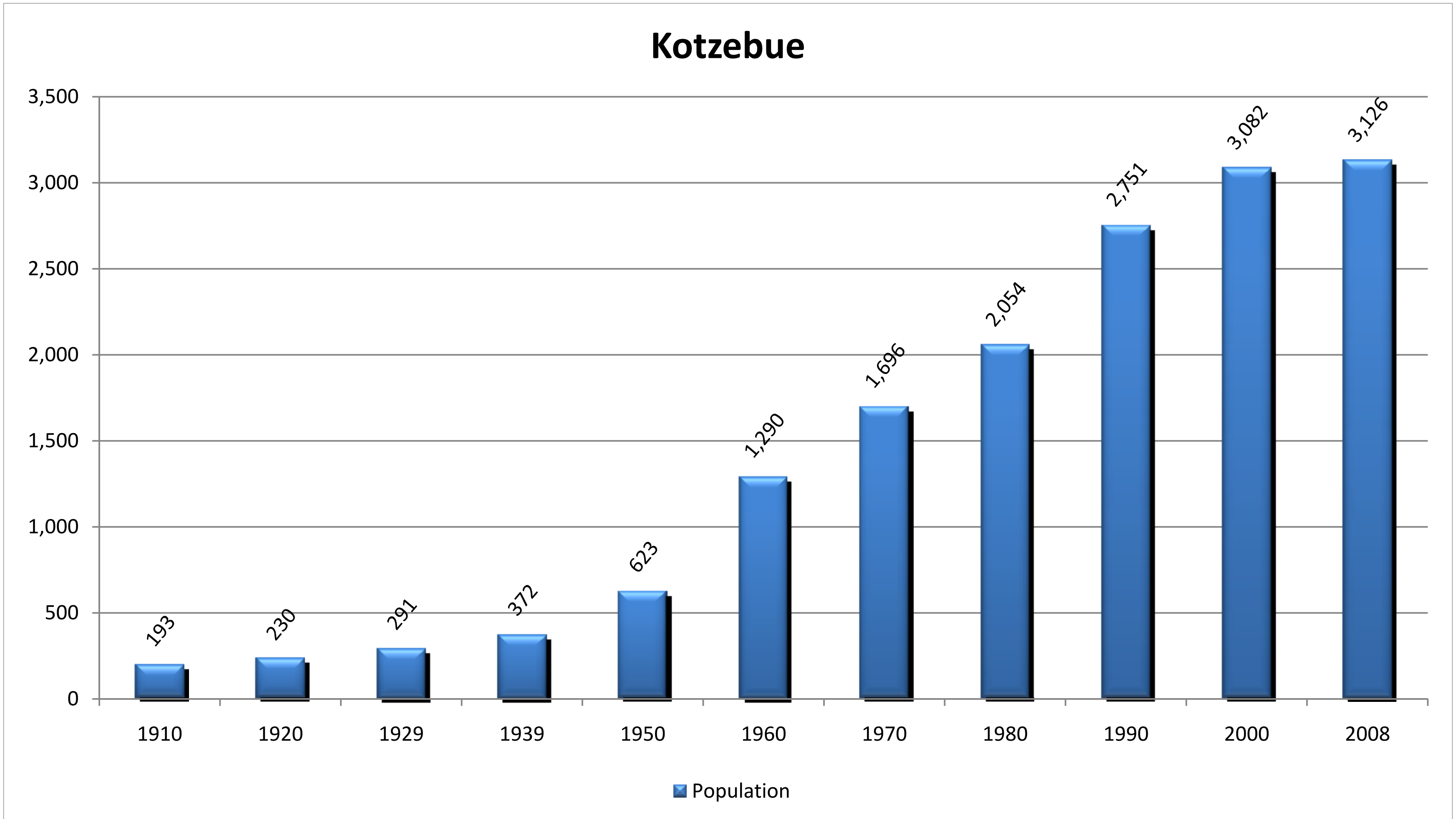
Like many early villages in Alaska, Kikiktagruk was a semi-permanent village. Villages were seasonal, and people moved back and forth from different villages and camps, taking advantage of different resources at different times of the year. The modern village of Kotzebue was established in 1897. At that time, a reindeer station was built. As a result of the station's activities and influence, Kotzebue became a permanent settlement (OHA 2009).

Modern Day Kotzebue

The City of Kotzebue remains a transportation hub of northwest Alaska. It is the transfer point between ocean and inland shipping. It does not have a natural harbor and is ice-free for only 3 months each year. Deep draft vessels must anchor 24 km (15 mi) offshore, and cargo is lightered to the docking facility. Local barge services provide cargo to area communities. Ralph Wien Memorial Airport supports daily jet service and air taxis to Anchorage via Nome.

In 2008, the State of Alaska estimated Kotzebue's population to be 3,126 (ADCCED 2009). Figure 3.2-10 shows the population trend from 1910 through 2008. This graph shows that the population has been steadily growing.

Figure 3.3.2-10 Kotzebue Population from 1910–2008



Sources: ADCCED 2009; U.S. Census Bureau 2009a, 2009b
Note: Years for which data are lacking are not represented here.

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Kotzebue has a relatively young population. The U.S. Census Bureau found 42 percent of Kotzebue's population was 19 years of age or younger in 2000. Table 3.3.2-5 compares age groups in Kotzebue, Alaska, and U.S. populations.

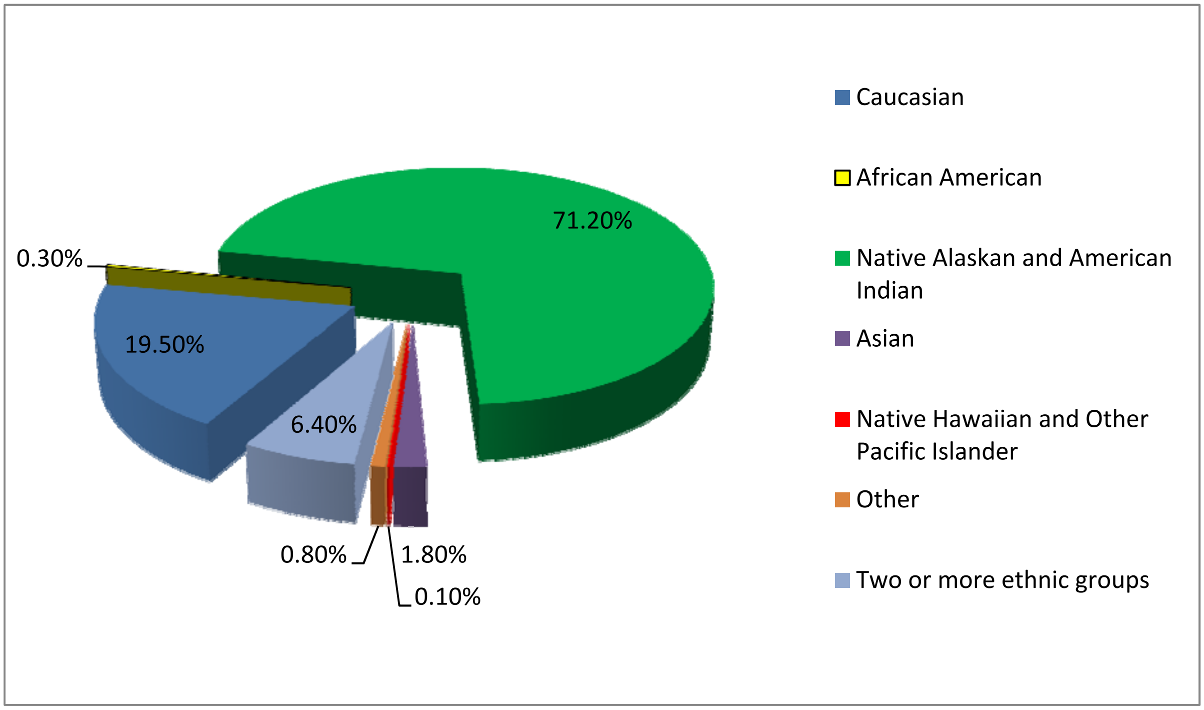
TABLE 3.3.2-5 Kotzebue Age Distribution Compared with that of Alaska and the United States

Age Category	Kotzebue 2000*	Alaska 2000*	U.S. 2000*
19 years and younger	42%	33%	29%
20–34 years	28%	21%	21%
35–54 years	22%	33%	29%
55 years and older	8%	13%	21%

Notes:
*Percent of total population depicted
Sources: ADCCED 2009; NSB 2005; Shepro et al. 2003; U.S. Census Bureau 2009a

The 2000 U.S. Census notes that the majority of the residents of Kotzebue are American Indian or Native Alaskan. While the census reports did not break down this category, likely most of these individuals are Iñupiat. Figure 3.3.2-11 depicts the ethnic makeup of Kotzebue.

Figure 3.3.2-11 Ethnic Makeup of Kotzebue in 2000



Source (U.S. Census Bureau 2009a)

Kivalina

Located 128.7 air-km (80 air-mi) northwest of Kotzebue, Kivalina is located on the tip of a barrier reef that is between the Chukchi Sea and the Kivalina River. Kivalina is the only village in NWAB whose residents hunt bowhead whale (ADCCED 2009).

Kivalina in the Past

Kivalina sits within traditional Kivalliñibmiut territory. The Kivalliñibmiut occupied approximately 5,646 sq km (2,180 sq mi.) in northwest Alaska. This area included a portion of the upper Kukpuk valley and the Kivalina and Wulik River drainages along the Chukchi at mouths of those rivers and inland to the divide between the Noatak and Wulik watersheds in the Mulgrave Hills. The Kivalliñibmiut spent half the year on the coast and half the year inland (Burch 1998).

Russian explorers first noted the Kivalliñibmiut in the early 19th century. Aleksandr F. Kashevarov, leader of an expedition along Alaska's northwest coast, identified the Kivalliñibmiut as an Iñupiaq nation in 1838 (Burch 1998). Lieutenant Zagoskin visited and wrote about Kivalina in 1847 (ADCCED 2009; OHA 2009). At that time, the village was on the north side of Kivalina Lagoon, not on the south as it is today (OHA 2009).

Modern-Day Kivalina

The modern village of Kivalina was settled around the turn of the 20th century (Burch 1998). A post office was built in 1940, and an airstrip in 1960. Kivalina was incorporated as a city in 1969 (ADCCED 2009).

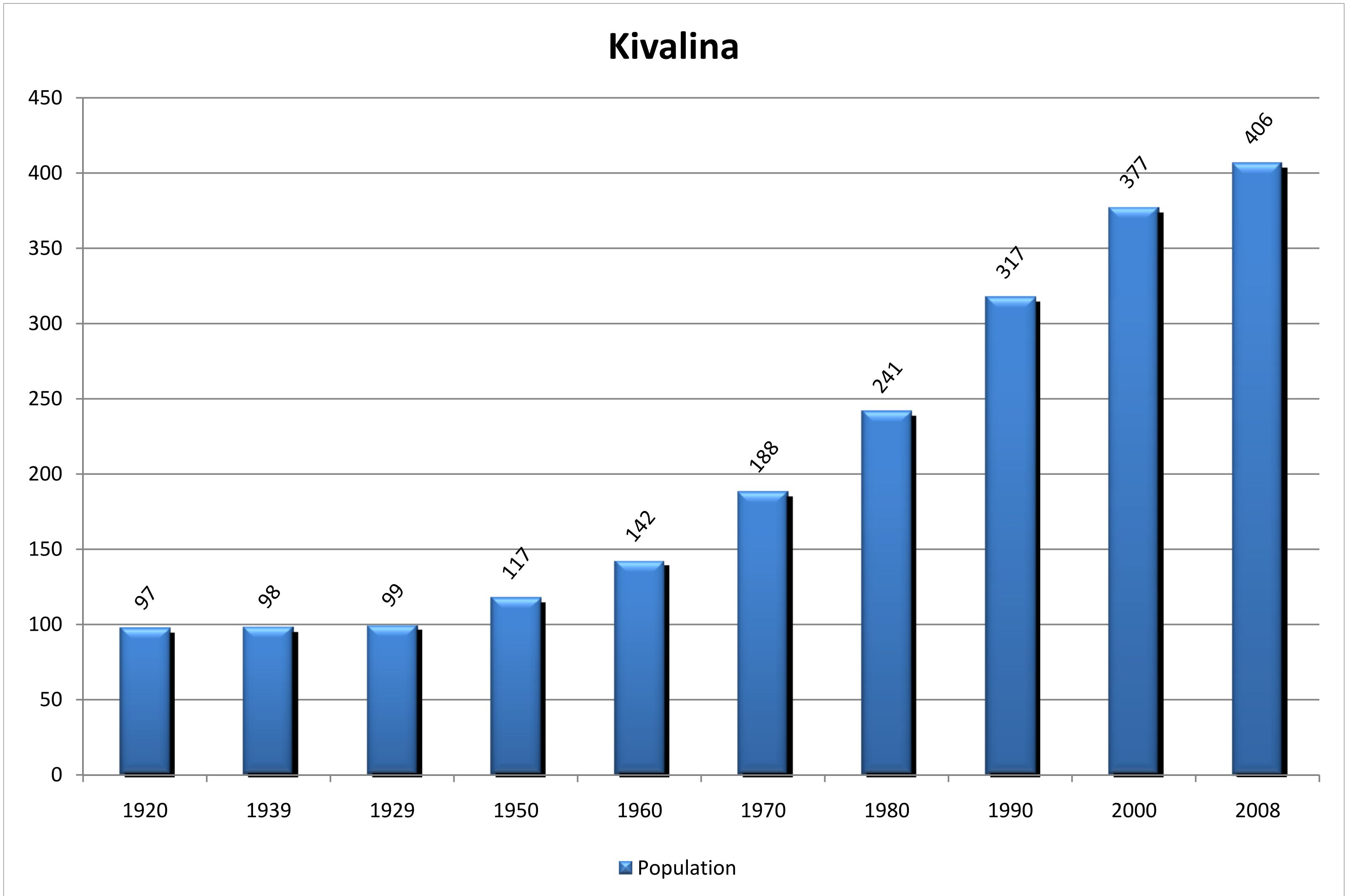
The city intends to move to a new location 4 km (2.5 mi) away. Severe erosion and damage from wind-driven ice threatens the current city site.

Transportation to and from Kivalina is mainly by plane and barge. Daily flights connect Kivalina with Kotzebue. Crowley Marine Services provides barge service to and from Kotzebue in July and August. Residents also travel in and out of the city by small boats, ATVs, and snowmachines (ADCCED 2009).

Kivalina lacks a piped water and sewage system for homes, but the school and the clinic have individual water and sewer systems. Water use comes from the Wulik River and is transported 4.8 km (3 mi) via a surface transmission line to Kivalina. It is treated and stored in a 1,892.7-cubic m (500,000-gallon) tank from which water is hauled to the school, washerteria, and homes. Residents haul their own water. One-seventh of Kivalina homes have tanks providing running water to the kitchen. Houses are not fully plumbed. Residents haul honeybuckets to the landfill for disposal (ADCCED 2009).

In 2008, the State of Alaska estimated Kivalina's population to be 406 (ADCCED 2009). Figure 3.3.2-12 shows the population trend from 1920 through 2008. This graph shows that the population has been steadily growing.

Figure 3.3.2-12 Population of Kivalina from 1920–2008



Sources: ADCCED 2009; U.S. Census Bureau 2009a, 2009b
Note: Years for which data are lacking are not represented here.

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Kivalina has a relatively young population. The U.S. Census Bureau found 48 percent of the population was 19 years of age or younger in 2000. Table 3.3.2-6 compares age groups in Kivalina, Alaska, and U.S. populations.

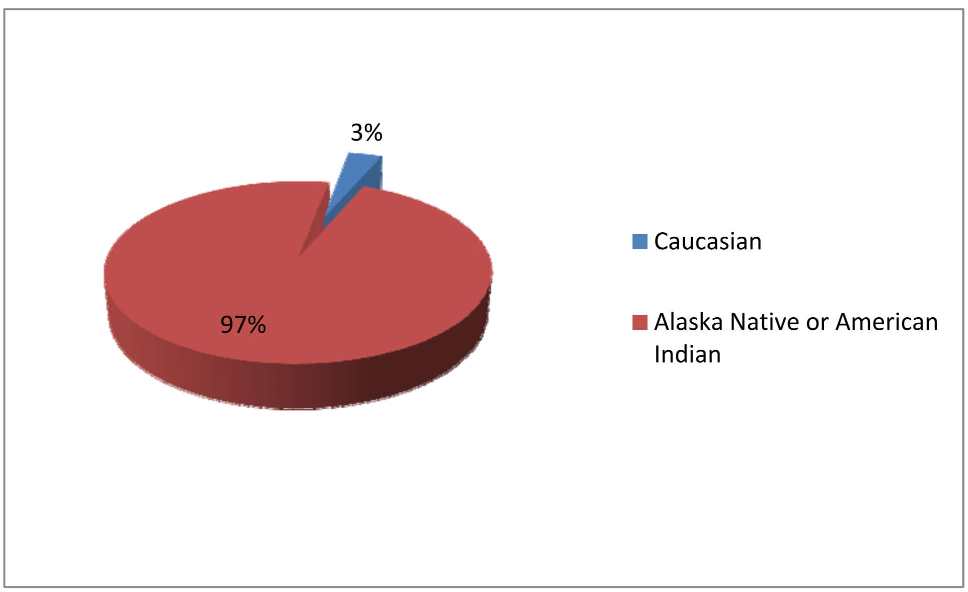
TABLE 3.3.2-6 Kivalina Age Distribution Compared with that of Alaska and the United States

Age Category	Kivalina 2000*	Alaska 2000*	U.S. 2000*
19 years and younger	48%	33%	29%
20–34 years	20%	21%	21%
35–54 years	20%	33%	29%
55 years and older	12%	13%	21%

Notes:
*Percent of total population depicted
Sources: ADCCED 2009; NSB 2005; Shepro et al. 2003; U.S. Census Bureau 2009a

The 2000 U.S. Census notes that a majority of the residents of Kivalina are American Indian or Native Alaskan. While the census reports did not break down this category, likely most of these individuals are Iñupiat. Figure 3.3.2-13 depicts the ethnic makeup of Kivalina.

Figure 3.3.2-13 Ethnic Makeup of Kivalina in 2000



Source: U.S. Census Bureau 2009a

3.3.3 Economy

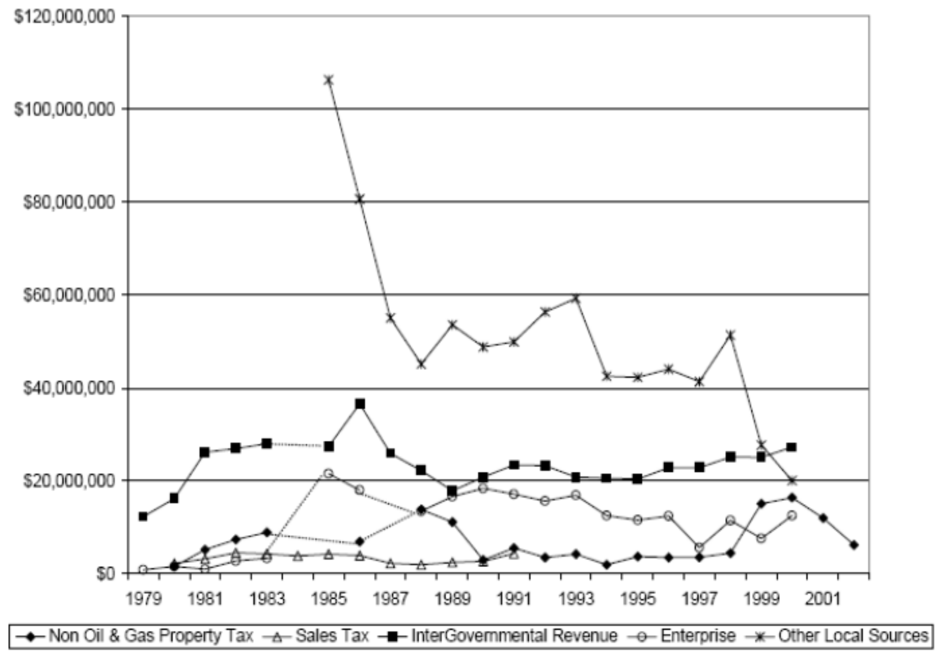
3.3.3.1 North Slope Borough Economy

It is important to understand the economic drivers in the NSB and influence area of the Chukchi Sea Lease Sale 193. Future regional and local economic development depends on natural resource development. This very development has the potential to affect the environment and subsistence use areas. The resource development-based economy also provides jobs and opportunity. With the cash-based economy, residents are pulled from their subsistence economy, decreasing the Traditional

Knowledge of subsistence reserves and habitat. The cumulative effects of the proposed Chukchi Sea oil and gas development must be counterbalanced by the indirect and direct economic benefits and community development that could also result.

ASRC and the village corporations exert considerable economic force in the region, providing employment in all sectors of the regional economy. Aside from the multinational resource development corporations, other major players in the North Slope economy are the federal government, State of Alaska, and local governments. The NSB is at the center of the region's economy, providing public services and facilities funded by oil and gas tax revenues. Revenues from oil and gas development provide most of the revenues to the NSB. These revenues are currently on the decline (Figure 3.3.3-1).

Figure 3.3.3-1 North Slope Borough Tax Revenues from 1975–2002

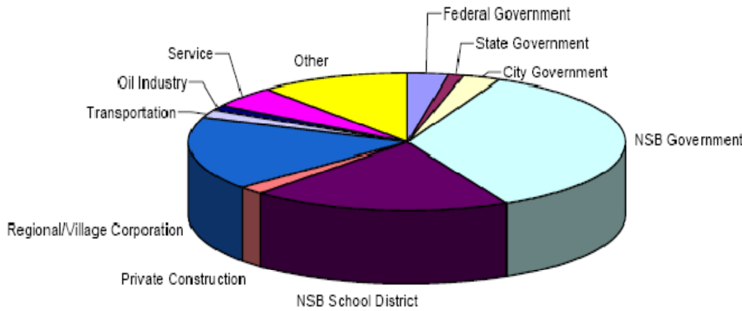


Note: Data for enterprise, intergovernmental and non-oil and gas property tax revenues were unavailable for 1984. Estimates of revenues from other local sources were unavailable for the years 1973 to 1984. The estimates of revenues from non-oil and gas property taxes for 1985 and 1987 were not included because of questions about their validity.

Note: Excludes oil and gas property tax revenues from 1975–2002
Source: Northern Economics Incorporated 2006: Figure 4-2

Direct and indirect economic benefits of OCS oil and gas exploration and development have the potential for revenue sharing for the North Slope governments and village corporations. Workforce development and training programs are needed to increase local hiring in the villages and residents' employment participation within the resource development economy (Figure 3.3.3-2).

Figure 3.3.3-2 North Slope Borough Resident Employment by Sector in 2003



Source: Shepro et al. 2003

High unemployment and underemployment remain characteristics of the North Slope, according to the *North Slope Borough 2003 Economic Profile and Census Report.* Most of the employment in the NSB is in the public sector: local, state, or federal government (Figure 3.3.3-2).

3.3.3.2 Northwest Arctic Borough Economy

The economy of the NWAB is fueled by government jobs, in addition to opportunities provided by mining, health care, transportation and construction industries. Subsistence remains a significant economic factor in the NWAB, in the smaller communities in particular. As in the NSB, subsistence and wage-based employment exist as the primary interdependent aspects of the overall economy.

Kotzebue is the largest town in the NWAB and serves as the regional economic center, as well as transportation center. Transportation-related activities, resulting from the community's location at the confluence of several major river systems in conjunction with its marine docking facilities, contribute significantly to the local economy (NWAB 2009). Kotzebue maintains a higher rate of employment and mean income than smaller communities in the region. In 1991, nearly 75 percent of adults in the community reported holding some type of wage employment, though over half of those held seasonal jobs and only 45 percent were employed year-round. This is due in large part to the town's role as economic center and the availability of seasonal jobs in the construction and fishing industries. Employment with federal, state, and local government provide the majority of resources for the community (MMS 1995). One hundred twelve residents have commercial fishing permits (NWAB 2009).

The economy in Kivalina is more heavily influenced by subsistence activities, which are supplemented and financed by wage-based employment (NWAB 2009). Government services in the administration, education, health, and social services sectors provide the primary employment opportunities in the community, and secondary economic contributions come from mining and retail trade. Kivalina has a relatively low level of employment, approximately 56 percent in 1991, and only 20 percent of available jobs provided year-round employment (MMS 1995). Art and jewelry produced from subsistence resources generate revenue for Kivalina residents. Local stores and airlines also provide jobs in the community, which has no restaurants or hotels. Two Kivalina residents have commercial fishing permits (NWAB 2009).

Employment

The economy of the NWAB is fueled by government jobs in addition to opportunities provided by mining, health care, transportation, and construction industries. The Red Dog Mine, located 145 km (90 mi) north of Kotzebue, contributes more than 25 percent of NWAB's wage and salary payroll.

Top employers in the NWAB include the Maniilaq Association, a tribally operated company providing regional health and social services (Maniilaq Association 2003), Kikiktagruk Iñupiat Corporation, the NWAB School District, CH2M HILL (formerly Veco Construction), and Teck Alaska Incorporated (formerly Cominco Alaska), who provides mining support services for Red Dog Mine (NWAB 2009).

Economic Development

There are several prospects for future economic development in the NSB that have implications for societal and environmental baseline conditions and potential effects.

Oil and Gas Industry

Oil and gas development on the North Slope fuels the State of Alaska budget, NSB government, the industry, and employees working in the oil fields. Revenues derived from resource development on the North Slope have enabled the NSB to invest in modern infrastructure and facilities. While the NSB has supported onshore oil exploration and development, it has also required of the industry prevention measures to protect subsistence resources, wildlife, and the arctic environment. Given the vast reserves in the Arctic—not only oil and gas, but other natural resources—future economic development undoubtedly will be resource-based. There can be economies of scale in the development of infrastructure to support this development. The best available technology must be applied to the development challenges, utilizing the best available scientific studies balanced by Traditional Knowledge. Minimizing the environmental and societal effects while providing business and job opportunities will go far in maintaining a high quality of life for residents.

Coal

Approximately one-third of the U.S. total coal resources are located in the western portion of the NSB (Glenn Gray and Associates 2005). This coal is high in British Thermal Unit value and low in sulfur. However, lack of surface transportation and other infrastructure is an obstacle to developing the coal resource.

Minerals

In the southwest area of the NSB, hard rock mineral deposits have been identified adjacent to the Red Dog zinc mine near Kotzebue in the northern portion of the NWAB. Should the transportation system that connects the Red Dog mine with the Chukchi Sea be extended, these minerals may be developed. As with potential development of coal, additional resource development affects the culture of the North Slope.

Sand and Gravel

Sand and gravel deposits located throughout the NSB and NWAB are a critical commodity for the villages in the region and the oil and gas industry. Locally available sand and gravel are valuable to the oil and gas industry for the construction and upkeep of roads and pads.

3.3.4 Subsistence

Subsistence is defined in Alaska Statute 16.05.940 as:

"The noncommercial, customary, and traditional use of wild, renewable resources by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or family consumption and for customary trade, barter, or sharing for personal or family consumption . . ."

But to the Iñupiat of northern Alaska, subsistence is more than a legal definition or means of providing food; subsistence is life. The Iñupiaq way of life is one that has developed over the course of generations upon generations. Their adaptations to the harsh arctic environment have enabled their people and culture to survive and thrive for thousands of years in a world seen by outsiders as unforgiving and inhospitable. Subsistence requires cooperation on both the family and community level. It promotes sharing and serves to maintain familial and social relationships within and between communities.

Subsistence is an essential part of local economies in the arctic, but it also plays an equally significant role in the spiritual and cultural realms for the people participating in a subsistence lifestyle (Brower 2004). Traditional stories feature animals that are used as subsistence resources, conveying the importance of subsistence species within Iñupiaq society. These stories are used to pass information pertaining to environmental knowledge, social etiquette, and history between generations, as well as to strengthen social bonds. The Iñupiaq way of life is dependent upon and defined by subsistence.

Subsistence foods have been demonstrated to contain important vitamins and antioxidants that are better for one's health than processed foods purchased at stores. Consumption of subsistence foods can lower rates of diabetes and heart disease and may help to prevent some forms of cancer. Traditional foods in the arctic contain high levels of vitamin A, iron, zinc, copper, and essential fats; and the pursuit of subsistence resources provides exercise, time with family, and a spiritual as well as cultural connection with the land and its resources (Nobmann 1997).

Subsistence activities in the NSB today are inextricably intertwined with a cash economy. The price of conducting subsistence activities is tied to the price of the boats, snow machines, gas, and other modern necessities required to participate in the subsistence lifestyle of Alaska's North Slope. Many people balance wage employment with seasonal subsistence activities, presenting unique challenges to traditional and cultural values regarding land use and subsistence. Some studies have indicated a correlation between higher household incomes and commitment to, and returns from, the harvesting of natural resources (NRC 1999). Surveys conducted by the NSB reveal a majority of households continue to participate in subsistence activities and depend on subsistence resources (Shepro et al. 2003).

Quantification of subsistence resources harvested is difficult, and errors are inherent in the data. Some of the problems associated with the collection of subsistence data can be traced to individuals' willingness to share information and the difficulty of conducting subsistence surveys around peak harvest times, as well as cultural and language complexities (SRBA 1993a; Fuller and George 1997) . Another issue that comes up when documenting subsistence species harvested is the misidentification of species. Locals often use a colloquial term for a particular resource, which can vary between communities and can be at odds with the classifications of western science. By appearance, some fish species are so comparably similar that they are commonly mistaken for one another, including Dolly Varden, an anadromous species, and Arctic char, which is the closely related, lake-occurring species. Other species often misidentified include burbot, which are commonly referred to as ling cod; least cisco, sometimes called herring; and chum salmon, which can be mistaken for silver salmon. Some species of birds are also misidentified. White-fronted geese are confused with Canada geese, and various species of eiders, especially females, can be confused with each other (Fuller and George 1997).

3.3.4.1 Whales

Whales are harvested for their meat, oil, baleen, and bone. In whaling communities, a special significance is reserved for the bowhead whale. The Iñupiat people see themselves and are known by others as being whalers, and the bowhead whale is symbolic of this pursuit. Whaling is entwined with Iñupiaq culture, so much so that whaling is seen as an embodiment of Iñupiaq culture. Whaling has traditionally been a kinship-based activity; families are the foundation of whaling crews, and the distribution of meat and *maktak* is used to uphold ties between families and communities across

Alaska. It also serves to connect the Iñupiat people with their community, their land and its resources, as well as their past.

Traditionally, as with all subsistence resources, all parts of the whale were harvested. Before these northern communities had access to modern building materials, whale bones were used in the construction of houses. Beluga oil could be used in the preparation of caribou hides and, although not as commonly done as with caribou or seals, the back of the beluga could be used for sinew, and beluga skin could be used for boot soles (Rachael Sakeagak and Irene Itta in Panikpak Edwardsen 1980). Whalebone was used for a multitude of items such as bowls, spoons, ladles, handles, and tools (Murdoch 1892). Baleen and bone are particularly popular in modern times for producing Native art.

3.3.4.2 Walrus

Walrus are harvested for their meat, hides, and ivory tusks. Walrus hides are used for clothing, and ivory is used in the production of local art and crafts (AES 2009). As with seals, walrus intestines were used historically for window coverings or food containers (Hilda Webber in Panikpak Edwardsen 1980). Walrus have traditionally served as an important food source for dog teams but are predominantly used for human consumption today (SRBA 1993b).

3.3.4.3 Seals

Seals are harvested for their meat, oil, and hides (MMS 2007). Seals harvested by Chukchi communities include ringed, spotted, and ribbon seals, all species of hair seals, and bearded seal, or *ugruk* in Iñupiaq. There is a preference for the meat of the bearded seals over that of ringed seals, which are the most common species of seal in the Chukchi (AES 2009; BLM 2003). While ringed seals are principally harvested for their meat, bearded seals are harvested for both their meat and blubber, which is rendered into oil (SRBA 1993a). Bearded seals are also prized for their hides, which are used for covering *umiaqs*, the traditional skin-covered boats used to hunt bowhead whales.

Traditionally, seal skins and intestines were used to make warm, waterproof clothing, bags, boots, and mittens, as well as a multitude of other items. Intestine bags were used as containers for seal oil, food, and water. They were carried on one’s person, or sled bags were made specifically for use on dog sleds. Seals harvested at different times of the year were used for different things; fall seals, for example, were favored for boots because they did not have scratches on their skin. No part of the seal went to waste; laces were made from the seal skin, intestines were used for window coverings or rain gear, and when the skins were changed on the *umiaqs,* the old skin could be used for boot soles (Ida Numnik, Daisy Oomittuk, Bessie Ericklook, and Irene Itta in Uqaluktuat/Panikpak Edwardsen 1980).

3.3.4.4 Polar Bears

Polar bears are hunted for both their meat and pelts (AES 2009). At a conference in 1980, Iñupiaq elder Ida Numnik (cited in Panikpak Edwardsen 1980) recalled using the sharpened forearm bones of polar bears for scraping hides; now metal scrapers can be purchased from the store. Hunters often took polar bear hides to sit on while sitting on the ice waiting for seals (Dinah Frankson in Panikpak Edwardsen 1980). Local harvest of polar bears has declined since 1972, when the State of Alaska and the federal government passed legislation protecting polar bears. Alaska Natives are still permitted to hunt polar bears, but the sale of polar bear hides is prohibited (BLM 2003; Lentfer n.d.).

3.3.4.5 Birds and Waterfowl

Birds and waterfowl compose a relatively small percentage of the total annual subsistence harvest, but the harvest of birds, ducks, and geese is traditionally rooted and culturally significant. Perhaps just as important, birds are valued for their taste, and they have a special place in holiday feasts and important celebrations (MMS 2008). Bird feathers were used in decoration for clothing, especially parkas (Martha Awalin, personal communication, January 22, 2009). Additionally, bird eggs are an important subsistence food source (BLM 2003).

3.3.4.6 Fish

Fish are a substantial and significant supplemental subsistence resource for North Slope communities. More than 25 species are harvested, and the wide variety in species available for the affected communities allows for their harvest all year long (Fuller and George 1997; Jones 2006). The role that fishing has played in the subsistence economy has changed over time and can vary from year to year. Historically, some families would concentrate specifically on fishing, and other years they might not fish at all (SRBA 1993a). The subsistence trade network allows for this kind of resource procurement, and families can supplement their harvest with resources obtained from other families and communities. Marine, anadromous, and freshwater species are all harvested as subsistence species.

3.3.4.7 Terrestrial Mammals

In addition to being an important food resource, caribou have traditionally been prized for their hides, which were used to make clothing (Schrader 1901). Boots, socks, mittens, parkas, and pants were all made from caribou hides. Heavy caribou parkas with the hair on the outside and thick caribou boots with the hair turned in were worn during the cold winters (Irene Itta in Panikpak Edwardsen 1980, Rausch 1951). The hides of caribou taken during the winter were used to make bedding, and caribou antlers were used to scrape hair off the hides. Caribou stomachs could be used for bags, such as was done with sea mammal intestines (Alice Ahtuangaruak and Bessie Erickook in Panikpak Edwardsen 1980). Every part of the caribou was utilized. Caribou continue to be a substantial resource in the study area, providing the majority of meat harvested from terrestrial mammals each year (Fuller and George 1997).

Other terrestrial resources are also harvested, including bear, wolf, wolverine, rabbits, Dall sheep, moose, and squirrels (Fuller and George 1997). Small furbearing animals are used to make modern parkas, and the soft fur of the wolf or wolverine is used for the parka ruff (Irene Itta in Panikpak Edwardsen 1980).

3.3.4.8 Barrow

Spring bowhead whaling in Barrow takes place in the ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area. The spring hunt commences in April or May, with May typically being the most successful month, and lasts until late May or early June (BLM 2004). Fall bowhead whaling takes place between August and October. The fall hunt is generally conducted in an area that extends 16 km (10 mi) west of Barrow to 48 km (30 mi) north of Barrow, and southeast 48 km (30 mi) off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasionally, bowhead whale hunting may extend east as far as Smith Bay and Cape Halkett. Table 3.3.4.8-1 depicts the number of Bowhead whales harvested annually between 1993 and 2008 by the community of Barrow.

TABLE 3.3.4.8-1 Bowhead Landings at Barrow (1993–2008)

Year	Spring	Fall
1993	16	7
1994	15	1
1995	9	11
1996	5	19
1997	10	21
1998	9	16
1999	18	6
2000	5	13
2001	19	7
2002	3	17
2003	10	6
2004	7	14
2005	29	--
2006	22	--
2007	20	--
2008	21	--

Sources: J. J. Burns 1993, EDAW/Aecom 2007, BLM 2003

The spring beluga hunt takes place between April and June in the open leads between Point Barrow and Skull Cliff. Later in the spring, whalers in Barrow hunt belugas in open water around the barrier islands off Elson Lagoon, generally within 16 km (10 mi).

Barrow residents hunt walrus in early summer until early fall, generally between June and September. The area for hunting walrus ranges from west of Barrow southwestward to Peard Bay, generally within 56 km (35 mi) of shore. Polar bears are hunted during the fall and winter (October–June) in the same general vicinity that walrus are hunted, from west of Barrow southwestward to Peard Bay, within 56 km (35 mi) of shore.

Seal hunting occurs primarily in winter, with some open-water sealing along the Chukchi coastline and in the Beaufort Sea as far east as Dease Inlet and Admiralty Bay, generally within 48 km (30 mi) from shore. Table 3.3.4.8-2 depicts the marine mammals harvested by Barrow hunters in addition to Bowhead whales.

TABLE 3.3.4.8-2 Average Annual Take of Marine Mammals Other than Bowhead Whales Harvested by Barrow (1987-1999)

Walrus	46
Beluga Whales	2
Ringed Seals	394
Bearded Seals	175
Spotted Seals	4

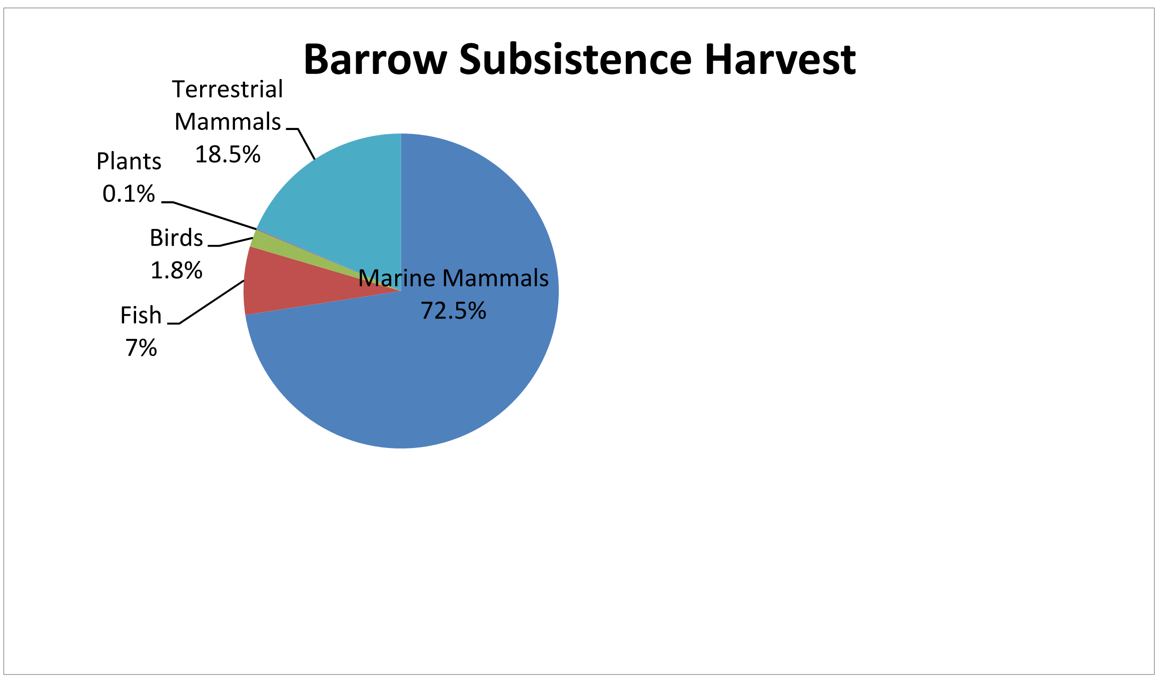
Sources: SRBA 1993; BLM 2003; BLM 2005

The birds and waterfowl most heavily harvested by Barrow residents are eider and white-fronted geese. Other species harvested during the 1996–1997 season were brant, northern pintail, ptarmigan, snow geese, tundra swans, and one (reported) American widgeon (Bacon et al. 2009). Additional species not harvested during the 1996–1997 season, but harvested on occasion, include spectacled eiders, mallards, long-tailed ducks, cranes, loons, and red-throated loons (NSB 2005; SRBA 1993a). Barrow residents usually hunt for migratory birds along the Chukchi Sea coast. Migratory bird hunting areas in the Chukchi Sea extend southwest along the coast to Skull Cliffs located 72 km (45 statute mi) from Barrow and southeast along the Beaufort Sea coast to Dease Inlet.

Barrow residents fish all five species of Pacific salmon: chum, silver, king, pink, and sockeye. The species of fish reportedly harvested in the highest numbers are whitefish (generic), least cisco, broad whitefish, Arctic cisco, and Arctic grayling. Additional species harvested include rainbow smelt, Arctic cod, Arctic flounder, saffron cod, sculpin, burbot, Arctic char, lake trout, pike, bullhead whitefish, Bering cisco, humpback whitefish, and round whitefish (AES 2009; Johnson and Daigneault 2008). These activities generally occur less than 8 km (5 mi) offshore and also inland.

The percentage of terrestrial mammals harvested in Barrow is inversely proportional to the marine mammal harvest for a given year, but can range between about 18 and 30 percent of the total edible harvest (Fuller and George 1997; SRBA 1993a). Of all terrestrial mammals, caribou are harvested in the greatest numbers and are utilized more than other subsistence resources in Barrow (SRBA 1993a). The largest percentage of caribou are taken by hunters in boats during July and August. Dall sheep and moose are also harvested by Barrow residents, but more often by non-Natives than Iñupiaq hunters. Furbearing animals are taken during the winter months (Fuller and George 1997).

Figure 3.3.4-1 Barrow Subsistence Harvest



Note: Data represented in terms of edible pounds harvested.
Source: Fuller and George 1997.

3.3.4.9 Wainwright

The spring bowhead whale hunt for Wainwright occurs between April and June in leads offshore from the village. Whaling camps can be located up to 16–24 km (10–15 mi) from shore, depending on where the leads open up. Whalers prefer to be closer, however, and will sometimes go overland north of Wainwright to find closer leads (SRBA 1993b). The spring beluga hunt is concurrent with the bowhead hunt, but belugas are typically taken only during the spring hunt if bowheads are not present in the area. Belugas are also hunted later in the summer, between July and August, along the coastal lagoon systems. Belugas are usually taken less than 16 km (10 mi) from shore. Table 3.3.4.9-1 depicts the number of Bowhead whales harvested annually between 1993 and 2004 by the community of Wainwright.

TABLE 3.3.4.9-1 Bowhead Landings at Wainwright (1993–2004)

Year	Wainwright
1993	5
1994	4
1995	5
1996	3
1997	3
1998	3
1999	5
2000	5
2001	6
2002	?
2003	?
2004	4

Sources: J. J. Burns 1993, EDAW/Aecom 2007, BLM 2003

Walrus are usually taken within about 45 mi (72 km) from shore. Between July and August, walrus are taken from the southern edge of the retreating ice pack (SRBA 1993b); from August through September they can be taken at local haulouts, especially between Milliktagvik and Point Franklin. Icy Cape is also a haulout for walrus and used by Wainwright residents for subsistence hunting. By October, the walrus are migrating west toward their winter habitat in the Bering Sea, but they are rarely taken at this time of year because they will sink when shot in the water. For this reason, hunters try to harvest walrus when they are resting on the ice (SRBA 1993b).

Seals are most often taken between May and September. Wainwright hunters will travel as far south as Kuchaurak Creek (south of Point Lay) and north to Peard Bay. Hunters typically stay within 72 km (45 mi) of the shore. Table 3.3.4.9-2 depicts the marine mammals harvested by Wainwright hunters in addition to Bowhead whales.

Seals are most often taken between May and September. Wainwright hunters will travel as far south as Kuchaurak Creek (south of Point Lay) and north to Peard Bay. Hunters typically stay within 72 km (45 mi) of the shore. Table 3.3.4.9-2 depicts the marine mammals harvested by Wainwright hunters in addition to Bowhead whales.

TABLE 3.3.4.9-2 Average Annual Take of Marine Mammals Other than Bowhead Whales Harvested by Wainwright (1987-1999)

Walrus	58
Beluga Whales	8
Ringed Seals	86
Bearded Seals	74
Spotted Seals	12

Sources: SRBA 1993; BLM 2003; BLM 2005

Polar bears are hunted in the fall and winter. The hunting area for polar bears extends from Point Belcher to Point Franklin, including the Seahorse Islands, the barrier islands separating Peard Bay from the Chukchi Sea. Polar bears are also taken around Icy Cape.

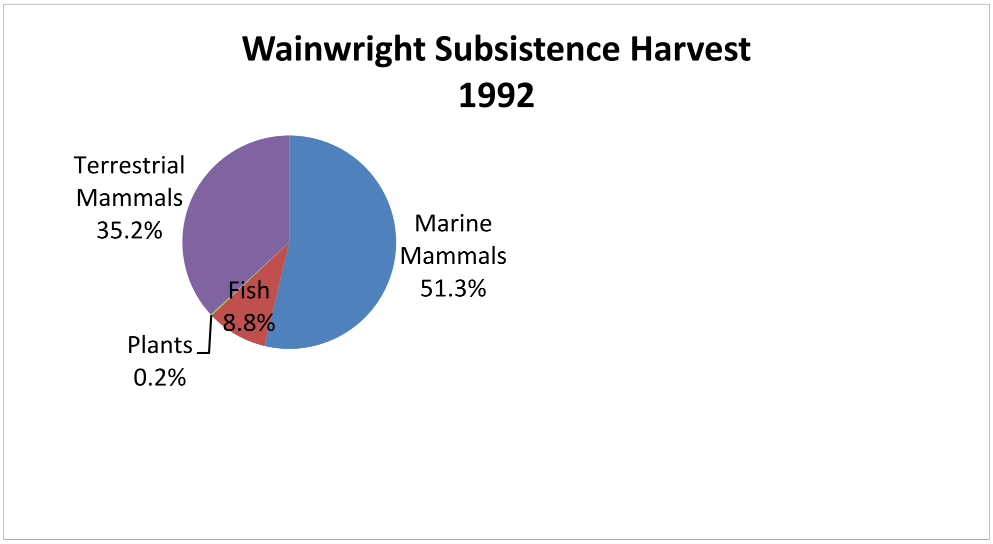
Birds and waterfowl, while composing a relatively small percentage of the overall subsistence harvest (2 percent between 1988 and 1989 and 4.5 percent in 1992 [Fuller and George 1997; SRBA 1993]), are considered to be a highly valued resource by Wainwright residents (Bacon et al. 2009). The most commonly harvested birds are white-fronted and brant geese and eiders (Fuller and George 1997; SRBA 1993b). Multiple species of eider are harvested, though the number of Spectacled eiders taken has decreased as a result of the federal no-hunt policy on the North Slope (Fuller and George 1997). Species of geese taken also include snow geese, emperor geese, and Canada geese. Additional bird species used as subsistence resources are ptarmigan, northern pintail, and long-tailed (also referred to as oldsquaw) ducks (Fuller and George 1997; SRBA 1993b).

The bird hunt typically peaks in the spring months of May and June but, depending on how successful hunters are with other resources, can carry on into September. Geese, especially brants, are also harvested during the fall migration. Ptarmigans are taken in small numbers throughout the winter. Migratory birds are hunted along the coast between Skull Cliff to the north of Wainwright and Kasegaluk Lagoon to the south. Birds are also taken inland along the Kuk River (SRBA 1993b).

The number of fish harvested fluctuates yearly, as do all other resources, contributing between 4 and 9 percent of the total edible pounds harvested for Wainwright (Fuller and George 1997, SRBA 1993b). Species that generally contribute the most in terms of edible pounds harvested include smelt, arctic grayling, burbot, broad whitefish, and least cisco. Many other species are harvested when available, including but not limited to king, chum, pink, and silver salmons, saffron cod (tomcod), flounder, char, lake trout, pike, Bering cisco, humpback whitefish, and round whitefish (Bacon et al. 2009; Fuller and George 1997; SRBA 1993). Fishing generally occurs along the shore between the Ongorakvik River and up the coast northwest of Wainwright for approximately 32 km (20 mi) (AES 2009).

Caribou are the most commonly represented species of terrestrial mammals harvested in Wainwright and are often the only type hunted. Occasionally hunters will take a moose or brown bear; and small, furbearing animals are taken in the winter months, when the fur is optimal and travel can be done by snow machine (Fuller and George 1997; SRBA 1993b).

Figure 3.3.4-2 Wainwright Subsistence Harvest 1992



Note: Data represented in terms of edible pounds harvested.
Source: Fuller and George 1997.

3.3.4.10 Point Lay

Residents of Point Lay have not hunted bowhead whales in the recent past, but were selected by the IWC to receive a bowhead whale quota in 2009, and began bowhead hunting again in 2009. In the more distant past, Point Lay hunters traveled to Barrow, Wainwright, or Point Hope to participate in the bowhead whale harvest activities.

Beluga whales are harvested in June and July. They are taken in the highest numbers in Naokak and Kukpowruk Passes south of Point Lay, but hunters will travel north to Utukok Pass and south to Cape Beaufort in search of belugas. The whales are usually herded by hunters with their boats into the shallow waters of Kasegaluk Lagoon (MMS 2007).

Walrus are hunted in the late spring and summer, usually between June and August, depending on the condition of the ice. They are most heavily harvested in Kasegaluk Lagoon, south of Icy Cape. Hunters will travel up to 32 km (20 mi) offshore in search of walrus (AES 2009).

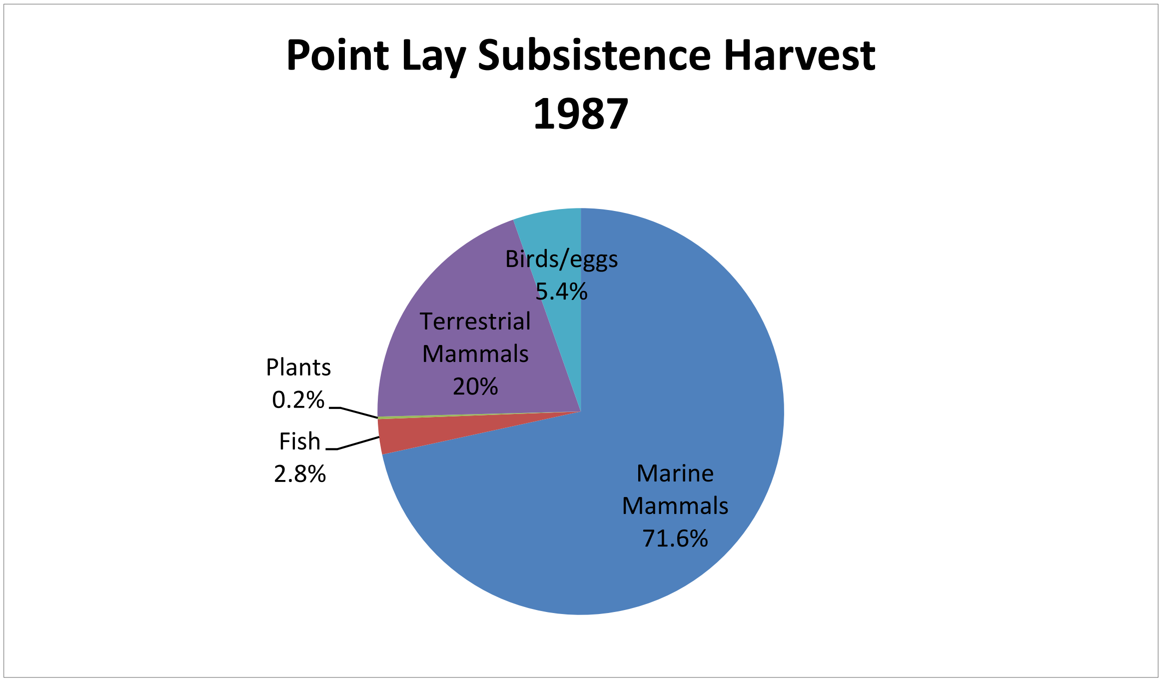
Ringed and bearded seals are harvested all year. Ringed seals are hunted 32 km (20 mi) north of Point Lay, as far as 40 km (25 mi) offshore. Hunters travel up to 48 m (30 mi) north of the community for bearded seals, which are concentrated in the Solivik Island area. Bearded seals are also taken south of the community in Kasegaluk Lagoon, and as far as 40 km (25 mi) from shore.

A majority of Point Lay residents, more than 60 percent, report harvesting birds and waterfowl. Migratory birds are hunted north along the coast to Icy Cape and as far south as Ledyard Bay. Subsistence species reported include long-tailed and northern pintail ducks, brant, Canada geese, murres, and ptarmigan. Birds are harvested as far as 32 km (20 mi) from shore, as well as inland. Bird eggs are also harvested.

Species of fish harvested in Point Lay include chum salmon, king salmon, smelt, tomcod, trout, grayling, humpback whitefish, and saffron cod, primarily to supplement their diet (Johnson and Daigneault 2008). Fishing activities generally occur along the shore and inland.

Caribou is a significant part of the Point Lay subsistence diet, and most households report hunting for caribou often. The rate of participation in the caribou hunt may be higher in Point Lay than in any other North Slope village (Fuller and George 1997).

Figure 3.3.4-3 Point Lay Subsistence Harvest 1987



Note: Data represented in terms of edible pounds harvested.
Source: ADF&G 2009

3.3.4.11 Point Hope

In Point Hope, the bowhead whale hunt occurs between March and June, when the pack-ice lead is usually 10–11 km (6–7 mi) offshore. Camps are set up along the landfast ice edge to the south and southeast of the village. Point Hope whalers took between one and seven bowhead whales per year between 1978 and 2008, with the exception of 1980, 1989, 2002, and 2006, when no whales were taken (Suydam and George 2004; Suydam et al. 2008, 2007, 2006, 2005). There is no fall bowhead hunt in Point Hope, as the whales migrate back down on the west side of the Bering Strait, out of range of the Point Hope whalers (Fuller and George 1997).

Belugas are also hunted in the spring, coincident with the spring bowhead hunt. A second hunt takes place later in the summer, in July and August, and can extend into September, depending on conditions and the IWC quota. The summer hunt is conducted in open water along the coastline on either side of Point Hope, as far north as Cape Dyer (MMS 2007). Belugas are smaller than bowhead whales, averaging approximately 1,400 lbs in useable weight compared to nearly 30,000 lbs for bowheads[4], but beluga whales often make up a significant portion of the total harvest for Point Hope (Fuller and George 1997; SRBA 1993). Ninety-eight belugas harvested in 1992 made up 40.3 percent of the total edible harvest for that year. Three bowhead whales represented 6.9 percent of the total edible harvest for the same year (Fuller and George 1997).

[4] This estimate is taken from SRBA & Associates, 1993, and based on the mean total useable weight per whale of 28 bowhead whales harvested in Barrow over a 3-year period (1987–1989).

Walrus are most heavily harvested in the spring, between April and July, along the southern shore between Point Hope and Akoviknak Lagoon, but hunters will travel as far south as Ogotoruk Creek, 16 km (10 mi) southeast of Akoviknak Lagoon (AES 2009; Fuller and George 1997; MMS 2007). Walrus are also taken throughout the summer from boats, usually north of Point Hope; hunters will travel as far north as Ayugatak Lagoon, located approximately 16 km (10 mi) east of Cape Lisburne (AES 2009; MMS 2007). Walrus are generally taken within 32 km (20 mi) of the shore south of Point Hope and within 16 km (10 mi) of shore north of Point Hope (AES 2009).

Seals are harvested throughout most of the year, although they tend to be taken in the greatest numbers in the winter and spring months. The exception is the bearded seal hunt, which peaks later in the spring and into the summer (Fuller and George 1997; MMS 2007). Species of seals harvested by Point Hope hunters include ringed, spotted, and bearded. Seals are hunted on the ice (Fuller and George 1997). Hunters tend to stay close to the shore but will travel up to 24 km (15 mi) offshore south of the point, weather dependent. Seals are hunted to the north of the community as well, but less often, as the ice is less stable and can be dangerous. As with walrus, seals are taken between Akoviknak Lagoon to the south and Ayugatak Lagoon to the north (MMS 2007).

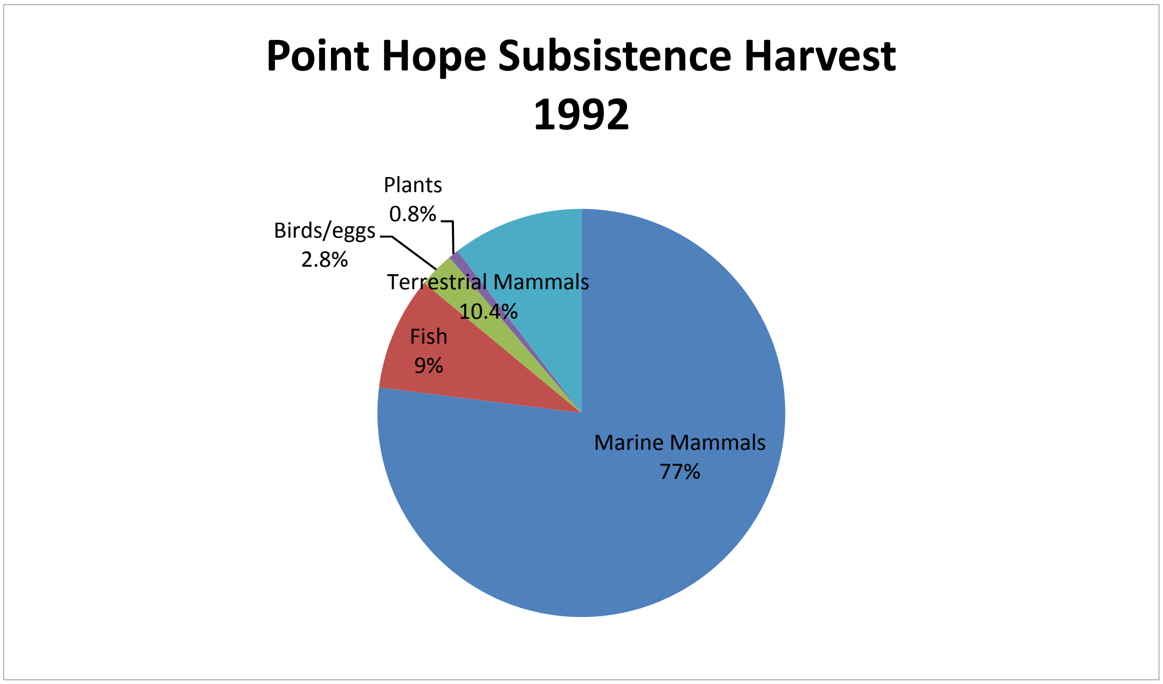
Polar bears are a variable resource that are often taken during seal hunts. The available data provide differing harvest estimates (i.e., Fuller and George 1997; MMS 2007) but suggest that as many as 30 or more can be taken in a given year. As they are usually taken during the seal hunt, the geographic range for hunting polar bears is represented by that for seals. Polar bears are usually hunted in the winter and early spring, between January and April, but are sometimes taken as early as October. They are taken are far as 16 km (10 mi) from shore (MMS 2007).

Fish are harvested by Point Hope residents year-round, in the open water throughout the summer and through the ice in colder months (NSB 2005). Pink and chum salmon are found in large numbers in rivers south of the community and are present as well, though in fewer numbers, in rivers north of Point Hope (Craig and Halderson 1986). A wide variety of fish species are harvested, including char, several species of salmon, whitefish, lake trout, flounder, and sculpin (Fuller and George 1997).

Birds harvested include ptarmigan, geese, swans, eider, and cranes. In addition to birds and waterfowl, eggs are also collected in considerable numbers, nearly 6,000 in 1992 (Fuller and George 1997).

As with other North Slope villages, caribou is considered to be the most significant terrestrial resource harvested by Point Hope residents, in terms of its contribution to the total subsistence harvest and as a material source. The other large land mammal harvested by Point Hope hunters is moose, which are probably taken from areas to the southeast of the community. Wolverine, red and Arctic fox, and ground squirrel are harvested for their fur (Fuller and George 1997).

Figure 3.3.4-4 Point Hope Subsistence Harvest 1992



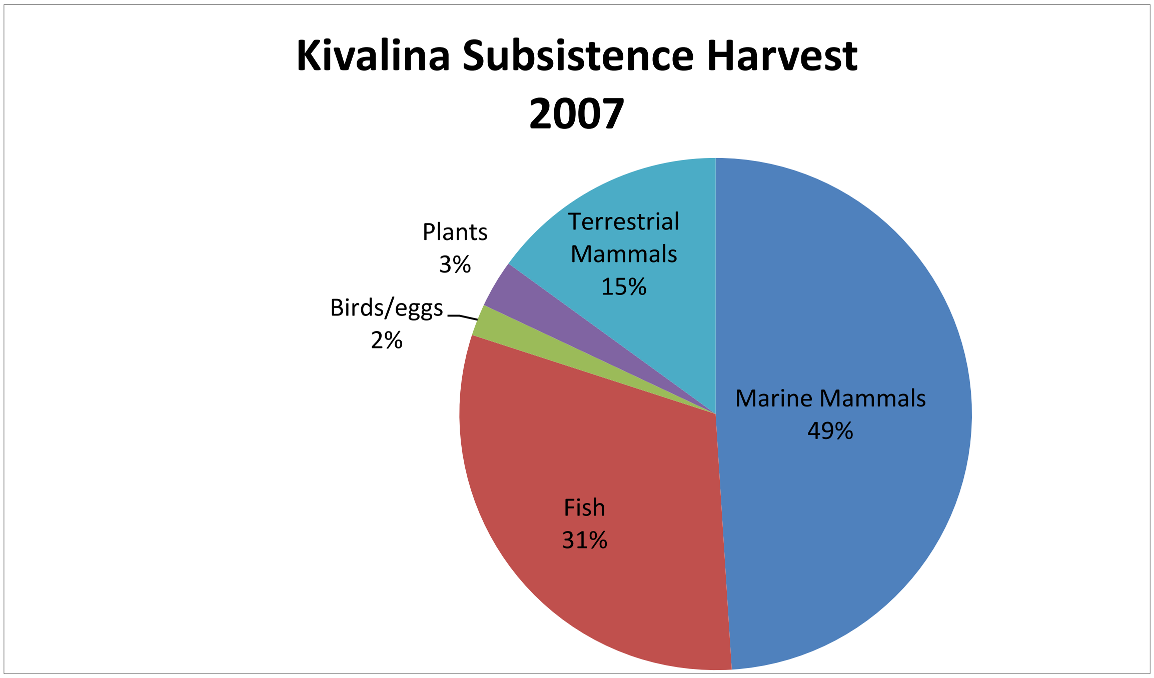
Note: Data represented in terms of edible pounds harvested.
Source: Fuller and George 1997

3.3.4.12 Kivalina

Subsistence is an extremely important part of the local economy in Kivalina, with nearly 100 percent of residents participating in the subsistence harvest. In 2007, marine mammals made up approximately 50 percent of the total subsistence harvest. Land mammals composed approximately 15 percent, while fish represented 30 percent of the subsistence harvest. Birds, waterfowl, eggs, marine invertebrates, plants, and berries made up the remainder of the subsistence harvest (ADF&G 2009).

Large terrestrial mammals harvested in Kivalina include caribou, moose, brown bear, wolves, wolverine, and Dall sheep. Kivalina residents harvest grey, bowhead, and beluga whales; four species of seals; polar bear; and walrus (Burch 1985). Kivalina's position on a lagoon between the Chukchi Sea and two large rivers makes it a prime fishery. Residents fish for trout and grayling year-round, while other species are fished seasonally (Jones 2006). Terrestrial mammals harvested by Kivalina residents include caribou, which is the only land mammal regularly hunted; moose, which tend to be taken incidentally during caribou hunts; and occasionally sheep. Furbearing animals harvested include red and white fox, wolverine, wolf, lynx, muskrat, and ground squirrel (Burch 1985).

Figure 3.3.4-5 Kivalina Subsistence Harvest 2007

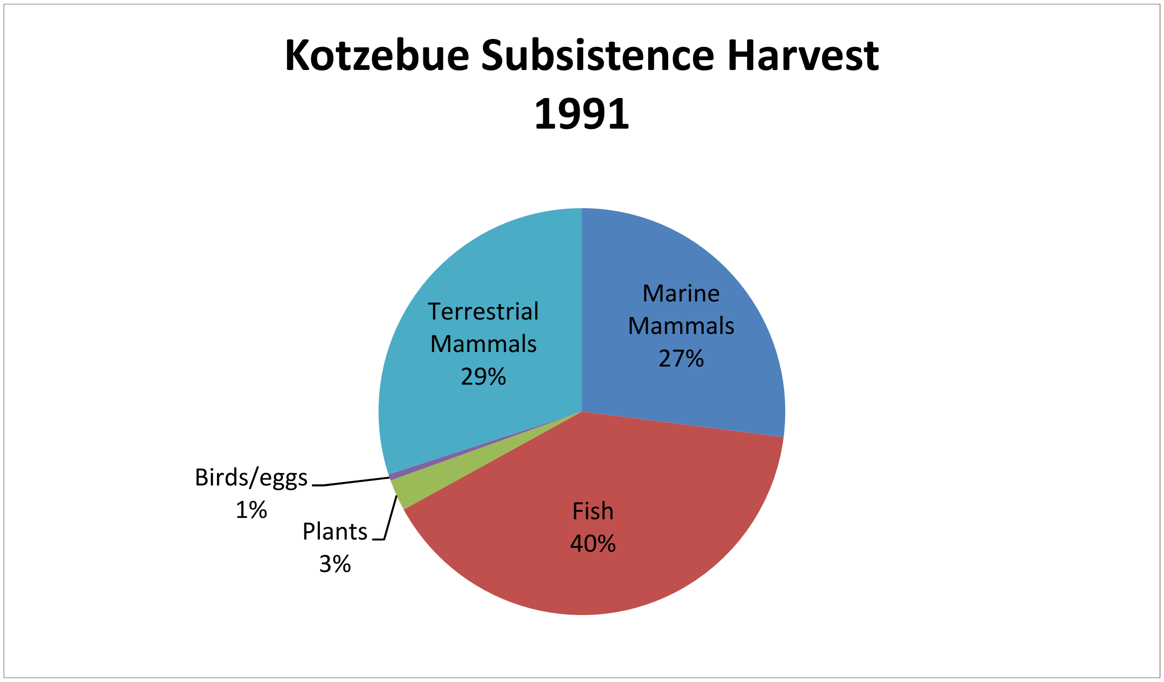


Note: Data represented in terms of edible pounds harvested.
Source: ADF&G 2009

3.3.4.13 Kotzebue

Despite being the largest community within the NWAB, Kotzebue residents continue to harvest a considerable percentage of their food resources by means of subsistence. In 1991, nearly 100 percent of households in Kotzebue reported using subsistence resources; of those households surveyed, 95 percent harvested wild resources. Resource exchange continues to play an important role in the subsistence economy, with more than 90 percent of the community either giving or receiving subsistence resources (Magdanz et al.1995a). Fish is considered to be one of the most important subsistence resources in the Kotzebue area, reflected in the significant numbers harvested. Caribou, moose, and musk-oxen are the large terrestrial resources harvested by Kotzebue residents. Small mammals such as ground squirrel, Arctic hare, and snowshoe hare are all harvested for both their meat and their fur; other furbearers, such as red and Arctic fox, wolverine, and wolf are harvested for their fur (BLM 2006).

Figure 3.3.4-6 Kotzebue Subsistence Harvest 1991



Note: Data represented in terms of edible pounds harvested.
Source: Magdanz et al. 1995

3.3.5 Sociocultural Values

Our Iñupiaq identity is as permanent as the land and the waters that sustain us. The land and the oceans and rivers are like us— they are permanent, but they also exist in a state of change. Our life as Iñupiat people is changing in many ways but the foundation of our life—our roots—establish our place and give us a firm grip on the earth. Our roots are expressed in our cultural heritage which is our land, our language, our traditional values, our family and our community ties, our subsistence practices and our stories and dances that have been passed on since time immemorial. These are the things that give us our identity and define us as Iñupiat. Our heritage has the answer for our hearts and we need to participate in cultural activities, speak our language, live our Iñupiat values and share the moments everyday that make our hearts stronger (Itta 2006).

Sociocultural values are those aspects, either physical or abstract, in which a group or groups—e.g., community, ethnic group, or culture—finds importance. These values are found in special or rare and everyday activities, objects, and meanings. As the term suggests, *sociocultural* entails those aspects that are both social and cultural. While often distinguished from the socioeconomic, the sociocultural can encompass it.

Many sociocultural values of the NWAB and NSB residents are discussed in other sections of this EED. Traditional Knowledge and subsistence, for example, embody and convey prominent sociocultural values. Both of these aspects are viewed as necessary to maintain and promulgate the local way of life, culture, and identity. Additionally, the communities discussed above are maritime communities, and therefore the marine environment and its resources are of value.

3.3.5.1 Iñupiaq Values

Iñupiat of the NWAB and NSB have specific values that they aspire to and have endorsed for generations. Because the majority of the population within this focus area are Iñupiat, Iñupiat values are prominent. Iñupiat values are basic human values, distinct to Iñupiat, "what makes us different from other people" (Joule 1996). These values are core to the Iñupiaq identity and culture.

Below are Iñupiaq values:

- Respect for elders—Elders are leaders, experienced, and are keepers and transmitters of knowledge
- Avoid conflict—Thinking, acting, speaking, and living in a positive manner is important
- Cooperation—Consensus building is valued. Anything can be accomplished together
- Domestic skills
- Family and family roles—The immediate and extended family and how people are related are important. Iñupiat have responsibility to their families. Family roles also provide a mechanism for teaching children
- Hard work
- Humility—Act on goodness and expect no reward in return
- Humor—Humor helps release stress of hard times
- Hunter success—Hunting provides food for the family and the village
- Knowledge of family tree
- Knowledge of language—Iñupiat identity is linked to Iñupiat language
- Love for children
- Respect for nature—Iñupiat culture depends on the natural resources and subsistence; therefore, Iñupiat strive to respect, preserve, and protect nature, which is needed to support future generations
- Respect for others/compassion—Iñupiat ancestors learned to survive a harsh environment through compassion, caring, kindness
- Responsibility to tribe
- Sharing—Acts of giving come back around
- Spirituality—The Iñupiat culture is a spiritual culture that is closely tied to the natural world

(ASRC n.d.; Nasirvik Elevated View 2009; NSB 2005; Tikigaq n.d.; The Village News Network 1996; and Wohlforth 2005).

Examination of these values allows an outsider to Iñupiaq culture to gain an understanding of the culture as well as learn what is important to the Iñupiat.

The significance of these values is evidenced by the frequency with which organizations reference and discuss them. They are incorporated into the mission statements of Ilisaġvik College (Ilisaġvik

College 2006 [copyright]), Ukpeabvik Iñupiat Corporation (Ukpeabvik Inupiat Corporation 2006 [copyright]), Tikigaq Corporation (Tikigaq n.d.), Maniilaq Corporation (Maniilaq Association 2003 [copyright]), and ASRC (ASRC n.d.), among others.

Traditionally, children learn these values primarily from their parents, but also from other community members. Reggie Joule expressed concern that recently children are not taught these values. In Joule's words, "we have become dependent on others too much. TV is teaching a lot of values these days" (Joule 1996). Recent efforts to incorporate these values into education and community have emerged. For example, the NSB School District displays posters throughout borough schools with the values (NSB 2005). The Village News Network brought together adults and children in an effort to reinforce heritage and create a special publication of values. This has been chronicled online with the Alaska Native Knowledge Network (The Village News Network 1996).

3.3.5.2 Subsistence

The importance of subsistence to the residents of the NSB and the NWAB cannot be overstressed. Therefore, while it is discussed in Section 3.3.4, it is mentioned again in order to reinforce its importance and to stress its linkage with sociocultural values.

Iñupiaq culture centers on and depends on the subsistence lifestyle (NSB 1980, 2005). Subsistence harvest not only provides nutritional sustenance, but also spiritual and cultural sustenance. It "links generations of Iñupiat in one long seasonal cycle" (Brower 2004).

Subsistence has connections to food production and distribution, settlement patterns, demography, land tenure systems, Traditional Knowledge, children's education, kinship, social roles, monetary employment, and values (Wolfe 2009). Subsistence is entrenched in the economic, political, cultural, and ideological realms (Wheeler and Thornton 2004).

The following excerpt from *Whaling: A Way of Life* demonstrates the importance of subsistence:

For the Tikibabmiut, the people of Point Hope, and other coastal Eskimos, their whole social structure was, and still is to a great extent, dependent on the capture of the bowhead whales and its associated activities . . . From preparation of their hunting gear, to the hunt, to the distribution of the whale shares, and to the various celebrations held throughout the year, the whaling captain and his crew play very important roles . . . [which] . . . have been prescribed by ancient customs and traditions to emphasize a spirit of sharing and caring for each other's welfare (Pulu et al. 1980).

This excerpt references some of the Iñupiaq values mentioned earlier: sharing, hunter success, and responsibility to tribe. While not referenced explicitly, one may infer that the excerpt speaks to cooperation, family roles, hard work, and spirituality.

Not only is the protection of subsistence activities important to Iñupiat, but also the subsistence areas and resources. Specific resources are discussed in Section 3.3.4. While villages may rely on some resources more than others, the Iñupiat will not likely say one resource is any more important than another. Rather, all resources that they use are valued, and these resources and the environments in which they exist should be respected and protected.

Like other Alaska Natives, the Iñupiat hold the protection of subsistence as a key political issue (Berger 1985; NSB 2005; Wolfe 2009; Wheeler and Thornton 2004). Subsequently, potential threats or effects on subsistence would be considered serious.

The Bowhead Whale

While Iñupiat consider all subsistence resources valuable, the bowhead whale deserves special attention. The bowhead whale has assisted the survival of the Iñupiat, both in sustenance and in culture, for at least a thousand years (Pulu et al. 1980). It has been used as food (half-cooked meat, *mikigaq,* whale burger, boiled *maktak* and meat, pickled *maktak, mamaaq,* and blubber). Ribs were used as steps out of subterranean homes and as fences. Ribs were also used, and may still be used, for arrow and spear points, net sinkers, ulu handles, and the back ends of seal spears. Shoulder blades were used to deflect wind and assist ventilation in semi-subterranean houses. In the past, lower jaw bones were used primarily for sled runners; now they may be used in construction for boat rack posts. Baleen once had many uses; now it is used for scrimshaw, baskets, sculptures, and other art (Pulu et al. 1980).

The bowhead whale helps maintain Iñupiaq identity, core values, yearly festivals, and calendar, in addition to provided food and materials. Iñupiat are identified as whalers, and their culture is a whaling culture. The bowhead whale receives more attention than other whales. In addition to utilizing the bowhead for food and other products, the Iñupiat place the bowhead at the center of celebrations such as *Nalukataq* (blanket toss) and messenger feast. Bowhead whale hunting reinforces core Iñupiaq values: cooperation, hard work, family, hunter success, sharing, and spirituality. For discussions and examples of the bowhead whales' significance and long history in Iñupiaq culture, see Brower 2004; Pulu et al. 1980; Sheehan 1997; and Wohlforth 2005. This is by no means an exhaustive list.

3.3.5.3 The Land, Sea—The Environment

Intrinsic to the Iñupiaq sense of place, culture, identity, and livelihood are the land and the sea—the environment in which they have lived for generations. This environment instills the sense of home and belonging; it encompasses the Iñupiat. They both depend on it and seek to protect it. The land and the sea inspire Iñupiaq culture (NSB 2005).

The Iñupiat are a resilient people who have, through several generations, adapted to what many others from other parts of the world consider a harsh and brutal environment. They have developed techniques, customs, ideals—a way of life—dependant on the specific arctic environment in which they live. Residents have expressed concern that development activities affect the environment and its resources, and they seek measures to protect them (for example, MMS 2007; NSB 2005).

The Iñupiat of Barrow, Point Lay, Point Hope, Wainwright, Kivalina, and Kotzebue live where the sea and the land meet. Both marine and terrestrial characteristics of this environment play an important role and are valued by the residents. The land is more than a place to live, and the sea is more than something to exploit. For example, Northwest Iñupiat elders view the Kotzebue Sound as a food-storage area (Craig n.d.).

3.3.5.4 Traditional Knowledge

The need for and the process of transferring information about life—values, traditions, history, family, roles, technologies, lessons, etc.—from one generation to another is very important to the Iñupiat. Iñupiat Traditional Knowledge is more than just the local knowledge of the North Slope and Northwest Arctic areas; it is also the act of transferring knowledge. According to Jana Harcharek, Iñupiaq educator and Coordinator of the NSB school district's bilingual and multicultural department, Traditional Knowledge "endures through the continuing practice of customs associated with a subsistence lifestyle" (Harcharek 1995).

Not only is it important that Traditional Knowledge continue with the Iñupiaq communities, but Iñupiaq residents strive to have Traditional Knowledge recognized and appreciated by those outside their culture. NSB mayor George Ahmaogak stressed the importance of applying Traditional

Knowledge in industry and government activities (Ahmaogak 1995) in (NSB 2005). Additionally, residents have requested mandatory incorporation of Traditional Knowledge in study, research, and monitoring plans (NSB 2005).

3.3.6 Historical and Archaeological Resources

Historical and archaeological resources are cultural resources that are 50 years of age or older. Cultural resources are physical resources associated with people, a society, or multiple societies. They consist of both built and natural parts of the physical environment and have some cultural value to one or more sociocultural groups (King 1998). This section addresses cultural resources that are at least 50 years old, which are present or potentially present in the planned project area, in relation to Statoil's 2010 3D seismic acquisition project.

3.3.6.1 Cultural Resource Types

Historic[5] preservation laws cover a variety of cultural resources (see Section 2.0 for a discussion of the historic preservation regulatory framework). These resources include historic buildings and structures, archaeological sites, and traditional cultural properties (TCPs).

Archaeological resources exhibit evidence of past human activity. They may be sites (locations) or artifacts of past human activity. Archaeological sites are generally thought of as being below the ground surface. However, archaeological sites sometimes exist at or above the ground surface. For example, historical archaeological sites may include historic buildings, remnants of historic buildings, or other structures that sit above the ground surface. Additionally, archaeological and historical sites may occur offshore. Examples include shipwrecks and submerged habitation sites on relict, now submerged, landforms.

A TCP is a property that is "is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that are: (a) rooted in that community's history, and (b) important in maintaining the continuing cultural identity of the community" (Parker and King 1998). Often these properties are ethnographic landscapes. Similarities exist between TCPs and other historic properties, and other kinds of historic properties may be part of a TCP. A key element of a TCP is its continuing importance and role to a living community. A TCP may be a location or area in which people have traditionally conducted and continue to conduct economic, artistic, or other cultural activities that are important in maintaining their traditional identity (Parker and King 1998). Subsistence activity areas, such as those listed in the Traditional Land Use Inventory, are potential TCPs.

3.3.6.2 Cultural Resources

Discussion of cultural resources specific to Statoil's 2010 seismic acquisition project area is not possible. Instead, discussion must address the broader Chukchi Lease Sale 193 area and the Chukchi Sea. An extensive survey for submerged cultural resources in the Chukchi Sea has not been conducted, although small, isolated, areas have been examined. The MMS maintains a database of Chukchi Sea geohazard studies used to interpret potential cultural resources on or just under the sea floor. This data set lacks site-specific surveys for Statoil's lease area (MMS 2009a, 2007a).

Figure 3.3.6-1 depicts the areas within the Lease Sale 193 area having archaeological (historical and prehistoric) resource potential. Offshore historical cultural resources potentially in the project area

[5] Historical resources are those associated with history; are at least 50 years of age; and younger than prehistoric resources. Prehistoric resources are associated with prehistory, a term used in the Americas generally to distinguish between pre- and post-European contact. Federal (and many state) regulations make a distinction between these resources and historic properties. Historic properties are those historical and prehistoric resources that are eligible for listing in the National Register of Historic Places (16 U.S.C. 470[w]5 1966). Hence historic properties are a special subset. To limit the confusion, the historic preservation discipline tends to use the terms historic properties and cultural resources.

include shipwrecks, submerged aircraft, and abandoned items. Potential submerged prehistoric cultural resources include archaeological sites on landforms once above sea level, such as relict river terraces, beach ridges, pingos, and shorelines.

Statoil's lease blocks do not fall within Chukchi Sea Lease Sale 193 lease blocks that the MMS designates as having higher potential for submerged cultural resources and its Final Lease Stipulations require archaeological reports (MMS 2008). However, the potential for cultural resources still exists in Statoil's lease blocks. Furthermore, in these stipulations the MMS reserves the privilege to require archaeological reports for additional lease (MMS 2008). Presumably, the requirement for an archaeological report will depend on the results of shallow hazard surveys conducted for lease blocks.

Submerged Prehistoric Archaeological Resources

The MMS maintains that submerged prehistoric archaeological remains may be present in areas of the Chukchi Sea that are shallower than the 60-m (200-ft) isobath. Thus it considers that areas above this isobath have potential for prehistoric cultural resources (MMS 2007b). The Bering Land Bridge existed after 80,000 years B.P.[6], and portions of the Chukchi Sea may have remained above sea level until 11,000–12,000 years B.P. (Elias et al. 1992; Elias et al. 1996; Keigwin et al. 2006; Rogers 2009).

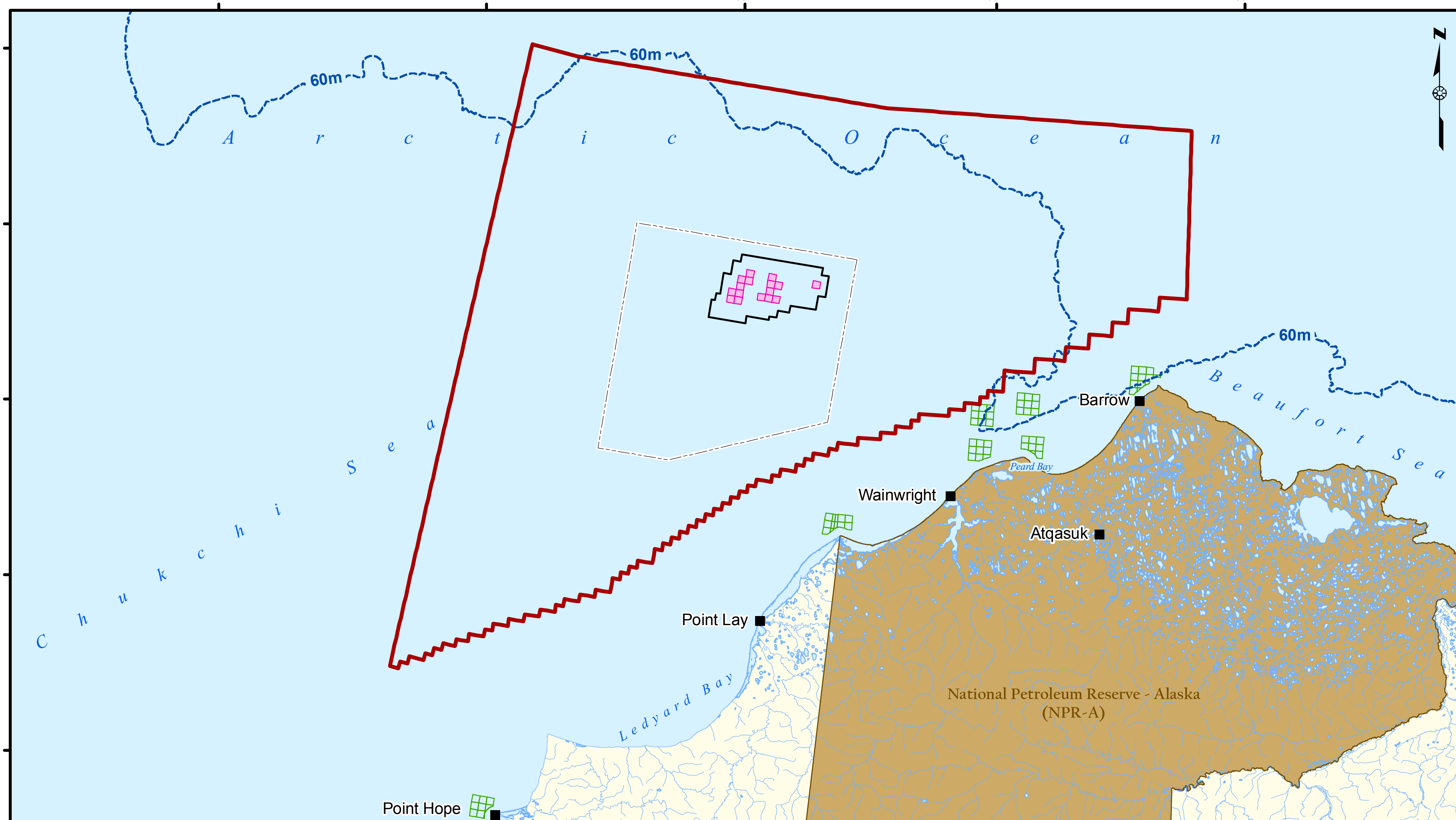
According to current archaeological theories, human populations may have migrated across the Bering Land Bridge from Asia to North America as early as 13,000 years B.P. (Bigelow and Powers 2001; Holmes 2001; MMS 2007b). While no one has yet written a comprehensive history of the Chukchi sea level, MMS' conservative estimate of Chukchi sea level at 13,000 years B.P. is the 60-m (200-ft) isobath (MMS 2007b).

Archaeologists determine archaeological site potential by understanding bathymetry, seafloor geology, past sea levels, and ethnographic and terrestrial archaeology models and knowledge. Using these and other techniques, archaeologists estimate former coastlines and relict terrestrial land forms suitable to past human activities. Relict landforms suitable for human activity, and thus having a high probability of prehistoric archaeological sites, include preserved paleo-river levees associated with paleo-river channels, river confluences, ponds, lakes, lagoons, or paleo-shorelines.

Prehistoric sites are not expected in some areas where the continental shelf is less than 60 m (197 ft) below current sea level because of certain environmental conditions. These are areas where: "(1) there are no Quaternary sediments, and (2) where extensive ice gouging has reworked the Quaternary section, but these are not well defined and will have to be determined on a case-by-case basis" (MMS 2007b).

Nonetheless, the potential for cultural resources cannot be ruled out in areas of dynamic ocean and environmental processes. No one has comprehensively studied the potential effects of ice gouging on submerged archaeological sites and site formation processes (Rogers 2009). The MMS determined that shipwrecks have likely survived in areas at depths beyond intensive ice gouging (MMS 2007b). Furthermore, archaeological investigations near Wainwright noted a significant number of 19th century shipwrecks in the beach and intertidal zones, thought to have been gouged and washed to shore (Beebe and Jensen 2006; Mishkar 2008).

[6] Present is equivalent to A.D. 1950. These date estimates are based on radiocarbon dating techniques in which 1950 is a "start" date.



Statoil Leases

3D Seismic Survey

Permit Area

Areas With Potential Historic And Archaeological Sites

Lease Sale 193 Area

60 Meter Contour
Areas shallower than 60 m have some potential for historic and archaeological resources.

National Petroleum Reserve - Alaska

Village

NAD83, Alaska Albers Equal Area

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

Statoil

ARCHAEOLOGICAL POTENTIAL IN THE NORTHEAST CHUKCHI SEA
Statoil
Environmental Evaluation Document

SCALE: 0 20 40 80 Miles

FIGURE: 3.3.6-1

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Submerged Historical Archaeological Resources

The vast majority of historical resources located in the Chukchi Sea, and potentially located in the project area, are shipwrecks. The treatment, management, and ownership of these shipwrecks vary, depending on whether the shipwreck was abandoned and where it is located. The Abandoned Shipwreck Act (Public Law 100-298; 43 U.S.C. 2101-2106) asserts title to abandoned shipwrecks:

- Embedded in a U.S. state's submerged lands
- Embedded in coralline formations protected by a state on its submerged lands
- Located on a state's submerged lands and included or determined eligible for inclusion in the National Register of Historic Places

That said, the U.S. government transferred management of many shipwrecks to respective states, while maintaining title of the wrecks. Indian tribes hold title to shipwrecks located in or on Indian lands (NPS 2002). Abandoned shipwrecks are included under many other laws governing cultural resources and historic properties, such as the NHPA.

The potential presence of shipwrecks is greater than that of prehistoric sites. In the shipwreck update analysis for proposed Sale 109 (MMS 1987), the MMS stated that shipwrecks might be present in the area northeast and west of Peard Bay and Point Franklin because the waters there are deeper and ice gouging is sparse. The MMS further stated that shipwrecks in shallower areas are more likely to have survived ice gouging than prehistoric sites because they have been present and experiencing ice gouging for a comparatively short period of time.

In the 2007 EIS for Lease Sale 193 (MMS 2007b), the MMS reevaluated the potential to encounter offshore resources. MMS determined that historic resources, such as shipwrecks, were more likely to be found intact in the OCS where they would be more protected from ice gouging and wave action than those closer to shore. MMS also noted, however, that:

Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS' Geological and Geophysical (G&G) Permit Stipulation 6 (regarding the discovery of archaeological resources) and CFR 251.6(a)(5) regarding G&G Explorations of the Outer Continental Shelf to not 'disturb archaeological resources,' most effects on archaeological resources in shallow offshore waters of the Chukchi Sea Proposed Action area would be avoided (MMS 2007b).

The MMS Shipwreck Database (MMS 2009b) is the most comprehensive dataset of shipwrecks in Alaska waters and contains 80 shipwrecks in the Chukchi Sea Lease Sale 193 area. Table 3.3.6-1 lists these shipwrecks.

TABLE 3.3.6-1 Shipwrecks in the Chukchi Sea Lease Sale 193 Area

Vessel Name	Type	Date Wrecked	Location
Caulaincourt	French whaling ship	9/5/1861	At Point Belcher
Henry Kneeland	Whaling ship	6/22/1864	In the Chukchi Sea
Gratitude	Whaling bark	7/2/1865	40 mi from Cape Lisburne
Ontario	Whaling bark	9/27/1866	In the Chukchi Sea
Hae Hawaii	Whaling bark	9/22/1868	In the Seahorse Islands, off Point Franklin

TABLE 3.3.6-1 Shipwrecks in the Chukchi Sea Lease Sale 193 Area

Vessel Name	Type	Date Wrecked	Location
Eagle	Whaling bark	9/30/1869	On Seahorse Shoal, off Point Franklin
Almira	Whaling ship	8/26/1870	Near Point Barrow
Hibernia	Whaling ship	8/28/1870	About 2 mi SW of Point Barrow
Comet	Whaling brig	9/2/1871	Between Point Franklin and Seahorse Islands
Roman	Whaling bark	9/7/1871	In the Seahorse Islands, off Point Franklin
Awashonks	Whaling bark	9/8/1871	S of Wainwright Inlet
Julian	Whaling ship	9/8/1871	S of Wainwright Inlet
Kohola	Whaling brig	9/9/1871	2 mi NE of Wainwright Inlet
Carlotta	Whaling bark	9/12/1871	Point Belcher, near Wainwright Inlet
Fanny	Whaling bark	9/13/1871	6 mi S of Point Belcher, ¼ mi from shore
Monticello	Whaling bark	9/13/1871	4 mi S of Point Belcher
Champion	Whaling ship	9/14/1871	Point Belcher, near Wainwright Inlet
Concordia	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Contest	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Elizabeth Swift	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Emily Morgan	Whaling bark	9/14/1871	1 mi N of Point Belcher
Eugenia	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Florida	Whaling ship	9/14/1871	In the Seahorse Islands, off Point Franklin
Gay Head	Whaling ship	9/14/1871	Point Belcher, near Wainwright Inlet
George	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
George Howland	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Henry Taber	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
James D. Thompson	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
John Wells	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Mary	Whaling ship	9/14/1871	S of Wainwright Inlet
Massachusetts	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Navy	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Oliver Crocker	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Paiea	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Reindeer	Whaling ship	9/14/1871	Point Belcher, near Wainwright Inlet
Seneca	Whaling bark	9/14/1871	Point Belcher, near Wainwright Inlet
Thomas Dickason	Whaling bark	9/14/1871	N of Wainwright Inlet

TABLE 3.3.6-1 Shipwrecks in the Chukchi Sea Lease Sale 193 Area

Vessel Name	Type	Date Wrecked	Location
Victoria	Trading brig	9/14/1871	S of Wainwright Inlet
William Rotch	Whaling ship	9/14/1871	S of Wainwright Inlet
Roscoe	Whaling bark	8/19/1872	Off Point Barrow
Arctic	Whaling bark	7/7/1876	18 mi from the "Bend" (Point Belcher)
Three Brothers	Whaling bark	9/11/1877	Off Point Barrow
W.A. Farnsworth	Whaling bark	9/15/1877	Near Point Barrow
William H. Allen	Trading brig	8/2/1878	Off Cape Smyth
Florence	Whaling bark	8/8/1878	4 mi S of Point Barrow
Daniel Webster	Whaling bark	7/12/1881	5 mi S of Point Barrow
North Star	Steam whaling bark	7/8/1882	Off Point Barrow, 2 ½ mi from shore
John Howland	Whaling bark	7/17/1883	S of Point Hope
Cyane	Whaling bark	8/23/1883	5 mi NE of Point Belcher
Louisa	Whaling bark	9/24/1883	Off Point Hope
Bowhead	Steam whaling bark	8/11/1884	Blossom Shoals, near Icy Cape
George and Susan	Whaling bark	8/10/1885	9 mi N of Wainwright Inlet
Mabel	Whaling bark	8/10/1885	At Wainwright Inlet
Clara Light	Whaling schooner/tender	8/31/1886	15 mi N of Point Franklin
Fleetwing	Whaling bark	8/3/1888	1 mi NE of Point Barrow
Mary and Susan	Whaling bark	8/3/1888	4 mi S of Point Barrow
Ino	Schooner	8/8/1888	At Cape Smyth
Ohio	Whaling bark	10/3/1888	At Point Hope
Thomas Pope	Whaling bark/tender	7/28/1890	Off Point Hope
Spy	Sloop	11/25/1890	At Point Barrow
William Lewis	Steam bark	10/3/1891	At Point Barrow
Emily Schroeder	Schooner	10/13/1893	Marryatt Inlet, Point Hope Lagoon
Hidalgo	Brig	7/24/1896	8 mi W of Cape Thompson, within 1 mi of Jabbertown
Navarch	Steam whaling bark	8/12/1897	Off Blossom Shoals, near Icy Cape
Orca	Steam whaling bark	9/21/1897	N of Seahorse Islands, off Point Franklin
Jessie H. Freeman	Steam whaling bark	9/22/1897	N of Seahorse Islands, off Point Franklin
Rosario	Schooner	7/2/1898	¾ mi SW of Point Barrow

TABLE 3.3.6-1 Shipwrecks in the Chukchi Sea Lease Sale 193 Area

Vessel Name	Type	Date Wrecked	Location
Grampus	Steam whaling bark	7/18/1901	Near Point Barrow
Laura Madsen	Whaling schooner	10/14/1905	At anchorage off Point Barrow
Ivy	Schooner	9/1/1908	At Point Barrow
Helen Johnston	Gas schooner	7/29/1910	7 mi E of Point Hope
Transit	Schooner	8/25/1913	5 mi SW of Cape Smyth
Arctic	Auxiliary gas schooner	8/10/1924	16 mi S of Point Barrow
Lady Kindersly	Canadian power schooner	8/31/1924	Off Point Barrow
Lettie	Gas screw	9/9/1924	½ mi NE of Wainwright Inlet and ½ mi from shore
Baychimo	Canadian trading/supply steamer	11/24/1931	Just S of Point Barrow
Arnold Liebes	Gas boat	1/1/1934	Off Point Barrow
C.B. Brower	Gas boat	1/1/1934	Off Point Barrow
Eli-Yuk	Oil screw	9/2/1963	Off Wainwright
Basil	Diesel boat	9/7/1950	At Cape Lisburne

Source: Table III.C.18 (MMS 2007b)
mi = Mile(s)
S = South
N = North
NE = Northeast
SW = Southwest

Many of the locations noted in Table 3.3.6-1 are generalized because they are based on historical reports. Few exact locations of shipwrecks are known. Using the generalized locations of reported wrecks, the MMS identified areas that have a high potential of containing shipwrecks and other historical archaeological sites (MMS 2007b). None of the Statoil's Chukchi Sea lease blocks fall within these high potential areas (Figure 3.3.6-1).

Figure 3.3.6-1 shows that areas of high potential for historic archaeological sites tend to fall closer to shore than the lease blocks. Noted and reported shipwrecks are identified north of Barrow, offshore southwest of Barrow and northeast of Wainwright, north of Icy Cape, and offshore of Point Hope.

Traditional Cultural Properties

As of today, no TCPs are designated in the project area. No ethnographic landscapes or places of traditional value within the project area have been evaluated using the National Register of Historic Places criteria and determined eligible as TCPs.

3.3.7 Coastal and Marine Uses

Coastal areas of Alaska are now regulated under the CZMA, 16 U.S.C. 1453, of 1972 and the Alaska Coastal Management Act (ACMA; Title 11, Alaska Administrative Code [AAC] Chapters 110, 112, and 114) of 1977. Both acts are designed for the protection of valuable coastal resources and other uses of coastal areas through balancing economic development with environmental conservation. Under the CZMA, any federal activities occurring in the OCS (e.g., oil and gas lease sales) are subject to a consistency review if there is any potential effect on coastal use or resource. The NSB has a Coastal Management Plan (CMP) in place (NSB 1984a, 1984b).\

Other than vessels associated with the proposed project activities, vessel transit in the project area is expected to be limited. The Chukchi Sea does not support an extensive fishing, maritime, or tourist industry between major ports. The main reason there is limited vessel movement is that the Chukchi Sea is ice-covered for most of the year. With the exception of research vessels, most vessels are expected to transit the Chukchi Sea area within 12.5 mi (20 km) off the coast. Sport fishing is not known to occur in the Lease Sale 193 area, and little if any sport fishing takes place in rivers flowing into the northeastern Chukchi Sea. Local boating occurs in coastal areas as part of normal subsistence fishing and whaling activities for the coastal villages of Barrow, Wainwright, Point Hope, and Point Lay.

During ice-free months (June–October), barges are used for supplying the local communities and the North Slope oil industry complex at Prudhoe Bay. Usually, one large fuel barge and one supply barge visit the North Slope coastal villages per year, and one barge per year traverses the Arctic Ocean to the Canadian Beaufort Sea (MMS 2009).

NOAA found the world's oceans were the warmest on record in 2009 (NOAA 2009). In August, arctic sea ice covered 3.89 million sq km (2.42 million sq mi), 18 percent less than average in the late 20th century (NOAA 2009). With the decrease in ice and opening of the Northwest Passage in 2007 and 2008 and opening of the Northern Sea Route along the Russian coastline in 2008, there is concern about the increase of vessels transiting the Arctic Region. Significant increases in cruise ships and tourism traffic due to decreasing ice has occurred (Lage 2009), especially around Greenland, which is an increasingly popular destination for arctic tourism (Littlejohn 2009; Arctic Council 2009).

The IMO approved guidelines for ships operating in arctic, ice-covered waters in December 2002; and revised guidelines were drafted and approved by the IMO in late 2009 (IMO 2009). These guidelines recognize the difficulty inherent in arctic travel, such as the lack of good charts, navigational aids, and communications systems;, and extreme weather conditions. In addition, the Arctic Marine Shipping Assessment developed a set of scenarios projected from 2009–2050 to aid in future arctic maritime operations (Arctic Council 2009).

With few ports and shallow, storm-driven seas, tourist vessels are still minimal in the northeast Chukchi. In the event, however, that vessel transit increased in the summer, the USCG is attending to more of the region and considering basing some types of response units seasonally in Kotzebue, Barrow, or Nome (Littlejohn 2009). The port city of Nome provides safe harbor for oceangoing vessels such as bulk carriers, cruise ships, tugboats, fuel barges, and large fishing vessels. The Port of Nome hosted 234 dockings in 2008, a sharp rise from 34 dockings in 1990 (Yanchunas 2009).

Regarding the Northwest Passage, most of the cruises stay within Canadian waters, and there is little or no cruise vessel movement expected to be in the Statoil planned seismic project area in 2010. Two cruise ships, the *Hanseatic* and the *Bremen,* traveled in the Chukchi during the summer of 2009, with stops in Barrow, Point Hope, and Nome (AES 2009).

3.3.7.1 Military Activities

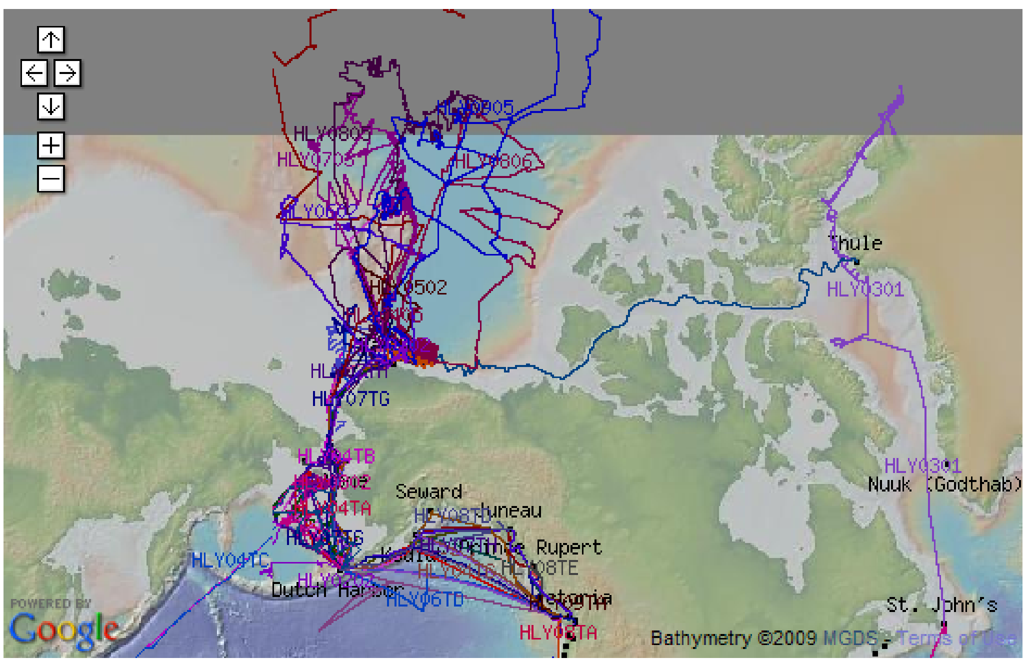
The USCG has jurisdictional responsibility for the protection of the public, the environment, and U.S. economic and security interests in international waters and America's coasts, ports, and inland waterways. As a part of their commitment to protect ecologically rich and sensitive marine environments, their presence is nationwide and more recently increasing in the extreme areas like the Arctic. The USCG has conducted limited activities in the Chukchi Sea. They are planning to extend operations in northern Alaska and the Arctic region (Bonk 2008; USCG 2008).

Issues with changing climate, receding ice pack, and economic activity appear to be influencing the expansion of operations north to the Arctic (NRC 2005). Figure 3.3.7-1 shows the activity of the USCG Cutter USCG *Healy* (WAGB-20) during the period 2000–2009. Since 2002, the USCG Cutter *Healy* has supported scientific research in the arctic waters off Alaska's coast (USCG 2009).

The USCG *Healy* (WAGB-20) is the U.S.' newest of three commissioned polar icebreakers. It also is the most technologically advanced polar icebreaker. *Healy* is designed to conduct a wide range of research activities, providing scientific laboratory space, electronic sensor systems, oceanographic winches, and accommodations for up to 50 scientists. *Healy* is designed to break 4 ½ ft of ice continuously at three knots. It can operate in temperatures as low as -50°F. The laboratory design and science capabilities were developed with input from the scientific community during design and construction of the ship. At a time when scientific interest in the Arctic Ocean basin is intensifying, *Healy* substantially enhances U.S. arctic research capability (USCG 2009).

As a Coast Guard cutter, *Healy* is also a capable platform for supporting other potential missions in the polar regions, including logistics, search and rescue, ship escort, environmental protection, and enforcement of laws and treaties.

Figure 3.3.7-1 Cruise Activity Catalog of the USCGC Healy (WAGB-20), 2000–2009



Source: National Science Foundation (NSF) 2009

There is interest in international boundary claims and future international maritime Arctic shipping routes (USCG 2008a). This would increase activities for both marine vessels and aircraft. The USCG District 17 has stated "all Coast Guard missions in southern Alaska must be expanded to northern Alaska" (USCG 2008a). In 2007, the USCG initiated its first air mission in northern Alaska by flying from Barrow to the North Pole. This became known as the Arctic Domain Awareness mission, with planned deployment of C130 aircraft to a Forward Operation Location in Nome, Alaska, to conduct a series of cold weather tests (Allen 2008).

Based on priorities outlined in the National Security Council's interagency review of Arctic policy, it is anticipated that the Coast Guard will have to extend these roles and missions into the Arctic in the next 5–10 years (Presidential Directive 2009). The Coast Guard will be involved in the implementation of any ship routing and transiting management plans.

3.3.7.2 Shipping

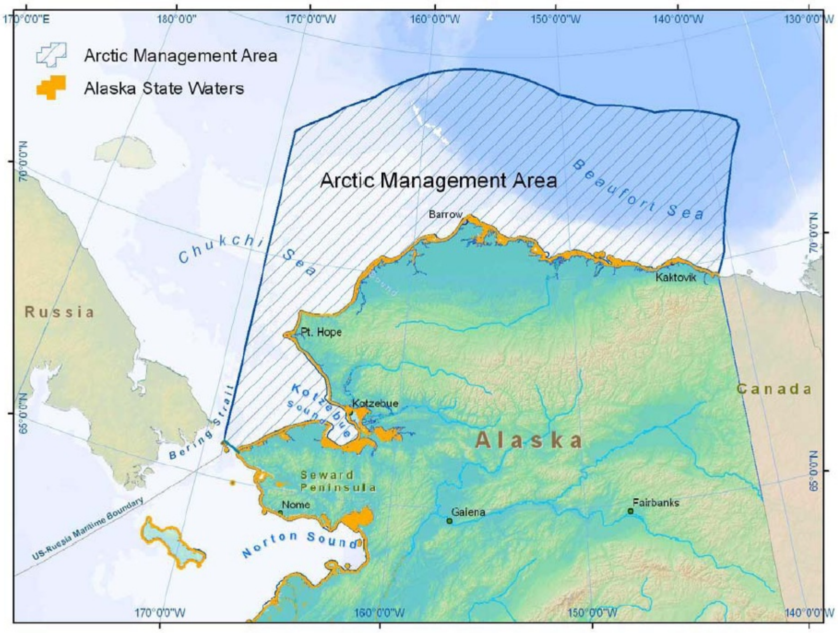
Marine shipping, which involves military and government vessels, as well as icebreakers, container ships, general cargo, bulk carriers, tankers ships, passenger cruise ships, tugs and barges, fishing vessels, and oil and gas exploration and exploitation vessels, is expected to expand with increased accessibility and marine transportation in the Arctic (PAME 2009). Marine shipping by barge to the coastal villages in the NSB occurs in the summer. On average, marine shipping to the villages of the NSB occurs only during 4 months of the year. This is due, in part, to the ice formation in the Bering Strait, Chukchi Sea, and Beaufort Sea. Air-cargo services to the villages in the NSB occur year-round. Northern Air Cargo serves Barrow once a day, Monday through Friday. Alaska Airlines flights are available, with two flights daily to Barrow and local flight service to the communities in the NSB.

3.3.7.3 Commercial Fishing

There is no known commercial fishing presently in the Chukchi Sea in the vicinity of the Lease Sale 193 Area or elsewhere in the northeastern Chukchi Sea. The nearest commercial fisheries are in Kotzebue Sound and include all waters from Cape Prince of Wales to Point Hope and the Colville River Delta (Gray 2005). No regulatory authority for commercial fishing exists in the NSB.

The Arctic Fishery Management Plan has been implemented since December 3, 2009 (NOAA 2009). The fisheries plan is wide open for research, especially because there are a lot of uncertainties in areas of management authorities, policies, and development of resources and sustainability in the face of a changing climate. Also, this plan closes the U.S. Arctic to commercial fishing within the Exclusive Economic Zone or that area from 6 km (3 nm) offshore the coast of Alaska to 370 km (200 nm) seaward (see Figure 3.3.7.-2). Enforcement for the area will be the responsibility of USCG and NOAA's Office of Law Enforcement. The plan does not affect arctic subsistence fishing or hunting.

Figure 3.3.7.-2 Map Showing the Arctic Management Area



Source: NPFMC 2009

3.3.7.4 Mariculture

There is no mariculture conducted in the Lease Sale 193 Area or elsewhere in the northeastern Chukchi Sea or adjacent coastal waters. Authority to propose any aquatic farm projects would go through the ACMP Consistency Review process. This process determines whether a project or activity follows procedures set out in 11 AAC 110.200–11 AAC 10.270 after determining the scope of the activities subject to review in consultation with the coastal district (ADCOM 2006).

3.3.7.5 Other Mineral Uses

There are deposits of coal and industrial and metallic minerals located in the NSB lands. There is an estimated 4 trillion tons of bituminous coal present in the northern and western portions of the NSB (ASRC 2009). Eighty-eight percent of the state's identified coal resources are in these Western Arctic deposits (Ground Truth Trekking 2007). The coal deposits exist within the Cape Beaufort, Deadfall Syncline, and Kukpowruk River basins on the North Slope. Two of the three, Deadfall Syncline and Kukpowruk River, extend into the Chukchi Sea. These coal deposits represent one-ninth of the world's known reserves and one-third of the U.S. reserves (Gray 2005).

A joint road project with the Alaska Department of Transportation and Public Facilities and the Alaska Department of Natural Resources ASRC, NANA, and Teck Cominco (now Teck Alaska Incorporated) was conducted in 2005. This project was to complete reconnaissance for a 90-mile road between Deadfall Syncline coal mine near Point Lay and the Red Dog Mine terminal. It was estimated that between 1 and 2 million tons per year could be exported from the mine to Asian markets. This deposit is located only 6 miles from tidewater on the Chukchi Sea.

Industrial mineral deposits of sand and gravel are found throughout the NSB. Sand and gravel deposits have been identified and worked from the beach and river areas located around Barrow. Gravel is used extensively for road building projects, oilfield roads, and facility and drilling pads.

ASRC has title to extensive deposits of gravel that are essential for oil and gas development projects in the Alaskan Arctic.

There are eight geological sites in the western part of the NSB that have potential for minerals development. These areas may have high concentrations of zinc, lead, and silver. In addition, there are mineral sites documented that have identified potential belts of gold, silver, copper, lead, zinc, iron, platinum, and uranium on the Lisburne Peninsula south of Point Lay (NSB 1989). At least five of the metallic mineral mines are located in the Chukchi Sea area. Table 3.3.7-1 shows the locations of metallic minerals historically mined in the NSB area.

TABLE 3.3.7-1 Locations of Metallic Minerals Historically Mined in the NSB Area

Location	Metallic Mineral
Misheguk Mountain	chromium
Siniktanneyak Mountains	chromium
Nimiuktuk	barium
Drenchwater	zinc, lead, silver
Whoopee Creek	zinc, lead, copper, cadmium, silver, gold
Story Creek	lead, zinc, silver, gold
Kivliktort Mountain	zinc, lead, barium
Kady	zinc, copper, lead, silver, gold
Outwash Creek	lead, zinc, copper, silver, manganese, nickel
Itkillik River West	barium, lead, zinc, copper
Porcupine Lake	copper, zinc, silver, fluorite
Esotuk Glacier	copper, lead, zinc, tin, tungsten, fluorite
Romanzof Mountains	copper, molybdenum, lead, zinc, silver, tin, fluorite, uranium

3.3.8 Land Use

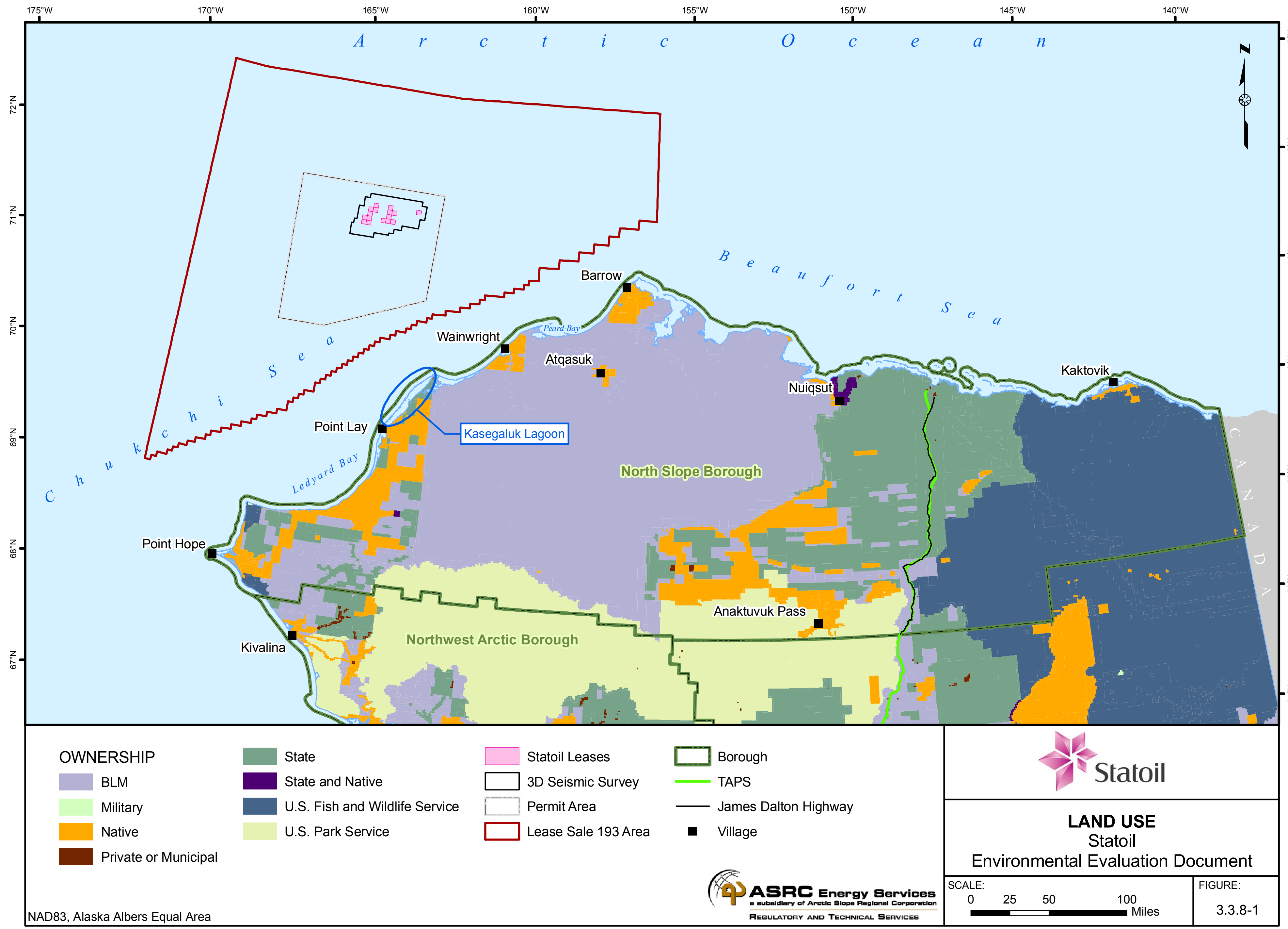
Land use within the NSB is categorized by community-related activities (residential, commercial, and public institutional use), subsistence, industrial and resource development, transportation, and recreation. Several zoning districts are identified in the NSB Comprehensive Plan (2005), including Village District, Barrow District, Conservation District, and Resource Development District. Additionally, 3,021 hectares (7,466 acres) of land that had been donated in 1992 by UIC for the purpose of scientific research and monitoring activities were rezoned as the Scientific Research District (Scannet 2009).

The James Dalton Highway Transportation Corridor District is defined in a separate comprehensive plan for the area surrounding the highway as an independent Transportation Corridor (ASCG 2005; NSB 2005). Two more districts, Special Habitat District and Subsistence Use District, were proposed through Title 19 Land Management Regulations with the adoption of the NSB Comprehensive Plan in 2005, but have yet to be realized.

The villages of Wainwright, Point Lay, and Point Hope are zoned as Village Districts. There is no legal zoning within the communities, but NSB, in coordination with the villages, has identified and delimited the following classifications for land use in the Village Districts: residential, commercial, public, semi-public, and industrial. The Barrow District has four zoning ordinances outlined in the Title 19 Land Management Regulations: industrial, mixed use, suburban, and reserve districts (NSB 2005). Both the Village Districts and the Barrow District are aimed at maintaining traditional values and lifestyles in and around the NSB communities. The most significant difference between the two zoning classifications is that there is a recognized need for balance between development and tradition in the much larger community of Barrow.

The NWAB defines six zoning districts: Village District, Subsistence Conservation District, Commercial Recreational Conservation District, General Conservation District, Resource Development District, and Transportation Corridor District. Kivalina falls within the Village District classification, as do all other villages in the NWAB, with the exception of Kotzebue.

No zoning authorizations are required from the NSB or the NWAB for Statoil's seismic activities in 2010.



LAND USE
Statoil
Environmental Evaluation Document

FIGURE: 3.3.8-1

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3.3.9 Environmental Justice

EPA defines Environmental Justice as "the fair treatment and meaningful involvement of all people, regardless of race, color, national origin or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (EPA 2006). The Environmental Justice Strategic Plan integrates Environmental Justice into the EPA's programs and operations, specifically to be in accordance with EO 12898, which focuses on minority and low-income communities that are disproportionately and adversely affected by environmental and human health risks (EPA 2006).

The EPA has developed criteria to determine whether a population is considered to be minority or low-income. When compared to the reference population of an area, if the potentially affected communities have ethnic or economic characteristics that are 1.2 times or more than the reference population, then that community is considered an Environmental Justice population (MMS 2008). The State of Alaska socioeconomic averages are used as a reference for North Slope villages because the population centers on the North Slope are predominantly Alaska Native and Native American. The North Slope villages on the Chukchi coast comprise 55.8–90.2 percent American Indian or Alaska Native populations; this is nearly six times greater than the state average of 15.4 percent (MMS 2008). Table 3.3.9-1 shows the ethnic composition of the North Slope coastal villages.

TABLE 3.3.9-1 Ethnic Composition of Barrow, Wainwright, Point Lay, and Point Hope

	Total	Hispanic or Latino	White	Black or African American	American Indian or Alaskan Native	Asian	Native Hawaiian and Pacific Islander	Other	Two or More Races
State of Alaska									
Population	626,932	25,852	423,788	21,073	96,505	24,741	3,181	1,388	30,454
Percent		4.1	67.6	3.4	15.4	3.9	0.5	0.2	4.9
Barrow									
Population	4,681	153	972	44	2,558	429	59	1	365
Percent		3.3	21.2	1.0	55.8	9.4	1.3	0.0	8.0
Wainwright									
Population	546	0	37	1	493	0	0	0	15
Percent		0.0	6.7	0.2	90.2	0.0	0.0	0.0	2.7
Point Lay									
Population	247	6	28	0	204	1	0	0	14
Percent		2.4	11.3	0.0	82.5	0.4	0.0	0.0	5.6
Point Hope									
Population	757	13	66	1	659	1	0	1	29
Percent		1.7	8.7	0.1	87.0	0.1	0.0	0.1	3.8

Source: MMS 2008

In order to get a marine mammal IHA from the NMFS, Statoil developed a POC, which included Leadership and Community meetings. Statoil made two trips to the North Slope during the winter of 2009–10. The purpose was to meet with village officials during the first trip and to host community meetings open to the public during the second trip. The Leadership meetings were:

- October 27, 2009, presentation to the NSB Planning Commission in Barrow;
- October 27, 2009, through November 5, 2009, Leadership Meetings in Barrow, Wainwright, Point Hope, Point Lay, and Kotzebue; and
- December 14, 2009, meeting with the NSB Wildlife Department and members of the Alaska Eskimo Whaling Commission (AEWC) to discuss proposed activities, potential effects, and measures for mitigating effects.

Both the Leadership and Community meetings were intended to inform leadership and residents about Statoil's seismic plans for the 2010 season and to hear and be advised of stakeholder concerns. If an EIS or an EA (or both) were required for this project, the POC meetings would satisfy the Environmental Justice needs required by the NEPA process. Although not required for Environmental Justice purposes, the POC meetings inherently provided invaluable Environmental Justice information and concerns of local residents regarding Statoil's project.

During the POC Community meetings, many of the same concerns were themed throughout all of the villages. The list below is a collection of these questions and concerns:

- The Ocean is their garden and needs to be respected and protected.
- Community members' lifestyle (subsistence) needs to be protected.
- Elders' Traditional Knowledge of weather, ice, and animals needs to be used.
- Carbon capture and storage needs to be better explained.
- The difference between 3D seismic and shallow hazards surveys is not clear.
- Will Statoil be conducting exploration drilling?
- Inupiat MMOs should have certain authority aboard vessels during operations.
- Has Statoil had an oil spill?
- Baseline studies: When are they conducted? Who funds them (industry)? Can they be trusted?

Additionally, residents of each of the four villages visited had unique questions and concerns. The lists below are a compilation of those grouped by the corresponding village and the POC community meeting date.

- Barrow on January 11, 2010:
  - How will crew changes be done, and why was Nome chosen?
  - Why is your program only doing 3D in one area?
  - What is the timeline for the project?
  - What are the technical specifications for the boats and equipment that will be used?
  - How many Inupiat MMOs will you need, and what authority will they have?

– What will you do to ensure that the Inupiat MMOs are not treated unfairly?

– What precautions do you have in place for the marine mammals?

– What determines the dB levels that you have to abide by for the various marine mammals?

– Will you operate 24/7? and how will you deal with nighttime operations in regard to protecting marine mammals?

– What has the NSB found through all the whale studies they have been conducting?

– Why can't you use data from the previously drilled wells?

– Will you come back and drill exploratory wells?

- Wainwright on January 13, 2010:

– Why does Statoil need more seismic data?

– Why don't the companies share the data?

– How many rigs does Statoil have in Norway?

- Point Hope on January 14, 2010:

– Are you saying that the area concerned is 915 sq mi? How many seismic tests are you planning?

– Are the airguns tubes?

– Baseline studies should not be done after seismic has already been conducted.

– The baleen whales can be heard 15 mi away; bowhead navigation can be affected by sound.

– You are destroying the food whales eat and driving them farther out; reductions in tom cod have already been experienced.

– Point Hope has finally gotten their walrus back; now Statoil's seismic activity is threatening to take them away again through disturbance.

– What is the mileage/distance for the safety radii?

– How did Statoil come up with the dB levels?

– Activity in August and September will have an effect, even if it is more than100 mi away.

– How deep is the survey?

– Does the Inupiat MMO have the power to shut down the survey?

– Statoil must respect the community and remember they are a visitor in the village.

– If Statoil wants to meet with the Native Village of Point Hope Council, they must give adequate notice to provide reading materials (10 copies) at least 1 month in advance.

– Grayling have begun to taste and smell different.

– What about the oil spill in Norway? Was Statoil involved in the Australian oil spill?

- Point Lay on January 15, 2010:
  - How loud is the sound, and how many miles does it travel? Sideways and downwards? Will the animals hear it?
  - Are all the vessels coming up in August?
  - Do the airguns operate 24/7 regardless of weather?
  - Will Statoil help with the Com and Call Centers this year?
  - Will Statoil drill on their leases? When?
  - What happens to the sewage on the boats?
  - What about MMO opportunities?

Statoil is aware of and will promptly and formally respond to all questions and concerns that arose at both the Leadership and Community meetings. They will also begin developing mitigation measures for relevant issues that will be in place prior to 2010 open water activity.

Many of the questions and issues recorded at the POC meetings are addressed in the EED and the staholder engagement plan. Some questions and issues raised at the POC were not specifically relevant to the 2010 seismic operation. Many of these issues and questions will be addressed at subsequent stages of project development should Statoil consider additional exploration and development of its prospects.

4.0 ENVIRONMENTAL CONSEQUENCES

Section 4.0 and related subsections discuss the anticipated environmental consequences of the Statoil 2010 Chukchi Marine Seismic Survey project to the physical environment, the biological environment, and the socioeconomic environment within the project area and potentially affected NSB and NWAB communities. Specifically, Section 4.1 presents the expected environmental effects from the seismic survey project to the physical environment. Section 4.2 next discusses the expected environmental effects to biological resources. And lastly, Section 4.3 discusses the expected effects to socioeconomic resources.

The Chukchi Sea is a biologically rich area with a broad diversity of fish and wildlife resources. As discussed in Section 3.0 and related subsections, many of these biological resources are seasonal and closely associated with the annual cycle of sea ice cover and open water. The Statoil 2010 Chukchi Marine Seismic Survey project will be conducted only when the project area is free of ice. Therefore, the potential effects of this project are generally limited to the resources associated with open water such as whales, fishes, and birds. Marine mammals associated with the ice pack edge, such as seals, walruses, and polar bears, may also be near the project area, depending on the location of the ice pack edge during the seismic survey.

As discussed below, the project is anticipated to have zero to minimal potential effects on the physical environment.

With respect to the biological environment, sound exposure from Statoil's proposed seismic survey project on marine wildlife is expected to be the primary source of potential effects. Statoil has developed a number of mitigation measures for this project that are expected to minimize incidental sound disturbances to marine mammals and other marine wildlife. These mitigation measures are discussed throughout Section 4, with application to physical, biological, and socioeconomic resources, and in greater detail in Section 6, Mitigation Measures.

Secondary, and less likely, sources of potential effects from the seismic survey project include vessel transiting, vessel emissions, vessel minor wastewater discharge volumes, and potential hydrocarbon release during a possible refueling operation.

Effects on biological resources associated with the transit of the seismic source vessel and two support vessels are expected to be minimal and temporary and are not discussed in further detail. The only effect on wildlife expected to occur as a result of transit is temporary deflection away from the vessel. Vessel transit from Dutch Harbor to the project area is expected to take 5 days. MMOs will be aboard vessels during transit to monitor surrounding waters for marine mammals. Marine mammals will be avoided whenever possible during transit to the project area. Vessel transit is defined as the round-trip travel from Dutch Harbor to the project area, vessel operations during the seismic survey, and other movements of the vessel related to normal operations.

Disturbance of walruses by the presence of nearby vessels has been of special concern because of their vulnerability stemming from their tendency to aggregate in large groups. Effects of vessel presence near groups of walruses are uniquely discussed in further detail in the section on walruses under Section 4.2.4, Threatened and Endangered Species.

Emissions and wastewater discharge volumes from the seismic survey vessels are generally below applicable Federal Clean Air Act and CWA permit requirements and presumably will have zero to minimal effect on the physical and biological environments, and thus are not discussed in further detail below. The Statoil seismic survey fleet consists of modern vessels that meet all applicable

MARPOL 73/78, International Convention for the Prevention of Pollution from Ships. However, any effect from vessel emissions or discharges would be minimal, temporary, and localized.

Statoil will be contracting with Fugro for the vessels in the 2010 Chukchi Marine Seismic Survey. This project does not involve exploratory drilling or any other disturbances of the subsurface geology, thereby eliminating any possibility of a crude oil spill. The presence of the seismic survey vessel fleet can pose a potential hydrocarbon release, either from a vessel collision or an at-sea refueling mishap. The seismic survey project will be conducted during the long daylight environment, thereby reducing the likelihood of a vessel collision and any subsequent potential hydrocarbon release. Vessel refueling will be conducted primarily in Nome, with a contingency to have a single refueling event at sea. In the event of an at-sea fuel transfer operation, the seismic survey vessels will comply with all applicable MARPOL international, USCG, and state of Alaska oil spill prevention and response requirements. The anticipated effect from a fuel transfer mishap hydrocarbon release to the marine environment would be minor, temporary, and localized and thus is not discussed any further below.

The socioeconomic effects from the seismic survey project, as discussed in more detail in Section 4.3, are expected to be minimal, temporary, and localized.

4.1 Physical Environment

4.1.1 Geology and Geomorphology

The seismic acquisition activities of the Statoil 2010 Chukchi Marine Seismic Survey project will have no effects on the geology and geomorphology of the project area. Statoil's project is a seismic data survey, and the resultant activities will not affect the stratigraphy, seafloor sediments and geology, or sub-seafloor geology in any way.

4.1.2 Climate and Meteorology

The Statoil 2010 Chukchi Marine Seismic survey is a seismic data acquisition project. The narrow scope of this project, the limited number of vessels, and limited duration of the survey activities will not have any effect on the climate and meteorology of the project area.

4.1.3 Physical Oceanography

The Statoil 2010 Chukchi Marine Seismic Survey will have no effect on the physical oceanography of the project area, including the Chukchi Sea circulation patterns, topography, bathymetry, or incoming watermasses; atmospheric pressure systems; surface-water runoff; density differences between watermasses; or seasonal and perennial sea ice.

4.1.4 Sea Ice

The Statoil 2010 Chukchi Marine Seismic Survey will have no effect on the sea ice of the project area. Statoil has specifically designed its project to begin during the open water season. Statoil will not be using ice-breakers or other ice-related support vessels for this project since they will not be necessary to navigate the open waters of the Chukchi during the survey. However, the presence of sea ice in the project area will affect the survey by reducing the geographical extent of the survey area. It may also extend survey activity beyond the nominal 60-day (late July through early October) survey time period and into mid-to-late October and November. Regardless of the sea ice status, the survey vessels will have left the project area and returned to Dutch Harbor by the end of November.

4.1.5 Water Quality

The Statoil 2010 Chukchi Marine Seismic Survey project may have a minimal, temporary, and localized effect on water quality in the project area. As discussed in Section 2.1.8, discharges from seismic survey vessels are not subject to coverage under the Arctic Oil and Gas General Permit (Permit No. AKG280000), but may fall under NPDES VGP limitations and Section 312 of the CWA within 6 km (3 nm) of the shore. The potential discharges associated with Statoil's proposed seismic survey vessels include:

- Deck drainage;
- Treated sanitary waste;
- Domestic waste;
- Desalination unit waste;
- Non-contact cooling water;
- Bilge water.

These discharges will fall within VGP limitations described in Section 3.1.5. On a temporary and localized scale the discharges have the potential to increase turbidity, suspended solids, organic content, and other water-quality characteristics. The EPA (2008) determined that discharges permitted under the VGP "will not cause unreasonable degradation of the marine environment." Sanitary waste, which does not require an NPDES VGP, will be treated by facilities that meet requirements certified under MARPOL Annex IV, 40 CFR Part 140, and 33 CFR Part 159. The estimated maximum discharge of treated sanitary waste from the seismic vessel is 2.2 gallons per minute, with discharges from the remaining two vessels being much less. The combination of the small wastewater discharge volumes and moving vessels will limit the potential effect on water quality to the immediate vicinity of the vessels within the project area. Any such potential effect will be minimal and temporary.

The NPDES VGP allows for the release of ballast water beyond 6 km (3 nm) of the shore, and 33 CFR 151 outlines the USCG ballast water management regulations. Each seismic survey vessel has internal segregated ballast water tanks; therefore, under normal circumstances, none of the vessels will release ballast water during the entire course of the proposed survey. This greatly reduces the possibility of introducing foreign species into the project area and waters of the United States.

In addition to meeting VGP requirements, Statoil's seismic survey operations and equipment will ensure that water quality outside of the 3 nm boundary is not adversely affected. All three vessels associated with the survey have been built within the last five years to meet modern environmental specifications. Also, in contrast to older models of seismic streamers, the model that Statoil will be employing is solid state and contains no kerosene or glycol liquid to maintain constant buoyancy. In the event of a streamer break there would be no resulting discharge to the marine environment.

4.1.6 Air Quality

The Statoil 2010 Chukchi Marine Seismic Survey project will have a minimal, temporary, and localized effect on air quality in the project area and no measurable effect on air quality on the Alaska Chukchi Sea coastline. The Statoil 2010 Chukchi Marine Seismic Survey project fleet will comply with current MARPOL Annex VI requirements to limit NO_x and SO_2 emissions. The short duration of the proposed survey, conformance with the MARPOL Annex VI requirements, and significant distance to shore will ensure that the potential effects from the vessels' emissions will not represent any threat to the project area or the Alaska Chukchi Sea coastline air quality.

In January 2010, as part of the Shell Chukchi Sea OCS oil and gas exploration drilling project, EPA determined that the Chukchi Sea Lease Sale Area 193 air quality met all NAAQS criteria for healthy air quality (EPA 2010a). In 2007, the MMS determined that the effects to air quality from oil and gas development and production activities from the Chukchi Sea Lease Sale Area 193 would cause only small, local, and temporary increases in criteria pollutant concentrations (MMS 2007b). The MMS determined that oil and gas development and production activities would trigger EPA air permit requirements, including the requirement to meet the NAAQS and applicable PSD increments. The MMS determined that criteria pollutant concentrations would meet the applicable NAAQS and would be below levels considered harmful to the public health and welfare (MMS 2007b).

The MMS also considered potential emissions from the Chukchi Sea Lease Sale Area 193 oil and gas exploration activities. The MMS projected that up to four seismic surveys could be conducted during each open water season and assumed that seven to fourteen additional exploration wells will be needed to discover and delineate the first commercial field (MMS 2007b). The MMS further projected oil and gas exploration drilling activity on the Alaskan Chukchi Sea OCS may also trigger EPA air permit regulations, depending on the size and duration of the activity. The proposed Shell 2010 Chukchi Sea OCS exploration drilling project, with its larger vessels and larger engines, triggered EPA air permit requirements. On March 31, 2010, EPA issued Shell an OCS/PSD permit authorizing exploration drilling activity on the Chukchi Sea OCS. The Statoil 2010 Chukchi Marine Seismic Survey project, with its seismic source vessel and two support vessels, will not trigger EPA permit requirements. The Statoil seismic survey project will be conducted utilizing newer vessels with smaller, cleaner, diesel-burning engines.

The Statoil 2010 Chukchi Marine Seismic Survey project will have a minimal to negligible effect on onshore O_3 concentrations, arctic haze, and GHG emissions. The MMS determined that the exploration, development, or production scenarios associated with the Chukchi Sea Lease Sale Area 193 are not likely to result in a significant increase in onshore O_3 concentrations (MMS 2007b). Photochemical pollutants such as O_3 are formed from the interaction of NO_x and VOC emissions in the presence of sunlight. The seismic survey emissions, coupled with the few and distant North Slope onshore NO_x and VOC emission sources, should not result in any significant increase of onshore O_3 concentrations. Arctic haze is a winter and early spring phenomenon caused by anthropogenic air pollution from the Eurasian continent. The Statoil seismic survey project will occur in the arctic summer, early fall months of July, until possibly November; thus, the Statoil seismic survey project will have no effect on arctic haze.

The Statoil seismic survey project GHG emissions will be insignificant in relationship to the Alaska statewide GHG inventory and statewide oil and gas industry total of approximately 53 MMtCO2e and 15 MMtCO2e, respectively. In 2008, the MMS projected GHG emissions (CO_2 and methane) from the proposed Chukchi Sea Lease Sales area between 0.342–0.484 MMtCO2e, or approximately 0.005–0.007 percent of the 2005 U.S. nationwide total of 6,628 MMtCO2e (MMS 2008). Thus, GHG emissions from the Statoil 2010 Chukchi Marine Seismic Survey project will be a small portion of an already small contribution to the U.S. and global GHG emission inventory.

4.1.7 Acoustic Environment

Potential effects on the marine acoustic environment within the Statoil 2010 Chukchi Marine Seismic Survey area include sound generated by the seismic airguns and vessel transit. These effects are expected to be localized to the project area and temporary, occurring only during seismic data acquisition.

Sounds generated by Statoil's proposed seismic acquisition project in the Chukchi Sea will propagate into a marine environment that already receives sounds from numerous natural and some anthropogenic sources. Anthropogenic sounds from oil and gas operations have resulted in elevated underwater sound levels, primarily in the frequency region below 1,000 Hz (Lawson 1999) and illustrated in Figure 3.1.7-2.

The M/V *Geo Celtic* will tow two airgun arrays (of which one will be active and the other on standby), each consisting of 26 active airguns, with a maximum discharge volume of 3,000 cu in. The depth at which the array is towed and the array design can have a major effect on the maximum near-field output and on the shape of its frequency spectrum. Typically, an airgun array is fired every 10–15 seconds. The M/V *Geo Celtic* array has been designed so that most of the energy is focused downward. This, along with the short duration of each pulse, limits the total sound energy introduced into the water column. Although the array is designed to focus sound energy downward, the sound can propagate horizontally for several kilometers (Greene and Richardson 1988; Hall et al. 1994).

Sounds from seismic exploration activities, of the type proposed by Statoil, are at relatively high intensity at the sound source, within the 216–259 dB range (MMS 2007; Richardson et. al 1995; Burgess and Green 1999). Although the peak source levels of these energy sources are typically between the 250–255 dB range, horizontal transmission is more in the range of 200 dB (Engås et al. 1996). The energy intensity rapidly degrades along the horizontal axis; Table 4.1.7-1 shows the relative degradation of sound energy with horizontal distance measured from a similarly sized sound source used in the Chukchi Sea, and Table 4.1.7-2 shows the estimated degradation of sound energy for the proposed sound source.

TABLE 4.1.7-1 Measured Distance to Received Sound Levels from a 3,147 cu in Airgun Array

Received Sound Levels[a] dB re 1 uPa rms	Meters		
	Distance 2006[b]	Distance 2007[c]	Distance 2008[c]
190	460	550	610
180	1,400	2,470	2,000
160	8,000	8,100	13,000

a = Received levels of airgun intensity are measured in dB re 1 uPa rms (averaged over pulse duration)
b = Blackwell et al. 2007
c = Funk et al. 2008
d = Hannay and Warner 2009

TABLE 4.1.7-2 Estimated Distance to Received Sound Levels from a 3,000 cu in Airgun Array

Received sound levels [a] dB re 1 uPa rms	Distance meters
190	700
180	2,500
160	13,000

[a] = received levels of airgun intensity is measured in dB re 1 uPa rms (averaged over pulse duration)

The sound level typically considered to be of sufficient intensity to cause an effect on marine mammals (e.g., harassment) by the NMFS and USFWS (as included as permit stipulations for sound-generating activities such as seismic surveys) is 160 dB re 1 μPa rms or greater. Mitigation measures that will be put into place are addressed in detail in Section 6.0 but, in general, include development of acoustic safety radii, altering course and speed to maintain safety radii, and performing ramp-up, power-down, and shutdown procedures. In addition, although the mitigation measures have been designed to mitigate effects on marine mammals, they are also expected to mitigate effects on other marine life, such as fish.

4.2 *Biological Environment*

4.2.1 Lower Trophic Organisms

Lower trophic-level organisms present in the prospect areas include phytoplankton, zooplankton, and benthic invertebrates. The types of lower trophic organisms found in the Statoil seismic acquisition area are discussed in Section 3.4, along with information on their abundance and distribution (MMS 2009). No sensitive benthic communities are known to occur within the project area. The potential effect of sound from the seismic source on lower trophic-level organisms would be immeasurable to very low (MMS 2007).

4.2.1.1 Effects of Seismic Sound Source

Studies on euphausiids and copepods, which are some of the more abundant and biologically important groups of zooplankton in the Chukchi Sea, have documented the use of hearing receptors to maintain schooling structures (Wiese 1996) and detection of predators (Wong 1996); therefore, these organisms have some sensitivity to sound. However, the intensity of this type of seismic energy is much lower than the intensity of sound energy required to negatively affect zooplankton (MMS 2009).

The physiology of many marine invertebrates is such that they are the same density as the surrounding water; therefore, sudden changes in pressure, such as that caused by sudden loud sound, is unlikely to cause physical damage. There have been some studies evaluating potential effects of sound energy from seismic surveys on marine invertebrates (e.g., crabs and bivalves) and other marine organisms (e.g., sea sponges and polychaetes). Studies on brown shrimp in the Wadden Sea (Webb and Kempf 1998) have revealed no particular sensitivity to sounds generated by airguns used in seismic activities with sound levels of 190 dB at 1.0 m (3.3 ft) in water depths of 2.0 m (6.6 ft). According to reviews by Thomson and Davis (2001) and Moriyasu et al. (2004), seismic survey sound pulses have limited effect on benthic invertebrates, and observed effects are typically restricted to animals within a few meters of the sound source. No appreciable, adverse effect on benthic populations would be expected, due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations (MMS 2009).

4.2.2 Fish and Shellfish Resources

Fishery resources are important to the Chukchi Sea subsistence user. Fish and shellfish in waters of the project area include Arctic cod, saffron cod, sculpin, walleye pollock, Pacific sand lance, Pacific herring, Bering flounder, rainbow smelt, and snow crab. Waters of the project area are dominated by marine fish. Migratory fishes (anadromous and amphidromous) prefer coastal waters, and an abundance is not expected to occur in the 2,368 sq km project area proposed for 2010 seismic operations. The total area of the Chukchi Sea (Russian and American) is 595,000 sq km. Statoil's project is not expected to affect Chukchi sea fish populations (Turnpenny and Nedwell 1994; Saetre and Ona 1996; Slotte et al. 2004; Wardle et al. 2001; Thomson 2002; Payne et al. 2009). Any effects on fish and shellfish within the project area will be localized, temporary, and minor. The following section reviews potential effects to fish and shellfish.

4.2.2.1 Effects of Seismic Sound Source on Fish

The anticipated effect of seismic activities on fish will likely include a behavioral reaction resulting in temporary displacement from preferred habitat or avoidance exhibited to the sound levels, this type of fish dispersal has been observed in several studies (Slotte et al. 2004; Engås et al. 1996; Dalen and Knutsen 1987). Ramp-up procedures which initiate incremental sound increases of the airgun prior to the start of each daily survey minimize the potential for a startle responses or a sudden abrupt change in fish (Blaxter et al. 1981, Hastings and Popper 2005) as they have the ability to relocate before the sound source reaches or exceeds an unfavorable threshold. The behavioral response of fish responding to a sound source is provided in Table 4.2.2.-1.

TABLE 4.2.2-1 Behavioral Response of Fish due to Sound

Received Level	Behavioral Reaction
180 dB	Alarm response—general increases in activity and changes in schooling or position in the water column
200–205 dB	Startle response—faster and more erratic swimming, jerking movements concurrent with airgun shot

Reference: McCauley 1994; McCauley 2000

When the behavioral response of fish was tested in cages located near an airgun, fish demonstrated a startle response to short-range startup or high-level airguns. There was a greater startle response from smaller fish when the airgun sound source exceeded 156 dB. However, over time, fish appeared to show some habituation to sound source and startle was less apparent. After the airgun operation stopped, fish returned to their normal behavioral pattern within 14–30 minutes (McCauley 2000). The estimated distance to received sound levels from Statoil's 3,000 cu in airgun array is provided in Table 4.1.7-2 (Section 4.1.7, Acoustic Environment).

4.2.2.2 Effects of Seismic Sound Source on Shellfish

The effect of seismic activities on snow crab is not expected to result in a behavioral reactions or physiolocial stress that may negatively affect the Chukchi Sea snow crab population, or those species depending on crab for foraging opportunities (Christian 2003, 2004). Crabs do not possess hearing capabilities, and only some crab species can detect sound waves. In a controlled experimental study, adult male snow crabs, female snow crabs carrying eggs, and fertilized snow crabs, were subject to a 200 cu in airgun energy source fired directly 50 m above. This experiment did not result in any direct mortality. While the developmental rate for eggs of a single female snow crab was slower compared to unexposed fertilized eggs/embryos, embryos carried by female crabs were able to successfully hatch (Christian et al. 2004). Moreover, when caged snow crab were monitored with a video camera, they were found to remain within the 200-m (657-ft) radius of a hydrophone transmitting 221 dB of sound energy, and did not exhbit any notable startle responses during exposure to airguns (Christian et al. 2003).

4.2.3 Essential Fish Habitat

NMFS has not designated EFH in the proposed project area. The NMFS regulations could conceivably designate EFH within the Arctic Management Area, including the project area, if a commercial fishery should occur. Fish species that would likely be protected include Arctic cod, saffron cod, and snow crab.

4.2.4 Threatened and Endangered Species

Potential effects of the Statoil 2010 Chukchi Marine Seismic Survey are discussed in this section specific to the listed and candidate species protected under the ESA. This includes the Steller's and spectacled eider, Kittlitz's murrelet, yellow-billed loon, polar bear, endangered whales, and walrus.

Each species is discussed according to the potential effects of exposure to a seismic sound source, effects of vessel transit (if applicable), and in the case of birds, the potential for bird strikes.

4.2.4.1 Birds

Steller's and Spectacled Eiders

The Arctic Coastal Plain of Alaska provides valuable nesting and molting habitat for threatened Steller's and spectacled eiders, as described earlier in Section 3.2.4. The proposed seismic survey will have negligible or minimal effects on these species and their habitats due to the distance of the project from the coast and nearshore molting areas like the Ledyard Bay Critical Habitat Unit. Staging and migration events are also not likely to be affected significantly due to the short duration of these events and the timing of the proposed seismic survey. The USFWS (2009) has concluded that the presence of seismic vessels and the associated sounds that seismic surveys generate are not likely to produce any measurable adverse effects on Steller's or spectacled eiders.

Kittlitz's Murrelet

Kittlitz's murrelets are likely to be found in low densities near the project area while seismic surveys are being conducted. Previous studies found that their reactions to the presence of large marine vessels are not significantly different from other diving seabirds and had no discernable effect on their feeding ecology (Agness et al. 2009). The USFWS (2009) has concluded that seismic marine surveys in the Alaska OCS would not likely produce any measurable negative effects and would not jeopardize the existence of the species or its habitats.

Yellow-Billed Loon

Yellow-billed loons are not likely to be found in the project area as they are usually found in coastal waters less than 10 m (33 ft) deep (Fischer and Larned 2004). Any disturbance to this species would be similar to other species described earlier. The likelihood of these disturbance effects is very small due to the movement of yellow-billed loons out of the Chukchi Sea by mid-June (USFWS 2009).

Effects of Vessel Transit

The extremely low densities of any threatened and endangered birds expected in the project area reduce the likelihood of any effects occurring from seismic vessels transiting the project area (USFWS 2009). Vessels transiting the project area would likely cause short-term disturbance to waterbirds, includingthreatened and endangered bird species, directly within the vessels path. This effect would likely be minimal, as birds would move away from the vessel and return once the vessel has departed (Agness et al. 2008). Anecdotal reports of seabird response to large marine vessels off the coast of the Alaska Peninsula and Aleutian Islands support this conclusion (USACEa, b, c). Any adverse effects from seismic vessel present in the project area would be negligible (MMS 2006).

Effects of Seismic Sound Source

The sound generated from the operation of a seismic airgun array travels horizontally and vertically in the water column. Sound generated from a typical seismic airgun array in water depths comparable to the project area (25–50 m [75–150 ft]) will travel about 50–75 km (30–45 mi) (Richardson et al. 1995). The sounds generated from the proposed seismic survey may lead to some disturbance of birds in the project area (MMS 2006). There is little research into the effects of underwater seismic airgun pulses on seabirds. Lacroix et al. (2003) studied the behavioral and ecological response of long-tailed ducks to seismic airgun sound in the Beaufort Sea. The ducks were observed to move from the path of the approaching vessel while the airguns were in operation and return once the vessel left the area.

The small density of listed species and short duration of the proposed seismic surveys in the project area further reduce the likelihood of any adverse effects on individuals or local populations (MMS 2006).

Vessel Strikes

The presence of the seismic survey vessels do pose a risk of collisions by threatened and endangered species; however, this risk is expected to be extremely low. Previous seismic surveys in the Lease Sale 193 area in recent years have not reported strikes with any bird species. This is likely due to the low densities of birds in the area and the nearly 24-hour daylight in July and August when seismic surveys are conducted.

4.2.4.2 Polar Bear

Few polar bears are likely to encounter seismic survey vessels in the project area, and those that do may not react to them. Any adverse effects that do occur are likely to be limited to temporary, minor, disturbances to a small number of polar bears. The limited effects that could occur will be mitigated by ITR and LOA criteria (USFWS 2009).

Previous marine studies suggest that the number of polar bears observed in the project area is low and disturbance by industrial projects is minimal. Five polar bear observations (11 individuals) were recorded during the University of Texas at Austin's marine geophysical survey in the northern Chukchi Sea and Arctic Ocean performed by the USCG cutter Healy in 2006. All bears were observed on the ice between July 21 and August 19. Four of the groups exhibited changes in behavior when the helicopter or vessel were near, suggesting that disturbance from vessels may cause changes in behavior (USFWS 2007). None of the bears were in the water where possible effects from operating airguns may have occurred (USFWS 2007).

Since 1968, there has been only one documented case of a lethal take of a polar bear associated with Alaska oil and gas activities, at the Stinson site in the Alaska Beaufort Sea in 1990 (MMS 2007). The Chukchi Sea OCS oil and gas exploration activities in the 1980s and early 1990s did not result in any population level effects on polar bears (USFWS 2007). Exploration of the Chukchi shelf was discontinued after 1991 until 2006 when three open water seismic surveys were conducted.

Effects of Seismic Sound Source

Behavioral Reactions

MMOs were in place for seismic and shallow hazard surveys by Shell Offshore Inc. in the Chukchi Sea in 2008, and no polar bears were observed by MMOs on either the seismic vessel or its support vessels. Some polar bears were observed during the shallow hazard surveys (USFWS 2009), which is likely related to survey location, as seismic surveys occur in open waters away from ice concentrations, while shallow hazard surveys are close to shore, thus in closer proximity to bears near barrier islands. The MMOs involved reported 50 percent of polar bears observed did not respond to vessel presence, while 50 percent looked at the vessel. One polar bear swam toward the vessel, and the seismic airgun array was shut down to prevent possible effects from sound.

In 2006, three seismic surveys were conducted at different times in the Chukchi Sea, with a total survey line length of 26,029 km (Funk 2009). Four polar bears were observed on these surveys, three of which responded to the vessels by moving away. The polar bears were closely associated with ice and observed by vessels transiting the survey areas. None were observed during the active seismic surveys that occurred in relatively ice-free areas in the Chukchi Sea (USFWS 2009, Funk 2009, USFWS 2007).

Seismic operations in the Chukchi Sea have been authorized under the MMPA through the issuance of ITRs and LOAs, which require a number of mitigation measures, including the use of MMOs on vessels conducting seismic activities. Observers ensure vessels remain at least 0.8 km (0.5 mi) from polar bears observed on land or ice and provide the observation data to the USFWS. These data provide an indication of the level of effects that may result from future seismic surveys and exploratory drilling activities (USFWS 2009).

Masking

Masking is the coverage or reduction of a sound (e.g., marine mammal communications) when a stronger sound (e.g., airgun sounds) interferes with that sound (Richardson, Greene, et al. 1995). No adverse effect from this seismic survey is expected in regard to masking, as few polar bears are expected to exist in the seismic area; therefore, the likelihood of intraspecific communication will be extremely low.

Hearing Impairment

As polar bears normally swim with their heads above the surface, where underwater sounds are weak or undetectable (Richardson et al. 1995), it is unlikely these sounds would cause auditory impairment or other physical effects. Sound produced by seismic activities can elicit several different responses in polar bears. It may act as a deterrent to bears entering the area of operation, or attract curious bears. However, there is no evidence that airgun pulses can cause serious injury or death, even in the case of large airgun arrays (USFWS 2009).

The Chukchi Sea ITRs issued under the MMPA require mitigation measures for seismic survey operations in the Chukchi Sea. MMOs are responsible for instructing the vessel's captain to power down or shut down airgun arrays if polar bears enter the water within the 190 dB ensonification zone. This mitigation significantly reduces any adverse effects that might occur. Given that this seismic acquisition activity will avoid sea ice areas, coupled with the fact that polar bears swim, it is unlikely that seismic sounds would affect a bear long enough to have a significant effect on it (USFWS 2009).

4.2.4.3 Endangered Whales

Bowhead, humpback, and fin whales are the endangered whale species present in the Chukchi Sea during the time of Statoil's proposed seismic surveys. Bowhead whales are expected to be the most common whale in the area during project activities. All endangered whales in the Chukchi Sea are baleen whales, and they react similarly in the presence of seismic sounds. In the following analysis of the effects of seismic sounds on endangered whales, humpback, fin, and bowhead whales will be discussed jointly, because most studies have involved data on all baleen whales, not one species in particular. Information regarding the distribution, life history, and abundance of these whales in the Chukchi Sea is detailed in Section 3.2.4, Threatened and Endangered Species. These whales are baleen whales and are expected to respond similarly to other non-endangered baleen whales discussed in detail in Section 4.2.6, Marine Mammals.

Statoil will provide MMOs on all marine vessels to ensure that there will be a minimal effect on endangered whales present in the project area during seismic activities. Statoil's project activities are not expected to result in a significant effect on species or stocks of endangered whales. Expected effects on endangered whales by Statoil's seismic activities are discussed below. The availability of bowhead whales for subsistence uses is also not expected to be affected. A detailed discussion of the potential effects of Statoil's seismic activities on subsistence use of bowhead whales is included in Section 4.3.4, Subsistence.

Statoil has applied to NMFS for an authorization for Level B takes (harassment) of endangered whales due to sound exposure associated with seismic survey operations. The mitigation measures to be implemented during this survey are based on Level B harassment criteria using 160 dB re 1µPa rms and will, as such, minimize any potential risk of injury, such as damage to the hearing apparatus. The 180 dB re 1µPa rms radius (for whales and walruses) and the 190 dB re 1µPa rms radius (for seals and polar bears) are the levels where it is thought temporary hearing threshold shifts could occur, and they will also be closely monitored by MMOs. For a complete explanation of the estimated number of endangered whales expected to be taken by harassment during the proposed seismic acquisition project, consult Statoil's IHA application submitted to NMFS in December 2009. This section provides an overview of potential effects of seismic sounds on endangered whales likely to be within Statoil's project area during seismic activities.

Effects of Seismic Sound Source

Little is known about the hearing sensitivities of cetaceans or about what frequency ranges they use in vocalizations for specific functions due to the difficulties involved in studying marine mammals (Richardson et al. 1995; NRC 2005, 2003). Scientists have speculated that a species' hearing ability is in the same range as its vocalizations (Ketten 1998). It is important to consider hearing sensitivities of endangered whales when evaluating effects of seismic sound emissions, because the level of the effect on the whale depends upon how sensitive it is to the frequency and intensity of the sound.

Behavioral Reactions

The only expected behavioral reaction of marine mammals to Statoil's seismic activities is short-term, temporary displacement or avoidance. Because MMOs will be aboard all vessels monitoring safety radii and because Statoil will employ ramp-up procedures when starting the airguns, effects on endangered whales are expected to be limited to avoidance of the area around the seismic operations. Sex, age, group size, reproductive status, and the type of activity in which the whales are involved at the time could all influence the reaction of the whales to sound created by Statoil's seismic surveys. An animal's previous exposure to seismic sounds in the past could also be a factor in its behavioral response (NMFS 2008).

Baleen whales tend to avoid airguns in operation. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient sound levels out to much longer distances. It has also been reported, however, that when exposed to strong seismic pulses, whales often exhibit avoidance behaviors such as moving out of the area or deviating somewhat from their normal migration path. Although the migration path was slightly altered, the whales remained within natural migration corridors (NMFS 2008).

Previous studies have found that feeding and migrating whales are likely to move away from seismic vessels when received airgun levels are greater than or equal to 163 dB re 1 µPa (Malme, Wursig, et al. 1988). Most reactions exhibited by bowhead whales were in response to manmade sounds below 1 kHz (Richardson et al. 1995). The endangered baleen whale species in the area are more likely to be affected by low-frequency sounds. One whale study found indications of behavioral changes such as increased swim speed and shorter blow periods near seismic activities at a distance of up to 30 km (19 mi) away (Wursig et al. 1999). Studies conducted near active seismic vessels found baleen whales as close as 3 km (1.86 mi) away from the vessel (Reeves, Ljungblad and Clarke 1984).

Studies involving bowhead and humpback whales have determined that received levels of pulses in the 160–170 dB re 1µPa rms range seem to cause obvious avoidance behavior in many of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 4–15 km (2–9 mi) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other disturbance reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and studies have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re 1µPa rms.

Responses of humpback whales to seismic surveys have been studied during migration and on their summer feeding grounds. McCauley et al. (McCauley, Jenner, et al. 1998; McCauley, Fewtrell et al. 2000) studied the responses of migrating humpback whales off Western Australia to a full-scale seismic survey with a 16-airgun 2,678 cu in array and to a single 20 cu in airgun with a (horizontal) source level of 227 dB re 1 μPa m_{p-p}. They found that the overall distribution of humpback whales migrating through their study area was unaffected by the full-scale seismic project, although localized displacement varied with pod composition, behavior, and received sound levels. Observations were made from the seismic vessel, from which the maximum viewing distance was listed as 14 km (8.7 mi). The initial avoidance response generally occurred at distances of 5–8 km (3–5 mi) from the airgun array and 2 km (1.2 mi) from the single airgun. However, some individual humpback whales, especially males, approached within distances of 100–400 m (110–437 yards), where the maximum received level was 179 dB re 1 μPa rms. The McCauley et al. (1998, 2000a, b) studies show evidence of greater avoidance of seismic airgun sounds by pods with females than by other pods during humpback migration off Western Australia (McCauley, Fewtrell, et al. 2000; McCauley, Jenner, et al. 1998).

Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64-Liter (100 cu in) airgun (Malme and Miles 1985). Some humpbacks seemed “startled” at received levels of 150–169 dB re 1 μPa. Malme and Miles (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis.

Responsiveness of bowhead whales to seismic surveys can be quite variable depending on their activity (feeding vs. migrating). Summer studies in the Canadian Beaufort Sea by (Miller, Moulton, et al. 2005) and (Harris, Elliot and Davis 2007) showed that many feeding bowhead whales tend to tolerate higher sound levels than migrating bowhead whales before showing an overt change in behavior.

Bowhead whales on their summer feeding grounds in the Canadian Beaufort Sea showed no obvious reactions to pulses from seismic vessels at distances of 6–99 km and received sound levels of 107–158 dB on an approximate rms basis (Richardson, Wursig, and Greene 1986). Their general activities were indistinguishable from those of a control group. Bowheads usually did show strong avoidance responses when seismic vessels approached within a few kilometers (approximately 3–7 km) and when received levels of airgun sounds were 152–178 dB (Richardson et al. 1986; Richardson, Greene, et al. 1995; Ljungblad 1988; Miller, Moulton, et al. 2005). They also moved away when a single airgun fired nearby (Richardson, Wursig, and Greene 1986; Ljungblad 1988). In one case, bowheads engaged in near-bottom feeding began to turn away from a 30-airgun array with a source level of 248 dB re 1 µPa m at a distance of 7.5 km (5 mi) and swam away more quickly when it came within approximately 2 km (approximately 1.24 mi); some whales continued feeding until the vessel was 3 km (1.86 mi) away (Richardson, Wursig and Greene 1986).

On the summer feeding grounds, bowhead whales are often seen from the operating seismic ship, though average sighting distances tend to be farther when the airguns are operating. Similarly, preliminary analyses of recent data from the Alaskan Beaufort Sea indicate that bowheads feeding there during late summer and autumn also did not display large-scale distributional changes in relation to seismic operations (Christie et al. 2009; Koski et al. 2009). However, some individual bowheads apparently begin to react at distances a few kilometers away, beyond the distance at which observers on the ship can sight bowheads (Richardson, Wursig, and Greene 1986; Citta et al. 2007). The feeding whales may be affected by the sounds, but the need to feed may reduce the tendency to move away until the airguns are within a few kilometers.

Migrating bowhead whales in the Alaskan Beaufort Sea seem more responsive to sound pulses from a distant seismic vessel than do summering bowheads. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km (12–19 mi) from a medium-sized airgun source at received sound levels of around 120–130 dB re 1 μPa rms (Miller, Elliott, et al. 1999; Richardson, Miller, and Greene 1999; Manley et al. 2007). Those results came from 1996–98, when a partially controlled study of the effect of ocean-bottom cable seismic surveys on westward-migrating bowheads was conducted in late summer and autumn in the Alaskan Beaufort Sea. At times when the airguns were not active, many bowheads moved into the area close to the inactive seismic vessel. Avoidance of the area of seismic operations did not persist beyond 12–24 hours after seismic shooting stopped. Preliminary analysis of recent data on traveling bowheads in the Alaskan Beaufort Sea also showed a stronger tendency to avoid airguns in operation than was evident for feeding bowheads (Christie et al. 2009; Koski et al. 2009).

Aerial surveys flown between 1996 and 1998 showed that there was strong avoidance of the airguns operating, when most of the whales appeared to be migrating (Miller, Elliott, et al. 1999; Richardson, Miller and Greene 1999). In contrast, aerial surveys during the 2007–08 study showed less consistent avoidance by the bowheads, many of which appeared to be feeding (Christie et al. 2009; Koski et al. 2009).

Fin whales often have been seen in areas ensonified by airgun pulses (C. Stone 2003; Stone and Tasker 2006; MacLean and Haley 2004), and calls from fin whales have been localized in areas with airgun operations (McDonald, Hildebrand, and Webb 1995; Dunn and Hernandez 2009). Sightings by observers on seismic vessels during 110 large-source seismic surveys off the U.K. from 1997–2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. when they were silent (C. Stone 2003; Stone and Tasker 2006). However, these whales tended to exhibit localized avoidance, remaining significantly further (on average) from the airgun array during seismic operations compared with non-seismic periods (P = 0.0057) (Stone and Tasker 2006). In addition, fin whales were less likely to remain submerged during periods of seismic shooting (C. Stone 2003).

In a study off Nova Scotia, Moulton and Miller (2005) found little difference in sighting rates and initial average sighting distances of baleen whales when airguns were operating compared to when they were silent. However, there were indications that these whales were more likely to be moving away when seen during airgun operations. Baleen whales at the average sighting distance during airgun operations would have been exposed to sound levels of about 169 dB re 1 μPa rms (Moulton and Miller 2005). Similarly, ship-based monitoring studies of blue, fin, sei, and minke whales offshore of Newfoundland found no more than small differences in sighting rates and swim directions during seismic compared to non-seismic periods (Moulton, Mactavish, and Buchanan 2005, 2006; Moulton, Mactavish, Harris, et al. 2006). The authors of the Newfoundland reports concluded that, based on observations from the seismic vessel, some mysticetes exhibited localized avoidance of seismic operations (Moulton, Mactavish, Harris, et al. 2006; Moulton, Mactavish, and Buchanan 2006).

Masking

Masking of endangered whale calls by seismic sounds emitted by Statoil's proposed seismic acquisition project is expected to cause temporary and minimal, if any, effect on endangered whales near the project area. Masking is the coverage or reduction of a sound (e.g., marine mammal communications) when a stronger sound (e.g., airgun sounds) interferes with that sound (Richardson, Greene, et al. 1995). Masking from sounds introduced underwater can reduce the effective communication distance of endangered whales if the frequency of the source is close to that which they use and if the sound is present for a significant fraction of the time (Richardson, Greene, et al. 1995). Masking effects of pulsed sounds on endangered whale calls and other natural sounds are expected to be limited.

Some baleen whales are known to continue calling in the presence of seismic pulses (Richardson, Wursig, and Greene 1986; McDonald, Hildebrand, and Webb 1995; Greene, Altman, and Richardson 1999; Nieukirk et al. 2004; Smultea et al. 2004; Holst, Smultea, et al. 2005; Holst, Richardson, et al. 2006; Dunn and Hernandez 2009). Bowhead whales were thought to decrease their call rates in response to seismic operations, although movement out of the area might also have contributed to the lower call detection rate during a study in the Beaufort Sea (Blackwell, Greene, et al. 2009; Blackwell, Nations, et al. 2009). In contrast, Di Iorio and Clark (2009) found evidence of *increased* calling by blue whales during operations by a lower-energy seismic source (Di Iorio and Clark 2009).

Some studies suggest mammals have the ability to sort out sounds specific to communication, foraging, and safety while overlapping sounds occur (Southall et al. 2007; Madsen 2005). Other studies suggest several whale species might alter their vocalization levels to adjust to various levels of background sound (MMS 2006).

Hearing Impairment

Hearing impairments of endangered whales, especially permanent damage, are not expected as a result of exposure to seismic sound emitted during Statoil's proposed seismic acquisition project. In practice during Statoil's seismic surveys, few if any cases of temporary hearing impairments are expected, given the strong likelihood that baleen whales would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of damage. The ramp-up procedure will be used when starting airguns to give whales near the vessel the opportunity to clear the area before they are exposed to sound levels that might be strong enough to elicit temporary hearing impairments. As discussed earlier, single-airgun experiments with bowhead, gray, and humpback whales show that those species do tend to move away when a single airgun starts firing nearby, which simulates the onset of a ramp-up.

Exposure to sufficiently loud sounds can result in damage to endangered whales' hearing by causing a shift in hearing thresholds. The shifts can be temporary threshold shift (TTS) or permanent threshold shift (PTS). A threshold shift causes an animal to lose sensitivity to sounds that they could hear prior to the exposure. This type of damage can affect an animal by inhibiting its ability to locate prey, detect predators, or communicate with other individuals within its species. If TTS occurs, the whale will regain normal hearing ability some time after the exposure stops. PTS is permanent and cannot be reversed.

There are no data, direct or indirect, on levels or properties of sound that are required to induce TTS in any baleen whale. The frequencies to which mysticetes are most sensitive are assumed to be lower than those to which odontocetes are most sensitive; and natural background sound levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in mysticetes (Southall et al. 2007). However, preliminary simulation modeling that attempted to allow for various uncertainties in assumptions and variability around population means (Gedamke, Frydman and Gales 2008) suggested that some baleen whales whose closest point of approach to a seismic vessel is 1 km (0.62 mi) or more could experience TTS or even PTS.

4.2.4.4 Walrus

The seismic data acquisition survey will occur in areas of open water, where Pacific walrus densities are expected to be relatively low. Monitoring and mitigation measures related to the protection of walruses will be put in place. These measures include onboard MMOs who will assist the vessel in avoiding interactions with walrus groups, monitor established operational buffer zones around the vessel for walruses, and monitor walrus behavioral response to seismic activities (MMS 2007).

The probability of encountering walrus during seismic operations is highly dependent on the presence of ice in the area. During historical exploration activities in the Chukchi, ice was present in some years and not in others, with many more walrus being found in a prospect area when ice was near (MMS 2009). Seismic activity will not be conducted if there is heavy ice in the project area. If pack ice is present in feeding areas such as the Hanna Shoal area, walrus on ice floes could be affected. Effects would probably be limited to slight changes in distribution, with some walrus avoiding the area or retreating to the center of the ice floe. All such effects would be minor and temporary, lasting only as long as the ice and walrus, which are moving with wind and current, are in the area (MMS 2009).

Effects of Seismic Sound Source

Because seismic operations likely would not be concentrated in any one area for extended periods, any effects on walruses should be relatively short in duration; and there should be a negligible overall effect on the Pacific walrus population (MMS 2007).

Concern has focused on the intensity of effects on marine mammals from sound, and limited data are available pertaining to walrus hearing ability and the effects of anthropogenic sounds on this species. The underwater hearing of a walrus has been measured at frequencies from 125 Hz–15 kHz , with the range of best hearing from 1–12 kHz, and maximum sensitivity (67 dB re 1 μPa) occurring at 12 kHz (Kastelein et al. 2002). The energy emitted from a typical high-energy airgun is usually at relatively low frequencies, emitting energy at 10–120 Hz. (Goold and Fish 1998; Potter et al. 2007).

It is not known, however, how sound introduced into the environment will affect walrus during seismic surveys (MMS 2007). Avoidance behavior, such as temporary deflection, is the most likely behavioral response as a result of Statoil's seismic activities in the Chukchi Sea (MMS 2009).

Statoil's proposed seismic acquisition project will introduce airgun sounds into the marine environment that could affect walruses. There are, however, no data available to evaluate the potential response of walruses to these particular seismic operations (MMS 2007). Airgun sounds introduced into the environment have the potential to affect walrus behavior, mask intraspecies communications and other natural sounds, or cause hearing impairments (MMS 2009).

Behavioral Reactions

Behavioral reaction to sound can cause animals to flee a land or ice haulout en masse, potentially causing physical injuries or mortalities. The potential for a given sound to cause adverse effects on Pacific walruses is habitat-dependent (MMS 2007). Marine mammal monitoring programs are expected to provide some insight to the response of walruses to seismic operations from which future mitigations can be derived (MMS 2007).

Little is known regarding walruses' reaction to airgun sounds, but some studies have been conducted regarding their response to other types of sound such as those created during exploration drilling. J. C. Brueggeman (1990) evaluated responses of walrus in past drilling operations in the project area and compared behavior before and after drilling. Walrus density, mean group size, association with ice cover, distance from the ice edge, and distance from the area were compared. Walrus density and group size before and during drilling were found not to differ, but distribution did change. Walrus showed no preference for a particular amount of ice cover before operations but preferred areas of moderate ice cover during operations.MMOs onboard the seismic and support vessels in the 2006 open water season recorded a total of 1,186 walruses; 318 of the walruses sighted during seismic operations (27 percent) exhibited some form of behavioral response to the vessels (dispersal or diving). Seismic vessels in this season reported 33 walruses in 2006; most of the walruses were recorded by support vessels during ice-scouting missions. Nineteen walruses were observed within the predetermined 190 dB safety zone of ensonification and required the shutdown of airgun arrays.

None of these interactions were believed to result in anything other than a temporary change in the behavior of individual walruses (USFWS 2007).

Masking

Monitoring for walruses by MMOs will ensure that any effects of masking by Statoil's proposed seismic acquisition project will be minimal and temporary. Masking effects of airgun sounds on walrus calls and other natural sounds are expected to be limited due to the intermittent nature of the pulses. Walruses produce a variety of sounds (grunts, rasps, clicks), which range in frequency from 0.1–10 Hz (Richardson, Greene, et al. 1995). Quantitative research on masking effects on walruses has been limited because no audiograms (a test to determine the range of frequencies and minimum hearing threshold) have been done on the species. Masking effects of pulsed sounds on walrus calls and other natural sounds are expected to be limited. The intermittent nature of airgun pulses reduces the potential for masking.

Hearing Impairments

There is no specific evidence that exposure to pulses of airgun sound can cause PTS to the hearing of walruses. Although the hearing sensitivity of walruses is poorly known, source levels are thought to be high enough to cause temporary hearing loss in other species of pinnipeds. Therefore, it is possible that walruses within the 190-decibel (dB re 1 μPa) safety radius sound cone of seismic activities (industry standard) could suffer TTS. With Statoil mitigation measures in place (e.g., MMOs and shutdown procedures), the probability of walruses being exposed to sounds that could cause injury is unlikely (MMS 2007).

Effects of Vessel Transit

Vessel transit may temporarily displace walruses from preferred feeding areas or temporarily deflect them from migration routes. Due to the tendency of walruses to aggregate in large groups, they are particularly vulnerable to disturbance events. Females with dependent young are considered the least tolerant of disturbances, and walruses in the water are thought to be more tolerant to disturbance stimuli than those hauled out. Seismic survey vessels that are present during ice-minimum conditions in summer in the Chukchi Sea are likely to come into contact with adult females and subadult walruses (Jay, Ballechey, et al. 1996).

Walruses will flee haulout locations in response to disturbance from aircraft and ship transit, although reactions are highly variable (Richardson, Greene, et al. 1995). Helicopters, which are likely to elicit responses from walruses, will not be used during this Statoil seismic acquisition, except in the case of emergency. The reaction of walruses to vessel transit appears to depend on vessel type, distance, speed, and previous exposure to disturbances. Other factors, such as weather and length of time hauled, also may contribute to the response (MMS 2007). Documented reactions of walrus to vessels include waking up, head raising, and entering the water (Richardson, Greene, et al. 1995).

Brueggeman et al. (1990, 1991) monitored the behavior of walrus in response to vessels associated with exploration drilling in the prospect area in 1989 and 1990. They reported that none of the observed groups of walrus exhibited avoidance behavior in response to anchored or drifting vessels. Eighty-one percent of walruses encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walruses may be tolerant of ship activities and movements. Responses of walrus to moving vessels varied with distance, ranging from no response, to approaching the vessel, to avoidance behavior. Most walrus reacted when the vessel came within about 500 m (550 yd) of the walrus. Brueggeman et al. (1991) also noted that the behavioral effect on walrus was of a very brief duration, with displaced walrus occasionally reoccupying ice floes as soon as the vessel passed (MMS 2009). Therefore, effects of vessel presence on walruses should be minor and short-term, consisting only of temporary displacement (MMS 2009). Walrus hunters and researchers have noted that walruses tend to react to the presence of humans and machines at greater distances from upwind approaches than from downwind approaches, suggesting that odor may also be a stimulus for a flight response. The visual acuity of walruses is thought to be less than for other species of pinnipeds (Garlich-Miller, 2006, personal communication (MMS, Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea 2007).

Potential effects of vessel presence on marine mammals would be reduced with implementation of Statoil's mitigation measures, which prohibit vessels from operating within 800 m (0.5 mi) of walrus when they are observed on land or ice. Vessels under way will reduce speed and avoid multiple course changes when within 275 m (300 yd) of marine mammals in the water to avoid separating members from a group. Vessel speed will also be reduced during inclement weather conditions in order to avoid accidental collisions with marine mammals. No Statoil vessels will intentionally approach any marine mammal.

4.2.5 Marine and Coastal Birds

The distribution and abundance of bird species expected to be in the project area and associated coastal areas are discussed in Section 3.2.5. The species of birds expected in the project area when the vessels are operating are limited due to the distance from shore and the water depths. These species include northern fulmar, short-tailed shearwater, long-tailed duck, phalaropes, jaegers, glaucous gulls, black-legged kittiwake, thick-billed murre, Ross's gull, black guillemot, Arctic tern, least auklet, and crested auklet. Other species may be present in smaller numbers or found in shallower waters between the prospects and the coast.

Transit of the seismic and support vessels could result in very minor and temporary disturbance to birds found in offshore waters, leaving no demonstrable effect on the bird populations. The probability of effects to birds in coastal areas associated with activity from this seismic survey is extremely low (MMS 2007, 2009).

4.2.5.1 Effects of Seismic Sound Source

The sound generated from the operation of a seismic airgun array travels horizontally and vertically in the water column. Sound generated from a typical seismic airgun array in water depths comparable to the project area (25–50 m [75–150 ft]) will travel about 50–75 km (30–45 mi) (Richardson et al. 1995). Published research on the effects of seismic airgun sound on coastal and marine birds is limited. However, studies by Evans et al. (1993), evaluating marine bird behavior in the North Sea, found no observable difference in bird behavior in the presence of operating seismic vessels. Similar studies in the Canadian Arctic by Webb and Kempf (1998) and Stemp (1985) found no statistical difference comparing bird distribution with or without ongoing seismic surveys.

Lacroix et al. (2003) investigated the effects of a marine seismic survey on molting long-tailed ducks in the Beaufort Sea and found that the survey program did not cause them to move from their feeding areas and had no effect on their movements or diving behavior. These studies indicate that sound sources (seismic airguns) result in no long-term effects on birds. Any effects would consist of temporary and minor behavior responses, such as the flushing of birds from the vicinity of the vessel. Any such effects would likely last only minutes to a few hours (MMS 2009).

4.2.5.2 Effects of Vessel Transit

Vessel transit will primarily occur more than 97 km (60 statute mi) offshore where bird densities are relatively low. As vessels pass an area, most birds would likely move some distance away and then, soon after, continue foraging and resting.

Studies of bird response to vessel transit are limited. Lacroix et al. (2003) conducted an investigation of the effects of a marine seismic survey on ducks in the Beaufort Sea that involved the transit of five vessels with lengths of 23–41 m (75–135 ft). They found the survey activities had no significant effect on the birds' behavior. Agness et al. (2008) studied the effects of various types of vessels with lengths of 6–305 m (20–1,000 ft) on Kittlitz's murrelets and observed only temporary effects on the birds' behavior in the area. Neither the murrelet group size nor foraging habitat was affected by vessel activity.

Therefore, only minor disturbances from vessel transit are anticipated.

4.2.5.3 Vessel Strikes

Seismic surveys in the Lease Sale 193 area in recent years have not reported strikes with any bird species. Vessels transiting through open water can pose a collision risk to some species of birds; however, collisions between birds and seismic or support vessels are not expected to occur due to the relatively low density of birds in the project area and the nearly 24-hour daylight conditions for much of the project duration.

Studies indicate some bird species that fly at low altitudes or are attracted to lighting have the highest potential for colliding with vessels and that attraction or disorientation from lighting on project vessels may be exacerbated by fog or rain (Brown 1993). Little information is currently available on the cause and effect of light-induced bird strikes. The most relevant studies in the Arctic Ocean are those assessing the behavior of birds at the Endicott and Northstar facilities (Day et al. 2005), which are located on artificial islands in nearshore waters of the Alaskan Beaufort Sea. Studies conducted at the Northstar Island facilities for monitoring bird strikes indicate the probability of bird strikes with vessels in the project area will be extremely low at that time of year.

No avian collisions with the vessels are expected to occur during the planned seismic operations, as the project area is located at least 100 km (60 mi) offshore where bird densities are low.

4.2.6 Marine Mammals

Statoil's proposed seismic acquisition project activities are not expected to result in a significant effect on species or stocks of marine mammals. Statoil will provide MMOs on all vessels to mitigate effects on marine mammals present in the project area during seismic activities and vessel transit. Statoil's project activities should also not affect the availability of species or stocks for subsistence uses. A detailed discussion of the potential effects of seismic activities on subsistence use of marine mammals is included in Section 4.3.4, Subsistence.

4.2.6.1 Effects of Seismic Sound Source

Many marine mammals rely upon hearing for orientation, navigation, predator detection, mate selection, and communication (NRC 2003, 2005; Erbe et al. 1999). The proposed seismic activities potentially affecting marine mammals are expected to result in temporary displacement of whales and seals within the ensonification zones but are not expected to result in significant behavior disruption or physical injury.

Little is known about the hearing sensitivities of marine mammals or about what frequency ranges they use in vocalizations for specific functions due to the difficulties involved in studying them (Richardson et al. 1995; NRC 2005, 2003). Scientists believe that an animal's hearing ability is in the same range as its vocalizations (Ketten 1998). It is important to consider hearing sensitivities of marine mammals when evaluating effects of seismic sound emissions, because the level of the effect on the marine mammal depends upon how sensitive it is to the frequency and intensity of the sound.

Sounds introduced into marine mammal habitat could alter behavior, interfere with communication, mask important natural sounds, or cause hearing impairments. Effects on whale and seal populations in the Chukchi Sea are dependent upon the auditory and behavioral sensitivity of the species (Richardson, Greene, et al. 1995) and are likely to be short-term and temporary. Extrapolation about the effects of seismic sound on marine mammals from studies in locations other than in Statoil's project area are somewhat speculative, because characteristics of the specific environment such as seabed properties can greatly affect the propagation of sound from the source. Physical effects, such as injury or death, resulting from airgun operations are unlikely and not expected to occur during Statoil's proposed seismic activities.

Statoil has applied to NMFS for authorization of Level B takes (harassment of marine mammals) due to sound exposure associated with seismic operations. The mitigation measures to be implemented during this survey are based on Level B harassment criteria to minimize any potential risk of injury, such as damage to the hearing apparatus. Distances to received levels of 160, 180, and 190 dB re 1 μPa (rms) are of importance as safety radii for mitigation purposes. MMOs will monitor the 160 dB re 1μPa rms radius, which is the sound level at which marine mammals are expected to exhibit alterations in behavior. The 180 dB re 1μPa rms radius (for whales and walruses) and the 190 dB re 1μPa rms radius (for seals and polar bears) are the levels where it is thought temporary hearing threshold shifts could occur and they will also be closely monitored by MMOs.

For a complete explanation of the estimated number of animals expected to be exposed to airgun sounds of ≥160 dB re 1μPa, consult Statoil's IHA application, which was submitted to NMFS in December 2009. This section provides an overview of potential effects of seismic sounds on marine mammals likely to be within Statoil's project area during seismic activities.

Behavioral Reactions

The only expected behavioral reaction of marine mammals to Statoil's seismic activities is temporary displacement or avoidance.

Sound source energy propagated into the water by seismic airguns can be detected many kilometers away. Although baleen whales, toothed whales, and pinnipeds have all been shown to exhibit behavioral responses to seismic sounds, there are also studies for each of these groups that show no behavioral response. Sex, age, group size, reproductive status, and the type of activity in which the animal is involved at the time could all influence the reaction of an animal to sound created by Statoil's seismic surveys. An animal's previous exposure to seismic sounds in the past could also be a factor in its behavioral response.

Baleen Whales

Baleen whales tend to avoid airguns in operation. Whales are often reported to show no overt reaction to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient sound levels out to much longer distances. It has also been reported, however, that when exposed to strong seismic pulses, whales often exhibit avoidance behaviors such as moving out of the area or deviating from their normal migration path. Although the migration path was slightly altered, the whales remained within natural migration corridors (NMFS 2008).

Previous studies have found that feeding and migrating whales are likely to move away from seismic vessels when received airgun levels are greater than or equal to 163 dB re 1 μPa (Malme, Wursig, Bird, et al. 1988). Most reactions exhibited by bowhead whales were in response to manmade sounds below 1 kHz (Richardson, Greene, et al. 1995). Baleen whales are more likely to be affected by low-frequency sounds. One whale study found indications of behavioral changes, such as increased swim speed and shorter blow periods, near seismic activities at a distance of up to 30 km (18.64 mi) away (Wursig et al. 1999). Studies conducted near active seismic vessels found whales as close as 3 km (1.86 mi) away from the vessel (Reeves, Ljungblad and Clarke 1984).

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1µPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 4–15 km (2–9 mi) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other disturbance reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and studies have shown that some species of baleen whales—notably bowhead and humpback whales—at times show strong avoidance at received levels lower than 160–170 dB re 1µPa rms.

Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100-cu in airgun off St. Lawrence Island in the northern Bering Sea (Malme, Wursig, and Tyack 1986; Malme, Wursig, Bird, et al. 1988). They estimated, based on small sample sizes, that 50 percent of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1µPa on an (approximate) rms basis and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast and on observations of western Pacific gray whales feeding off Sakhalin Island, Russia (Wursig et al. 1999; Johnson et al. 2007; Meier et al. 2007; Yazvenko et al. 2007).

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive sounds do not necessarily provide information about long-term effects. However, gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration and extensive ship traffic in that area for decades (Malme, Miles, et al. 1984). Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson, Davis, et al. 1987). Populations of both gray whales and bowhead whales grew substantially during this time. In any event, the brief exposures to sound pulses from the proposed airgun source are highly unlikely to result in prolonged effects.

Toothed Whales

Toothed whales have a hearing sensitivity and/or produce most of their sounds at much higher frequencies than baleen whales; thus they are more likely to be affected by high-frequency sounds. Although their hearing is largely insensitive to the majority of sounds produced by airguns, some sound is still audible to these whales at distances up to tens of kilometers (Southall et al. 2007).

Toothed whales tend to react to seismic sounds, such as those produced in seismic surveys similar to Statoil's proposed project, at a shorter distance from the source than baleen whales. Studies in the Canadian Beaufort Sea have shown beluga whales to be fairly responsive to airgun sound (Miller et al. 2005). Seismic activities are expected to cause temporary displacement of beluga whales, but the effect is not expected to be significant. Reports suggest that belugas will remain far away from seismic vessels (Miller et al. 2005). A study in the Beaufort Sea observed low numbers of belugas within 10–20 km (6–12 mi) of seismic vessels (LGL and Greeneridge 1996). Belugas will likely occur in small numbers in the Chukchi Sea during the survey period.

Belugas may be a species that (at least at times) shows long-distance avoidance of seismic vessels. Aerial surveys during seismic operations in the southeastern Beaufort Sea recorded much lower sighting rates of beluga whales within 10–20 km (6–12 mi) of an active seismic vessel. These results were consistent with the low number of beluga sightings reported by observers aboard the seismic vessel, suggesting that some belugas might be avoiding seismic operations at distances of 10–20 km (6–12 mi) (Miller et al. 2005). Captive bottlenose dolphins and (of more relevance to this project) beluga whales exhibit changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran, Schlundt, et al. 2002; Finneran, Carder, et al. 2005). However, the animals tolerated high received levels of sound before exhibiting aversive behaviors. Statoil's seismic survey would produce similar sounds limited to distances less than 200 m (656 ft) of the 26-airgun array in shallow water.

Studies have shown that harbor porpoises show strong avoidance to airgun sounds with received levels of at least 140 dB re 1µPa (NMFS 2005). Harbor porpoises avoided feeding habitat when sounds greater than 180 dB re 1 µPa at 1 m were present (Johnston 2002). Harbor porpoises are expected to avoid seismic activities, and marine mammal monitoring would ensure minimal effects on toothed whales.

Stone (2003) reported that, during seismic activities, killer whale sightings remained constant, but distance from airguns during seismic shooting was significantly greater. They also appeared more resilient to airgun sounds in deeper waters (Stone 2003). Killer whales have been shown over a number of years to avoid high amplitude sounds (Morton and Symonds 2002).

Seismic operators and MMOs sometimes see dolphins and other small toothed whales near operating airgun arrays, although in general there seems to be a tendency for most delphinids to show some limited avoidance of seismic vessels operating large airgun systems. Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing. Nonetheless, there have been indications that small toothed whales sometimes move away or maintain a somewhat greater distance from the vessel when a large array of airguns is operating than when it is silent (Goold 1996; Calambokidis and Osmek 1998; Stone 2003).

Porpoises show variable reactions to seismic operations, and reactions apparently depend on species. During seismic surveys with large airgun arrays off the U.K. in 1997–2000, there were significant differences in directions of travel by harbor porpoises during periods when the airguns were shooting vs. when they were silent (C. Stone 2003; Stone and Tasker 2006).

Seals

Seals generally do not react to sound sources from airguns. Observation rates for ringed seals, bearded seals, and spotted seals in the Beaufort Sea were similar when there was no airgun firing (0.63 seals per hour) or a single airgun was firing, compared to a full array firing (Harris, Miller, and Richardson 2001).

Of the pinnipeds likely to be encountered in Statoil's project area, the ringed seal is by far the most abundant. It was estimated that less than 1 percent of Bering-Chukchi Sea stock and Beaufort Sea stock will be exposed to airgun sounds at received levels greater than or equal to 160 dB re 1 µPa (rms) during Statoil's seismic survey. Refer to Statoil's IHA application for precise estimates of the numbers of marine mammals expected to be taken by harassment. The estimated numbers of exposure for the bearded seals and spotted seals also represent less than 1 percent of their populations. It is likely that only a small percentage of the pinnipeds exposed to a sound level greater than or equal to160 dB would actually be disturbed.

Masking

Monitoring of safety radii for marine mammals will ensure that any effects of masking by Statoil's proposed seismic acquisition project will be minimal and temporary.

Masking is the coverage or reduction of a sound (e.g., marine mammal communications) when a stronger sound (e.g., airgun sounds) interferes with that sound (Richardson, Greene, et al. 1995). Masking from sounds introduced underwater can reduce the effective communication distance of a marine mammal if the frequency of the source is close to that which it uses and if the sound is present for a significant fraction of the time (Richardson, Greene, et al. 1995). Masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited.

Some whales are known to continue calling in the presence of seismic pulses (Richardson, Wursig, and Greene 1986; McDonald, Hildebrand, and Webb 1995; Greene, Altman, and Richardson 1999; Nieukirk et al. 2004; Smultea et al. 2004; Holst, Smultea, et al. 2005; Holst, Richardson, et al. 2006; Dunn and Hernandez 2009). Some studies suggest that marine mammals have the ability to sort out sounds specific to communication, foraging, and safety while overlapping sounds occur (Southall et al. 2007; Madsen 2005). Other studies suggest several whale species might alter their vocalization levels to adjust to various levels of background sound (MMS 2006).

Baleen Whales

Bowhead whales were thought to decrease their call rates in response to seismic operations, although movement out of the area might also have contributed to the lower call detection rate during a study in the Beaufort Sea (Blackwell, Greene, et al. 2009; Blackwell, Nations, et al. 2009). In contrast, Di Iorio and Clark (2009) found evidence of increased calling by blue whales during operations by a lower-energy seismic source (Di Iorio and Clark 2009). The ability of whales to change their calling behavior and their ability to tolerate some masking by natural sounds (Richardson et al. 1995) reduces the likelihood of more than minimal effects of masking by airgun sounds.

Toothed Whales

Masking effects of seismic pulses are expected to be negligible in the case of toothed whales, given the intermittent nature of seismic pulses produced by airguns and the fact that toothed whales communicate using calls at much higher frequencies than airgun sounds. Belugas on the St. Lawrence River in Canada adjusted by vocalizing more loudly when exposed to high-level sound sources (Scheifele et al. 2005). Dolphins and porpoises are also commonly heard calling while airguns are operating (Gordon et al. 2004; Smultea et al. 2004; Holst et al. 2005a, b; Potter et al. 2007).

Seals

Seals have best hearing sensitivity and/or produce most of their sounds at frequencies higher than the dominant components of airgun sound, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of airgun pulses reduces the potential for masking.

Physical Effects

Because MMOs will be aboard all vessels to monitor safety radii and because marine mammals tend to avoid the immediate area around operating seismic vessels (Malme et al. 1986), physical injuries of marine mammals resulting from sounds produced by Statoil's seismic survey are unlikely and not expected.

Exposure to sufficiently loud sounds can result in damage to marine mammals by causing a shift in hearing thresholds. The shifts can be temporary (TTS) or permanent (PTS). A threshold shift causes an animal to lose sensitivity to sounds that they could hear prior to the exposure. This type of damage can affect an animal by inhibiting its ability to locate prey, detect predators, or communicate with other individuals within its species.

If TTS occurs, the animal will regain normal hearing ability some time after the exposure stops. PTS is permanent and cannot be reversed. TTS or PTS are not expected as a result of Statoil's seismic surveys, because MMOs will be aboard all vessels to monitor the safety radii to ensure that marine mammals are not exposed to sounds that could cause physical damage. In addition to monitoring safety radii, Statoil will employ ramp-up procedures to give marine mammals sufficient time to leave the area prior to full-force airgun operations. The 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid TTS, let alone permanent auditory injury, at least for belugas and delphinids. The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely detectable TTS.

TTS and PTS in given species' ears depend on the frequency sensitivity of that species. Bowhead and gray whales operate at low frequency, killer whale and beluga at mid-frequency, and the harbor porpoise at high frequency (Finneran, Schlundt, et al. 2002). Whales are not expected to be exposed to sounds loud enough to induce TTS or PTS, because MMOs will be aboard all vessels monitoring safety zones and employing power-down and shutdown procedures if necessary.

Hearing capabilities of baleen whales have not been directly studied (Richardson, Greene, et al. 1995). Therefore, predictions of effects on their hearing are based upon assumptions rather than factual data (Richardson, Greene, et al. 1995; Ketten 1998; Gordon et al. 1998). There are no data identifying the level of sound intensity that causes a TTS in baleen whales, but because most baleen whales show avoidance at certain sound intensities, risk of TTS is small (Southall et al. 2007; MMS 2006).

Other physical effects that theoretically could occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, and other types of organ or tissue damage. However, studies examining such effects are limited. If any such effects do occur, they probably would be limited to unusual situations when animals might be exposed at close range for unusually long periods. It is doubtful that any single marine mammal would be exposed to strong seismic sounds for sufficiently long that significant physiological stress would develop. That is especially the case during Statoil's proposed seismic survey, where the airgun configuration focuses most energy downward, the ship is moving at 4–5 knots, and most animals are migrating southward.

Under prolonged exposure, pinnipeds have been shown exhibiting TTS. Kastak (1999) investigated the effects of sound on two California sea lions *(Zalophus californianus),* one northern elephant seal *(Mirounga angustirostris),* and one harbor seal *(Phoca vitulina).* Kastak (1999) subjected each pinniped to a sound source (100–2,000 Hz) for 20–22 minutes. Each pinniped showed a threshold shift averaging 4.8 dB (harbor seal), 4.9 dB (sea lion), and 4.6 dB (northern elephant seal) until the hearing threshold returned to pre-exposure values (under a 12-hour period).

4.2.7 Terrestrial Mammals

The Statoil 2010 Chukchi Marine Seismic Survey is an offshore data acquisition project and will not have an effect on terrestrial mammals.

4.3 Socioeconomic Effects

Socioeconomic effects are expected to be minimal and temporary. Subsistence resources are the most likely socioeconomic category to be affected; however, effects on subsistence resources, if any, will be localized and only last for the duration of the seismic acquisition project (refer to Section 4.3.4 for details).

4.3.1 Traditional Knowledge

Statoil has incorporated Traditional Knowledge in its evaluation of the environmental setting within which the 2010 Chukchi Marine Seismic Survey occurs. Statoil will continue to gather Traditional Knowledge through comprehensive stakeholder engagement activities with North Slope residents who use the subsistence resources of the Chukchi Sea region. The gathering of Traditional Knowledge is an ongoing process and includes the collection of both historical and contemporary knowledge of community elders, whaling captains, hunters, and other subsistence users. Statoil began the process of gathering Traditional Knowledge when it met with community leadership and the NSB planning commission and staff in 2009 and again at the POC meetings held in the communities in January 2010. Where applicable, this knowledge has been incorporated into Statoil's 2010 project performance. For example, MMOs will be recruited, trained, and employed on the seismic source and support vessels not only to fulfill 4MP requirements but also to provide Statoil with Traditional Knowledge about marine mammals and subsistence practices for use in future planning.

4.3.2 Community Profiles

The Statoil 2010 Chukchi Marine Seismic Survey will have negligible, if any, effects on the community population, infrastructure, and government organization of the communities closest to the project area. The project activities will be conducted between 100 mi (Barrow) and 340 mi (Kivalina) from the nearest North Slope community. Specific economic and subsistence activities of these communities and the potential for effects from the project are discussed in detail in Section 4.3.3, Economy, and Section 4.3.4, Subsistence.

4.3.3 Economy

Very few economic effects are anticipated for the affected communities as a result of Statoil's 2010 seismic exploration. The seismic source and support vessels will be self-contained, and Nome is the designated port for resupply and crew changes. Subsistence is a large component of both the NSB and NWAB economies and is key to the way of life in Chukchi villages. Because of the timing and location of the proposed seismic survey activity, Statoil expects effects on subsistence to be minimal. Effects are discussed in detail in Section 4.3.4.

4.3.3.1 Employment

Statoil's seismic acquisition project will potentially have a positive effect on employment for residents of the NSB and NWAB. Employment opportunities would include temporary positions for MMOs on the vessels. Twelve Iñupiat MMOs will be hired to work on the vessels for the duration of the project.

Increased NSB and NWAB employment and personal income could be generated if exploration, development, and production activities occurred in the future. Generally, employment and associated personal income expectations are low during the limited seasons of exploration, peaking during development, and dropping to a plateau during production.

4.3.3.2 Economic Development

Aside from MMO jobs, Statoil expects no immediate economic development directly resulting from this 1-year seismic acquisition project. If the project leads to future exploration, development and production, there may be an opportunity for economic development in both the NSB and the NWAB. These potential, indirect effects are beyond the scope of this document, and evaluation of these will be required at a later date if exploration occurs.

4.3.4 Subsistence

Effects from Statoil's 2010 Chukchi Marine Seismic Survey activities on subsistence resources and access to these resources are expected to be minimal, if any.

In the *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Activities in the Chukchi Sea Final Environmental Impact Statement,* the MMS concluded that short-term, local disturbance resulting from the lease sale, seismic activities, and potential activities could affect subsistence activities. However, the MMS also concluded that neither long-term, permanent effects would result, nor would harvest areas become unavailable to subsistence users (MMS 2007).

4.3.4.1 Barrow

Bowhead

Effects of the proposed seismic operations, including vessel transit, on the Barrow subsistence harvest of bowhead whale are expected to be negligible. The proposed seismic operations will be conducted approximately 241 km (150 mi) from Barrow and are not expected to conflict with subsistence hunting activities. Barrow concerns for subsistence harvest of bowheads are addressed as part of the POC process currently under way between Statoil and the affected subsistence communities.

The bowhead whale is extremely important to Barrow culture and a major part of the subsistence harvest. Residents of Barrow hunt bowheads during the spring migration, which takes place in the ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area. These spring hunts are conducted in open leads in the ice, typically from late March or early April until the first week of June. Statoil's operations commence in July after these spring hunts are completed. Therefore, the seismic program would have no direct effect on these subsistence activities.

Barrow residents also hunt bowheads in the fall (August–October). Most of this fall hunting is conducted east of Barrow; however, hunting is conducted along the Chukchi Sea coast west of Barrow in some years (Suydam et al. 2009). Statoil's activities would be conducted at a great distance from subsistence hunting areas. Effects on bowhead behavior or movements would be negligible during Barrow's fall whaling, as the whales will have already passed subsistence areas used by Barrow whalers when they enter Statoil's prospect areas.

Traditional subsistence users are of the opinion that whales can hear sounds at much greater distances and may modify their behavior for longer periods of time (MMS 2008), resulting in potentially greater effects on the subsistence hunt. Iñupiaq hunters are concerned that increased oil and gas industry activity will disrupt current whale migration routes. They fear the bowhead might change their route to one much farther from shore (MMS 2008, 2009). The majority of marine mammals are taken by hunters approximately 33 km (21 mi) from shore, and the seismic source vessel M/V *Geo Celtic* will remain much farther offshore—well outside the hunting areas. Considering the timing and location of the proposed seismic survey activities, the project is not expected to have any significant effects on the availability of marine mammals for subsistence. Statoil vessels will support the Marine Mammal Monitoring and Mitigation Plan (4MP) activities, which will serve to prevent and mitigate impacts to marine mammal subsistence resources.

Beluga

Seismic operations will be conducted approximately 241km (150 mi) from Barrow and are not expected to conflict or interfere with the community's subsistence harvest of beluga whales.

The importance of beluga in the subsistence harvest varies by year and village. The spring beluga hunt takes place between April and June in the open leads between Point Barrow and Skull Cliff. Later in the spring, whalers in Barrow hunt belugas in open water around the barrier islands off Elson Lagoon, generally within 16 km (10 mi). Belugas are occasionally hunted by Barrow residents in coastal waters during July and August, primarily after the spring bowhead hunt, but they represented only about 0.5 percent of the total Barrow subsistence harvest.

Iñupiaq hunters are concerned that sound may cause the whales to leave for the long term. According to the MMS (2008), sound energy from moving vessels could cause brief disruption to the beluga whale harvest, but not make the resource unavailable to subsistence users. Beluga whales respond differentially to vessel sound energy, but temporary and localized sound energy from vessels should cause only brief disturbances to the whales. These disturbance effects have a duration of 1 day or less (MMS 2008)

Hunters conduct themselves quietly when hunting beluga, even going as far as using hand signals to communicate. Beluga are said to have excellent hearing ability and can identify and remember individual outboard motor boats. Some Iñupiat worry that beluga will remember sound in an area from one year and avoid that area in following years (MMS 2008, 2009).

The seismic survey activities will take place well offshore, far away from areas that are used for beluga hunting by the Chukchi Sea hunters.

Walrus

Since the Statoil seismic survey will be conducted in open water conditions and far offshore, no effect on the subsistence harvest of walrus is anticipated.

Barrow residents harvest walrus in conjunction with the spring bowhead hunt in the Chukchi Sea from Point Barrow to Peard Bay, generally within 56 km (35 mi) of shore, but the primary hunting effort occurs from late June to mid-September, with a peak in August.

The numbers of walrus possibly encountered during the offshore seismic operations is variable and highly dependent on the amount and proximity of pack ice. Numbers of walrus observed during the monitoring of past exploration drilling in the Chukchi Sea have ranged from 20,000–25,000 (J. C. Brueggeman 1990, 1991).

Although a portion of the walrus harvest occurs in the spring prior to Statoil's proposed 2010 operations, some subsistence users hunt walrus throughout the summer, and these hunting activities could be affected if support vessels servicing the offshore operations and seismic operations were to use Barrow for services. Statoil anticipates the effects to be minor because support vessel service and crew change is planned out of Nome. In addition, Statoil has in place mitigation efforts to keep seismic and vessel disturbance from disrupting normal walrus behavior (foraging, migrating, etc.). Detailed information on potential effects of Statoil's proposed seismic activities on walrus are discussed in detail in Section 4.2.4.

Seal

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of seals is anticipated.

Ringed seals make up the bulk of the seal harvest. Residents hunt seal primarily in winter, with some open-water seal hunting along the Chukchi coastline and in the Beaufort Sea as far east as Dease Inlet and Admiralty Bay, generally within 48 km (30 mi) from shore. According to a subsistence harvest database, the 2000 annual harvest of bearded seals in Alaska was 6,788 (Angliss and Outlaw 2005). Bearded seals are an important subsistence source for villages because of their greater size compared to other seals. The skins are used for constructing boats (BLM 2005).

Most residents harvest ringed and bearded seals in the winter or in the spring before Statoil's 2010 seismic acquisition would commence. Some people harvest seal into the open water period. Because Statoil's project area is located a great distance offshore from any subsistence seal hunting areas, it is not anticipated that the seismic activity will effect subsistence seal hunting (MMS 2009).

Traditional Knowledge indicates that intense sound startles, annoys, and can cause flight of seals. During playback experiments, ringed seals approached and dove within 50 m (164 ft) of the sound source (received level 130 dB). These observations indicate seals are relatively tolerant; however, they may exhibit temporary displacement and avoidance behavior when vessels transit the area.

Transiting vessels may cause temporary behavior changes in bearded, ringed, and spotted seals hauled out on the ice or on beaches, as wells as those feeding and swimming in the water (MMS 2008). According to the MMS, moving vessels should not cause long-term effects on seal distribution or availability for subsistence harvest (MMS 2008, 2009). To further mitigate the chance of seismic activity interference with the occasional summer seal subsistence hunt, Statoil will use MMOs to monitor the presence of seals so that any adverse effects on ringed seals as a result of the proposed survey will be minimized.

Polar Bear

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of polar bears is anticipated.

Polar bear subsistence hunts occur any time between September and April, depending on the region. Barrow hunters harvest polar bears in the same general vicinity that walrus are hunted, from west of Barrow southwestward to Peard Bay, within 56 km (35 mi) of shore and generally within 3 km (2 mi) offshore.

Polar bears compose a small percent of the annual subsistence harvest. From 1995–2000, the average annual harvest from all coastal communities of the Southern Beaufort Sea polar bear stock in Alaska was 32 (Angliss and Lodge 2004). Because of the timing and location of the proposed seismic survey, the routing of transiting vessels, and the limited historical annual harvest of polar bears by Barrow residents, the proposed seismic activities will not create a change in polar bear availability (MMS 2008, 2009). Polar bears react little to vessels, as they do not stay long in the open water (MMS 2008). When they do react to vessels, polar bears show a range of behavioral responses, from curiosity to avoidance.

Birds

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of coastal or marine birds is anticipated.

Residents of all coastal villages harvest coastal and marine birds. Birds compose a small percent but an important part of the total subsistence harvest (MMS 2009). Birds are harvested throughout the spring, summer, and fall, both inland and in coastal waters, and often in conjunction with hunts for marine mammals. The birds and waterfowl most heavily harvested by Barrow residents are eider and white-fronted geese.

Barrow residents usually hunt migratory birds along the Chukchi Sea coast. Statoil’s lease blocks where seismic activities would occur are located more than 241 km (150 mi) from Barrow subsistence bird hunting areas, so activities within the prospects would have no effect on subsistence bird hunting or egg collection. Much of the spring waterfowl hunt would take place before seismic activities commence, and therefore, would not be affected.

The risk of seabirds colliding with seismic or support vessels is small due to the low density of birds in the northeastern Chukchi Sea (MMS 2009).

Fish

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of fish is anticipated.

Fish play an important dietary role in the North Slope subsistence system. Fish generally represent the second or third most important subsistence resource, depending on the community (MMS 2009). Coastal villages harvest pink and coho salmon, char, Bering cisco, humpback whitefish, broad whitefish, rainbow smelt, capelin, Pacific cod, saffron cod, Arctic cod, Bering flounder, and Arctic flounder. Barrow residents fish all five species of Pacific salmon, as well as whitefish (generic), least cisco, broad whitefish, Arctic cisco, and Arctic grayling. These activities generally occur less than 8 km (5 mi) of shore and also inland.

Subsistence fishing is not known to occur in the area of Statoil's prospects. Barrow residents primarily fish at inland fish camps. Thus the seismic project will not likely affect subsistence fishing. Marine gill net and jig fishing of whitefishes and least cisco occur along the shoreline just west of Barrow (Craig 1989). Fishing along the coast takes place mostly in the spring and summer in conjunction with waterfowl and marine mammal hunts. No vessels associated with Statoil's project are expected to be in these fishing areas.

Land Mammals

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of terrestrial mammals is anticipated.

Residents hunt caribou in coastal areas, however; offshore seismic activities will not have a negative effect on the availability of caribou for subsistence use because the activity will be far offshore. Vessels coming inshore will be arriving at established onshore facilities where active hunting is not expected.

4.3.4.2 Wainwright

Bowhead

It is not anticipated that the proposed seismic operations, including vessel transit, will effect the Wainwright subsistence harvest of bowhead whales. The proposed seismic operations will be conducted approximately 161 km (100 mi) offshore from Wainwright and are not expected to conflict with subsistence hunting activities. Wainwright concerns for subsistence harvest of bowheads are addressed as part of the POC process currently under way between Statoil and the affected subsistence communities.

The bowhead whale is extremely important to Wainwright culture and a major part of the subsistence harvest. During the fall bowhead migration, seismic activity could, in some circumstances, deflect bowhead whales further offshore and at a greater distance from Wainwright. If whales were to be temporarily deflected, this could increase the difficulty of the hunt and retrieval of the whale and could create a safety risk to the whalers. However, in studies involving behavioral responses to transiting vessels, effects have been limited to minor changes in behavior, including avoidance of the vessel; changes in speed or orientation; changes in dive intervals or duration; and respiratory changes. Though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route within a distance of 10–30 km (6–20 mi) (Hall et al. 1994).

The Wainwright spring bowhead whale hunt occurs between April and June in leads offshore from the village. Whaling camps can be located up to 16–24 km (10–15 mi) from shore, depending on where the leads open up. Whalers prefer to be closer, however, and will sometimes go overland north of Wainwright to find closer leads (SRBA 1993).

Statoil's operations would commence in July after the spring hunts are completed, so the seismic project would have no direct effect on these subsistence hunting activities. Considering the timing and location of the proposed seismic survey activities, the project is not expected to have any significant effects on the availability of marine mammals for subsistence. Statoil vessels will support the 4MP activities, which will serve to prevent and mitigate impacts to marine mammal subsistence resources.

Beluga

Seismic operations will be conducted over 161 km (100 mi) from Wainwright and are not expected to conflict or interfere with the community's subsistence harvest of beluga whales.

Wainwright hunters typically take belugas only during the spring hunt and if bowheads are not present. Residents also hunt belugas later in the summer, between July and August, along the coastal lagoon systems. Hunters usually take belugas less than 16 km (10 mi) from shore.

Iñupiat hunters are concerned that certain levels of sound may cause the whales to leave for the long term. According to the MMS (2008), sound energy from moving vessels could cause brief disruption to the beluga whale harvest, but not make the resource unavailable to subsistence users. Beluga whales respond differentially to vessel sound energy, but temporary and localized sound energy from vessels should cause only brief disturbances to the whales. These disturbance effects have a duration of 1 day or less (MMS 2008). Hunters conduct themselves quietly when hunting beluga, even going as far as using hand signals to communicate. Beluga are said to have excellent hearing ability and can identify and remember individual outboard motor boats. Some Iñupiat worry that beluga will remember sound in an area from one year and avoid that area in following years (MMS 2008, 2009).

Statoil's seismic activity will take place at a great distance offshore from traditional beluga subsistence hunting areas, and the seismic activity will not occur during traditional beluga hunting season. The vessels will not enter the Chukchi Sea until on or about July 1—after much of the beluga harvest in Wainwright has taken place. Statoil anticipates resupply and crew changes to be conducted out of Nome. Vessels will only travel to Wainwright if Nome is no longer a viable option.

Implementation of 4MP and POC will further minimize or avoid any potential for effects of transiting vessels on marine mammals, including belugas.

Walrus

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of walrus is anticipated.

Wainwright residents usually hunt walrus within about 72 km (45 mi) from shore. Between July and August, hunters take walrus from the southern edge of the retreating ice pack (SRBA 1993). From August through September, they take walrus at local haul-outs, especially between Milliktagvik and Point Franklin. Icy Cape is also a haul-out for walrus and used by Wainwright residents.

The numbers of walrus Statoil might encounter during the offshore seismic operations is variable and highly dependent on the amount and proximity of pack ice. Numbers of walrus observed during the monitoring of past exploration in the Chukchi Sea have ranged from 20,000–25,000 (J. C. Brueggeman 1990, 1991).

Because residents hunt walrus throughout the summer, they may be affected by vessel transiting and possibly seismic operations occurring in August. Statoil anticipates the effects to be minor because of the mitigation efforts put forth through the 4MP, which are used to keep seismic vessels from disrupting normal walrus behavior (foraging, migrating, etc.).

Seals

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of seals is anticipated.

Seals are an important subsistence resource to Wainwright hunters. Hunters most often hunt seals between May and September. Wainwright hunters will travel as far south as Kuchaurak Creek (south of Point Lay) and north to Peard Bay. Hunters typically stay within 72 km (45 mi) of the shore.

Ringed seals make up the bulk of the seal harvest. The Statoil project area is located more than 48 km (30 mi) offshore from any subsistence use areas, so activities within the prospects will have little effect on subsistence hunting for seals (MMS 2009).

Vessels in transit may cause temporary displacement of bearded, ringed, and spotted seals hauled out on the ice or on beaches, as well as those feeding and swimming in the water (MMS 2008). According to the MMS, transiting vessels should not cause long-term effects to seal distribution or availability (MMS 2008, 2009).

To further mitigate the chance of the seismic activity interfering with the occasional summer subsistence hunting of seals, Statoil will use MMOs to mitigate and prevent harmful effects on seals. Therefore, Statoil does not anticipate any adverse effects on ringed seals as a result of the proposed survey.

Polar Bears

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of polar bears is anticipated.

Wainwright hunters harvest polar bears in the fall and winter, from Point Belcher to Point Franklin, including the Seahorse Islands, the barrier islands separating Peard Bay from the Chukchi Sea. Residents also hunt polar bears around Icy Cape. Polar bears compose a small percent of the annual subsistence harvest.

Because of the timing and location of the proposed seismic survey, the routing of transiting vessels, and the limited annual harvest of polar bears by Barrow residents, the proposed seismic activities will not create a change in polar bear availability (MMS 2008, 2009). Polar bears react little to vessels, as they do not stay long in the open water (MMS 2008). When they do react to vessels, polar bears show a range of behavioral responses, from curiosity to avoidance. Statoil will take all reasonable steps to address and minimize conflicts with subsistence hunting activities of the local residents, in part through the POC and the outreach and consultation actions Statoil implements.

Birds

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of birds is anticipated.

Birds make up a small percentage of the subsistence harvest but are a highly valued resource by Wainwright residents (Bacon et al. 2009). The bird hunt typically peaks in the spring months of May and June, but depending on how successful hunters are with other resources, can carry on into September. Migratory birds are harvested for subsistence along the coast between Skull Cliff to the north of Wainwright and Kasegaluk Lagoon to the south (SRBA 1993).

Statoil’s lease blocks, where seismic activities would occur, are located more than 48 km (30 mi) from any subsistence areas, so activities within the prospects would have no effect on subsistence hunting for birds or egg collection. Much of the spring waterfowl hunting conducted in conjunction with spring marine mammal hunts would take place before seismic activities commence and, therefore, would not be affected.

Fish

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of fish is anticipated.

The amount of Wainwright’s fish harvest fluctuates yearly. The most common fish harvested include smelt, arctic grayling, burbot, broad whitefish, and least cisco (Bacon et al. 2009). Inland fisheries are generally more important to Wainwright residents, but residents conduct much subsistence fishing in the summer, along the shoreline and in lagoons and estuaries, from Peard Bay to Icy Cape and in the Kuk Lagoon.

Fishermen set gill nets in the inlet near the village and set ocean gill nets about 50 m (150 ft) from shore. They catch pink and chum salmon in the ocean and rainbow smelt, whitefish, cisco, and Arctic and saffron cod in the inlet (MMS 2009). Vessel activity in these areas would be expected to occur rarely, if at all, and would not be expected to conflict with fishing or alter fishing success.

Residents conduct much of the subsistence fishing nearshore and would be unaffected by the seismic project. Statoil expects no vessel associated with its project to be in these fishing areas. Effects on fish associated with the offshore operations would be minor because of the distance from fishing areas; operations will occur at a great distance from Wainwright subsistence fishing areas.

Land Mammals

Effects on the subsistence harvest of land mammals will not occur.

Offshore seismic activities are not likely to have any effect on land mammals, given the distance of such operations from shore. The movement of support vessels would have no effect on caribou or caribou subsistence hunts. Vessels coming inshore will arrive at established onshore facilities where active land mammal hunting is not expected. Implementation of Statoil’s POC should further minimize or avoid any such potential effects.

4.3.4.3 Point Lay

Bowhead

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of bowhead whales is anticipated.

Up until recently, Point Lay residents had not hunted the bowhead whale for over 70 years. In 2009 Point Lay was selected by the IWC to receive a bowhead whale quota, and residents began bowhead hunting again. A bowhead whale was taken by a whaling crew from Point Lay in 2009 for the first time in over 70 years. Residents of Point Lay hunt bowheads during the spring migration. These spring hunts are conducted in open leads in the ice, typically from late March or early April until the first week of June. Statoil’s operations would commence in July, after these spring hunts would be completed, so the seismic program would have no direct effect on these subsistence activities.

Seismic operations will be conducted approximately 209 km (130 mi) from Point Lay and are not expected to conflict with subsistence hunting activities. Specific concerns of the whaling captains will be addressed as part of the POC process currently under way between Statoil and the community. In addition, Statoil, through its 4MP, will take all necessary measures to monitor and mitigate for conflicts with the subsistence hunt.

Beluga

Seismic operations will be conducted approximately 209 km (130 mi) from Point Lay and are not expected to conflict or interfere with the community’s subsistence harvest of beluga whales.

The Point Lay beluga whale hunt occurs in July and sometimes continues into August. Point Lay hunters take beluga in the highest numbers in Naokak and Kukpowruk Passes, south of Point Lay, but will travel north to Utukok Pass and south to Cape Beaufort in search of belugas. Hunters usually herd whales into the shallow waters of Kasegaluk Lagoon with their boats (MMS 2007).

Subsistence hunters may view increased marine vessels from Statoil’s activities and associated sound propagation as potentially disruptive According to the MMS (2008), sound energy from moving vessels could cause brief disruption to the beluga whale harvest but not make the resource unavailable to subsistence users. Beluga whales respond differentially to vessel sound energy, but temporary and localized sound energy from vessels should cause only brief disturbances to the whales. These disturbance effects have a duration of 1 day or less (MMS 2008).

But Statoil's seismic activity will take place more than 209 km (130 mi) from Point Lay and their traditional beluga hunting areas. The vessels will not enter the Chukchi Sea until on or about July 1, after much of the beluga harvest has taken place. Statoil expects the implementation of its 4MP (see Section 4.1.7) and POC to further minimize or avoid effects of vessel traffic on marine mammals, including belugas.

Walrus

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of walruses is anticipated.

Point Lay residents hunt walrus in the late spring and summer, usually between June and August, depending on the condition of the ice. They harvest walrus most heavily in Kasegaluk Lagoon, south of Icy Cape. Hunters will travel up to 32 km (20 mi) offshore in search of walrus (AES 2009).

The numbers of walrus encountered during offshore seismic operations is variable and highly dependent on the amount and proximity of pack ice. Numbers of walrus observed during the monitoring of past exploration in the Chukchi Sea have ranged from 20,000–25,000 (Brueggeman 1990, 1991).

Statoil anticipates that effects on Point Lay walrus hunting will be negligible because of the distance the project occurs from the hunting areas and the mitigation efforts put forth through the 4MP, which is used to keep seismic and vessel disturbance from disrupting normal walrus behavior (foraging, migrating, etc.).

Seals

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of seals is anticipated.

Point Lay hunters harvest ringed and bearded seals all year. They hunt ringed seals 32 km (20 mi) north of Point Lay, as far as 40 km (25 mi) offshore. They hunt bearded seals as far north as 48 km (30 mi) south in the Kasegaluk Lagoon, and as far as 40 km (25 mi) from shore.

The location of Statoil's seismic survey is such that it would have negligible or no effect on Point Lay's seal subsistence hunting area. Furthermore, the small amount of vessel movement associated with this project should not cause long-term effects to seal distribution or availability (MMS 2008, 2009).

To further mitigate the chance of the seismic activity interfering with the occasional summer subsistence hunting of seals, Statoil will use MMOs to mitigate and prevent harmful effects on seals. Therefore, Statoil does not anticipate any adverse effects on ringed seals as a result of the proposed survey.

Polar Bear

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of polar bears is anticipated.

The seismic survey is not expected to interfere with subsistence polar bear hunting due to the limited annual harvest and the seasonal timing of the open water seismic activities. Statoil does not expect a change in polar bear availability to occur because of transiting vessels (MMS 2008, 2009). Polar bears react little to vessels; they do not stay long in the open water (MMS 2008). When they do react, polar bears show a range of behavioral responses to vessels, from curiosity to avoidance. The Statoil seismic project is located far enough away from subsistence hunting areas that any effects on hunting activities are unlikely. Furthermore, Statoil will take all reasonable steps to address and minimize conflicts with subsistence hunting activities, in part through the POC and the outreach and consultation actions Statoil implements.

Birds

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of birds is anticipated.

A majority of Point Lay residents, more than 60 percent, report harvesting birds and waterfowl. They hunt birds throughout the spring, summer, and fall—both inland and in, or adjacent to, coastal waters and often in conjunction with hunts for marine mammals.

Statoil’s lease blocks are located approximately 209 km (130 mi) from Point Lay’s bird subsistence areas. Activities within the prospects would have no effect on subsistence bird hunting or egg collection. Much of the spring waterfowl hunting occurs in conjunction with spring marine mammal hunts and will take place before seismic activities commence and, therefore, would not be affected. Activities associated with Statoil’s seismic survey will have negligible effects on birds. Vessels in transit have the potential to disturb birds, but the effects on the birds would be minor and temporary. The risk of seabirds colliding with seismic or support vessels is low due to the density of birds in the northeastern Chukchi Sea (MMS 2009).

Fish

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of fish is anticipated.

Point Lay residents subsistence fish mostly in the summer in marine environments from Icy Cape south to the southern end of Kasegaluk Lagoon. They set gill nets for pink and chum salmon, herring, char, and cisco (Craig 1989). No vessel associated with Statoil’s project would be expected to be in these fishing areas. Effects on fish associated with the offshore seismic operations would be minor and occur over 140 km (87 mi) from Point Lay fishing areas. Statoil expects the seismic survey to have little to no effect on Point Lay’s subsistence fishing activities or the resource.

Land Mammals

Effects on the subsistence land mammal harvests will not occur.

Caribou is a significant part of the Point Lay subsistence diet, and most households report hunting caribou often. The rate of participation in the caribou hunt may be higher in Point Lay than in any other North Slope village (Fuller and George 1997). Offshore seismic activities are not likely to affect land mammals because of the distance of the operations from shore. Vessel movement associated with supporting operations would have no effect on caribou subsistence.

4.3.4.4 Point Hope

Bowhead Whale

Effects of the proposed seismic operation, including vessel transit, on the Point Hope subsistence harvest of bowhead whale are not expected , as Point Hope whalers traditionally conduct a spring hunt. In Point Hope, the bowhead whale hunt occurs between March and June, when the pack-ice lead is usually 10–11 km (6–7 mi) offshore. The whales migrate back down on the west side of the Bering Strait, out of the range of the Point Hope whalers (Fuller and George 1997). Statoil’s operations commence in July after these spring hunts are completed. Therefore, the seismic program would have no direct effect on these subsistence activities.

Statoil's activities would be conducted approximately 386 km (240 mi) from Point Hope bowhead whale subsistence hunting areas. According to studies involving behavioral responses to transiting vessels, effects have been limited to minor changes in behavior, including avoidance of the vessel, changes in speed or orientation, changes in dive intervals or duration, and respiratory changes. Though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route within a distance of 10–30 km (6–20 mi) (Hall et al. 1994).

Specific concerns of the whaling captains will be addressed as part of the POC process currently under way between Statoil and the community.

Statoil will implement a 4MP l that serves to mitigate adverse effects on marine mammal resources and associated subsistence activities. Overall, bowhead whale physical disturbance and avoidance behavior from transiting vessels will be minimal (MMS 2008), and permanent changes in subsistence use areas and activities that are dependent on the bowhead behavior are not expected to occur.

Beluga

Seismic operations will be conducted approximately 386 km (240 mi) from Point Hope and are not expected to conflict or interfere with the community's subsistence beluga harvest. Residents primarily hunt belugas in the spring, coincident with the spring bowhead hunt. Beluga whales often compose a significant portion of the total harvest for Point Hope (Fuller and George 1997; SRBA 1993). A second hunt takes place later in the summer, in July and August, and can extend into September, depending on conditions and the IWC quota. Residents hunt beluga in open water along the coastline on either side of Point Hope, as far north as Cape Dyer (MMS 2007).

According to the MMS (2008), sound energy from moving vessels could cause brief disruption to the beluga whale harvest, but not make the resource unavailable to subsistence users. Beluga whales respond differentially to vessel sound energy, but temporary and localized sound energy from vessels should cause only brief disturbances to the whales. These disturbance effects have a duration of 1 day or less (MMS 2008).

The vessels will not enter the Chukchi Sea until on or about July 1, after much of the first beluga harvest in Point Hope has taken place. Implementation of Statoil's 4MP and POC is expected to further minimize or avoid effects of vessel transiting on marine mammals, including belugas. Thus, vessel transiting should have little effect on the availability of beluga to subsistence hunters and on the hunt (MMS 2008).

Walrus

Effects on the subsistence harvest of walrus are not anticipated as a result fo the proposed seismic activities. Point Hope residents harvest walrus most heavily in the spring, between April and July. They hunt walrus along the southern shore between Point Hope and Akoviknak Lagoon, but also along the shore from boats throughout the summer.

The Statoil seismic activities will occur after the main harvest of this area has taken place. The effects on Point Hope walrus hunting are anticipated to be negligible because of the distance of the project from the hunting area and because of the mitigation efforts included in the 4MP, which will be implemented to keep seismic and vessel disturbance from disrupting normal walrus behavior (foraging, migrating, etc.).

Seals

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of seals is anticipated.

Point Hope hunters harvest ringed, spotted, and bearded seal. Seals are harvested throughout most of the year, although they tend to be taken in the greatest numbers in the winter and spring months. The exception is the bearded seal hunt, which peaks later in the spring and into the summer (Fuller and George 1997; MMS 2007).

The location of Statoil's seismic survey is approximately 386 km (240 mi) from Point Hope, so it would have negligible or no effect on Point Lay's seal subsistence area. Furthermore, the small amount of vessel movement associated with this project should not cause long-term effects to seal distribution or availability (MMS 2008, 2009).

Polar Bear

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of Polar bears is anticipated.

Point Hope residents often take polar bears while hunting seals. They usually hunt polar bears in the winter and early spring, between January and April, but sometimes as early as October. They hunt as far as 16 km (10 mi) from shore (MMS 2007).

Polar bears compose a small percent of the annual subsistence harvest. Because of the timing and location of the proposed seismic survey, the routing of vessel transit, and the limited historical annual harvest of polar bears, the proposed seismic activities will not create a change in polar bear availability (MMS 2008, 2009). Furthermore, Statoil will take all reasonable steps to address and minimize conflicts with subsistence hunting activities of the local residents, in part through the POC and the outreach and consultation actions Statoil implements.

Birds

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of birds is anticipated.

The Point Hope bird harvest includes ptarmigan, geese, swans, eider, and cranes. In addition to birds and waterfowl, residents also collect eggs in considerable numbers; nearly 6,000 were collected in 1992 (Fuller and George 1997). Harvests occur throughout the spring, summer, and fall, both inland and in or adjacent to coastal waters, and often in conjunction with hunts for marine mammals.

Statoil's lease blocks are located at such a great distance from Point Hope's bird subsistence areas that activities within the prospects would have no effect on subsistence hunting for birds or egg collection. Much of the spring waterfowl hunting would take place before seismic activities commence and, therefore, seismic activities should not affect the subsistence activities. The risk of seabirds colliding with seismic or support vessels is small due to the low density of birds in the northeastern Chukchi Sea (MMS 2009).

Fish

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of fish is anticipated.

Statoil's seismic activities occur over 290 km (180 mi) from Point Hope subsistence fishing areas. Residents subsistence fish year-round. They set gill nets and beach seines to harvest char and pink, coho, and chum salmon from coastal waters from Cape Thomson north to Kilralik Point. They start when the shorefast ice breaks free in mid- to late June and continue through August (Craig 1989). They harvest Arctic and saffron cod through the ice during the winter months.

Land Mammals

Effects on the subsistence harvest of land mammal will not occur.

As with other North Slope villages, caribou may be the most significant terrestrial resource in terms of its contribution to the total subsistence harvest and as a material source (Fuller and George 1997). Offshore seismic activities are not likely to have any effect on land mammals, given the distance of such operations from shore. Vessel movement associated with support operations would have no effect on caribou subsistence activities.

4.3.4.5 Kivalina

Subsistence is an extremely important part of the local economy in Kivalina, with nearly 100 percent of residents participating in the subsistence harvest. In 2007, marine mammals made up approximately 50 percent of the total subsistence harvest. Kivalina residents harvest polar bear, walrus, four species of seals, and three species of whale: grey, bowhead, and beluga (Burch 1985).

Whales

Effects of the proposed seismic operations, including vessel transit, on the Kivalina harvest of whales are not anticipated because of the timing and location of the proposed activities.

Walrus

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of walrus is anticipated.

The seismic activity will occur more than 483 km (300 mi) north of Kivalina. Mitigation efforts implemented through the 4MP will be used to keep seismic and vessel disturbance from disrupting normal walrus behavior (foraging, migrating, etc.).

Seals

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of seals is anticipated.

Section 4.2.6 discusses potential effects of Statoil's seismic acquisition on bearded, ringed, and spotted seals. The timing and location of Statoil's seismic survey is such that the activities would have negligible or no effect on Point Lay's seal subsistence area. Furthermore, the small amount of vessel movement associated with this project should not cause long-term effects on seal distribution or availability (MMS 2008, 2009).

Polar Bears

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of polar bears is anticipated.

Polar bears compose a small percentage of the annual subsistence harvest. The expectation of no effect results from the limited annual polar bear harvest, the location of the seismic project with respect to the harvest area, and the seasonal timing of the open water seismic activities. Statoil expects no change in polar bear availability from transiting vessels (MMS 2008, 2009). Furthermore, Statoil will take all reasonable steps to address and minimize conflicts with subsistence hunting activities of the local residents, in part through the POC and the outreach and consultation actions Statoil implements.

Birds

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of birds is anticipated.

Residents hunt birds throughout the spring, summer, and fall. They hunt birds and collect eggs both inland and in or adjacent to coastal waters and often in conjunction with hunts for marine mammals.

Statoil's lease blocks are located at such a great distance from Kivalina's bird subsistence areas that activities within the prospects would have no effect on subsistence hunting for birds or egg collection. Residents conduct much of the spring waterfowl subsistence activities in conjunction with spring marine mammal hunts. These would take place before seismic activities commence and, therefore, would not be affected.

Activities associated with Statoil's seismic survey will have negligible effects on birds. Vessel movement has the potential to disturb birds, but the effects on the birds would be minor and temporary. The risk of seabirds colliding with seismic or support vessels is low due to the density of birds in the northeastern Chukchi Sea (MMS 2009).

Fish

Since the Statoil seismic survey will be conducted far offshore, no effect on the subsistence harvest of fish is anticipated.

Statoil expect no vessel activity associated with Statoil's program to occur in Kivalina's fishing areas. Kivalina's position on a lagoon between the Chukchi Sea and two large rivers makes it a prime fishery. Residents fish for trout and grayling year-round, while other species are fished seasonally (Jones 2006). Statoil's seismic activities will be at a great distance from these areas.

Land Mammals

Effects on the subsistence harvest of land mammals will not occur.

Large, terrestrial mammals harvested include caribou, moose, brown bear, wolves, wolverine, and Dall sheep (Burch 1985). Offshore seismic activities are not likely to have any impact on land mammals because these activities would occur at a great distance from shore. Vessel movement associated with support operations would have no effect on caribou subsistence activities.

4.3.5 Sociocultural Values

The effects on sociocultural values can include "consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society" (Interorganizational Committee on Guidelines and Principles for Social Impact Assessment 1994). Also included are effects on the culture, which involve changes to the norms, values, and beliefs guiding and rationalizing their cognition of themselves and their society (Interorganizational Committee on Guidelines and Principles for Social Impact Assessment 1994, King 1998).

It is not anticipated that the proposed matrine seismic surveys will effect the sociocultural values of residents of the area.

4.3.5.1 Effects on Iñupiaq Values

Statoil's seismic acquisition project is temporary and unlikely to have any effect on Iñupiaq values. Iñupiaq values are deeply integrated into and have a long existence in Iñupiaq culture. Rather, these values can be used to interpret and evaluate potential effects on other sociocultural aspects of the NSB and NWAB.

4.3.5.2 Effects on the Land and the Sea—to the Environment

As discussed in Section 3.3.5, the land and the sea are important to the Iñupiat of the NSB and the NWAB. Iñupiaq sense of place, culture, identity, and livelihood depend on this arctic environment. Thus any effect, real or perceived, to the environment or elements of the environment risks affecting Iñupiaq sociocultural values.

4.3.6 Historical and Archaeological Resources

It is not anticipated that Statoil's 2010 Chukchi Marine Seismic Survey project will adversely affect historical or archaeological resources within the project area. Section 106 of the NHPA requires that federal agencies take into account effects to historic properties within an undertaking's area(s) of potential effect resulting from that undertaking (36 CFR 800; King 1998, 2000). Effects may be beneficial, adverse, or benign. Adverse effects tend to be of greater concern and are thus the focus of the following discussion.

An adverse effect is anything that may negatively affect a property's historic integrity and thus its eligibility for listing in the National Register of Historic Places (36 CFR 800; King 1998, 2000). An adverse effect may be in the form of direct physical effects; visual effects; auditory effects; sociocultural effects; effects on culturally significant natural resources, such as subsistence plants or animals or those used for religious purposes; or indirect or secondary effects, such as induced erosion or public use. Specific examples of adverse effects to historic properties include:

- Destruction
- Alteration
- Removal of entire historic properties or elements thereof
- Alterations of setting
- Introduction of intrusive elements
- Neglect
- Transfer out of federal ownership (King 2000)

4.3.6.1 Effects on Submerged Historical and Prehistoric Archaeological Resources

Given the timing and location of Statoil's seismic acquisition project, it is unlikely to have an adverse effect on submerged historical and prehistoric archaeological resources. Seismic acquisition will be done by towing airguns. These airguns will remain suspended in the water and will not affect resources at or below the seafloor.

4.3.6.2 Effects on Terrestrial Historical and Prehistoric Archaeological Resources

No effects on terrestrial cultural resources are expected. The only land-based activities planned will be at established facilities: (1) crew change in Nome, (2) refueling in Nome, and (3) possible search and rescue helicopters out of Barrow. These activities will not affect terrestrial historical and prehistoric archaeological resources.

4.3.6.3 Effects on Traditional Cultural Properties

No TCPs have been identified within the project area.

4.3.7 Coastal and Marine Uses

Statoil's proposed 3D marine seismic survey activities are not anticipated to have any effect on the coastal and marine uses or the recreational and visual resources in the project area. All proposed project activities are expected to be conducted at a sufficient distance and out of sight from the coastal areas and not to conflict with marine activities such as military activities, commercial shipping, commercial fishing, mariculture, and recreational boating.

Currently, shipping and vessel transit occurs at low levels in the Lease Sale 193 area. This is not expected to change over the term of this seismic acquisition project. The presence of a seismic vessel in the area of Statoil's prospects, and the projected support vessels between the prospects and shorebase, will have no effect on current levels of cruise or recreational vessels over the span of the seismic survey. The planned seismic project will have no effect on commercial fishing, recreational fishing, or mariculture, as none of these is known to exist in the Lease Sale 193 area (MMS 2009).

It is anticipated that the proposed seismic activities will not have effects on coastal and marine uses.

4.3.8 Land Use

Statoil expects no effect on land use within the NSB and NWAB. Statoil's 2010 Chukchi Marine Seismic Survey will occur over 161 km (100 mi) offshore from the nearest NSB community and over 483 km (300 mi) from the nearest NWAB community. Statoil plans no shore-based activities during this project.

4.3.9 Environmental Justice

Statoil has engaged in accord with Environmental Justice provisions of EO 12898 with potentially affected subsistence communities regarding the proposed 2010 Chukchi Marine Seismic Survey activities. Meetings with leadership (city, tribal, and corporate) in the communities of Barrow, Wainwright, Point Hope, Point Lay, and Kotzebue were held in October and November 2009. Plan of Cooperation meetings were held in Barrow, Wainwright, Point Hope, and Point Lay in January 2010. In both instances, Statoil invited discussion from the community regarding the specific concerns they might have about the proposed seismic survey's effect on human and environmental health. Those community concerns have been documented and incorporated into the POC document in support of federal permits. As noted earlier, effects, in general, are expected to be temporary and minimal. The primary areas of potential effect for the residents of the NSB and NWAB are socioeconomic and subsistence. As discussed in detail in the Economic Effects, Subsistence, and Sociocultural Effects subsections in Section 4, effects on residents' economy, culture, and lifestyle are expected to be temporary, if there are any at all.

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5.0 CUMULATIVE EFFECTS

5.1 Introduction

The MMS (2007) prepared cumulative effects analysis as part of the Chukchi Sea Oil and Gas Lease Sale 193 EIS. The level, type, and location of the Statoil 2010 Chukchi Marine Seismic Survey is within the range of activities described in the Lease Sale 193 EIS. The MMS evaluated the past, present, and reasonably foreseeable activities within the next 20 years in their cumulative effects analysis. The MMS analysis considered oil and gas activities, as well as non-oil and gas activities, including sport and subsistence hunting and fishing, scientific surveys, and marine transportation. The Lease Sale 193 EIS included a greater than 70-page discussion of cumulative effects that concluded that the evaluated activities would not result in any significant cumulative effects.

The Statoil 2010 Chukchi Marine Seismic Survey EED incorporates the 2007 MMS analyses in the review of potential cumulative effects from the proposed seismic survey activities. Other reasonably foreseeable activities expected to occur in the Chukchi Sea 2010 open water season may include:

- Shell's proposed drilling program in the Chukchi Sea on their Burger, Crackerjack, and SW Shoebill Prospects;
- Shell shallow hazard and site clearance surveys in the Chukchi;
- Government funded research seismic survey in the Chukchi and Beaufort Seas (Nachman 2010).
- joint CPAI/Statoil/Shell ecosystems-based baseline studies using one research vessel

The Shell exploration drilling program is expected to be the closest industrial sound source to the Statoil seismic survey during the 2010 open water season. The Shell Burger Prospect drill sites are located approximately 30 km (18.5 mi) from Statoil's proposed 2010 Chukchi 3D Marine Seismic Survey area. The ensonification zones for the Statoil seismic survey and the Shell exploration drilling will not overlap. According to Shell's 2010 Chukchi Exploration Plan and IHA, the 120 dB ensonification zone around Shell's drillship is 2 km. Assuming that the Statoil seismic 160 dB ensonification zone radius is 13 km, there should be a minimum of 15 km separation between the Shell (120dB) and the Statoil (160dB) ensonification zones.

The other Shell Chukchi Sea prospects, Crackerjack and SW Shoebill, are located more than 50 miles away from the Statoil 2010 Chukchi 3D Marine Seismic Survey area. It has also been reported that the TGS-NOPEC 2D seismic survey has been cancelled.

Other Alaska Arctic Beaufort Sea 2010 open water reasonable foreseeable activities expected to occur include Shell's shallow hazards survey work in Harrison Bay; Shell's Camden Bay exploration drilling activity; the joint Canadian/U.S. research seismic activity in the Beaufort Sea; and GX Technology's Beaufort Sea seismic survey at the end of the open water season (tentatively planned for October and November 2010) (Nachman 2010).

5.2 Cumulative Effects on Physical Environment

The environment within the project area is considered to be generally pristine, with few, if any, effects evident from past activities. The Statoil 2010 Chukchi Marine Seismic Survey is limited in geographic scope and duration and is expected to be completed within 60 days starting August 1, 2010. The effects from the proposed seismic survey activity will be correspondingly limited. The proposed seismic survey project will have negligible to no direct effects on physical resources and, due to the abbreviated, temporary nature of the project, will have no indirect effects on physical resources. Cumulative effects on physical resources are anticipated to be negligible, as determined by the MMS (2007).

5.2.1 Water Quality

Water quality is considered to be generally pristine in the Chukchi Sea, with few, if any, effects of past human activities. Trace metal and hydrocarbon concentrations are thought to be low. The Statoil seismic survey activity will have some minor, local, and temporary water quality effect (turbidity and suspended solids) from the discharge of treated wastewater. The Statoil seismic survey fleet will meet all applicable EPA, USCG, and MARPOL Annex IV standards, including sanitary wastewater treatment and ballast water management. The Statoil seismic survey fleet vessels all have internal ballast water systems; thus, there will be zero ballast water discharge. The seismic survey fleet will not trigger the EPA Arctic Oil and Gas General Permit applicability, but may trigger the EPA NPDES VGP when within 5.6 km (3 nm) of the Alaska shore. The seismic streamers contain no liquid kerosene and thus eliminate a possible adverse effect from a potential streamer line break. The MMS (2007) determined that the effects on local water quality resulting from anticipated oil and gas activities are expected to be low and that regional effects are expected to be very low.

5.2.2 Sediments Quality

Sediment quality in the Chukchi Sea is considered to be good. The Statoil 2010 Chukchi Marine Seismic Survey will not disturb the seafloor and, thus, will have no measurable direct effect on sediments except for the localized, temporary vessel anchoring.

5.2.3 Air Quality

The MMS (2007) determined the overall air quality on the Alaska North Slope was relatively pristine, despite considerable oil and gas-related activity during the past 40 years. EPA (2010) determined that the air quality along the Alaska Chukchi Sea shore and the Lease Sale 193 air quality met all NAAQS for healthy air quality. The emissions from the Statoil 2010 Chukchi Marine Seismic Survey project will have a minimal effect on the project area air quality and even a lesser effect on the Alaska Chukchi Sea shore air quality located more than 100 miles distant. The seismic survey will not require an EPA construction permit or operating permit. The seismic survey vessel fleet will meet applicable MARPOL Annex VI standards to minimize NO_x and SO_2 emissions. The seismic survey fleet will have a minimal effect on onshore O_3 concentrations due to its distance from other NO_x and VOC emission sources. The seismic survey activity, scheduled for the July to November 2010 open water period, is expected to have no effect on Arctic haze, which is primarily a winter and early spring phenomenon. The seismic survey fleet GHGs will have a negligible effect on the worldwide, U.S., and Alaska GHG inventories. The MMS (2008) determined projected GHG emissions from future Chukchi Sea oil and gas activity would be approximately 0.005–0.007 percent of the 2005 U.S. nationwide total GHG emissions.

5.2.4 Acoustic Environment

The Statoil 2010 Chukchi Marine Seismic Survey will add sound energy to the marine environment that already receives sounds from numerous natural and anthropogenic sources. Natural sound sources include movement from ice, wind, wave action, precipitation, subsea earthquake activity, and marine mammals, fish, and shellfish. Anthropogenic sources include coastal and maritime vessel movement, commercial fishing, subsistence hunting, and oil and gas seismic and exploration drilling activity.

The Statoil seismic survey will produce sound energy from seismic airguns and vessel transit. Statoil will conduct the seismic survey activity in open water and will not use ice breakers for ice-management activity, thus eliminating one possible anthropogenic sound source. The MMS (2007) determined that available information indicated that the cumulative effects of all other past or currently occurring anthropogenic sound sources have had no long-lasting physiological or other adverse effect on the bowhead whale. The MMS (2007) included oil and gas exploration, production and development activity, and increased marine vessel movement in their cumulative effects analysis. The MMS (2007) determined that seismic survey activities could result in cumulative behavioral effects to the bowhead whale and that whales try to avoid vessels or seismic surveys if closely approached. The MMS (2007) found that the direct effect of oil and gas industry sound-producing activities would be a temporary, non-lethal avoidance behavior. The Arctic Council (2009) Arctic Marine Shipping Assessment 2009 Report acknowledged an increasing potential threat of marine mammal migration patterns because of sounds produced by marine shipping activity, due in part to climate change enabling greater arctic shipping activity. Potential direct effects on marine mammals from the Statoil seismic survey activity will be mitigated by conditions imposed in the NMFS IHA and the USFWS LOA that will include reducing or stopping the seismic sound source if and when marine mammals get too close to the seismic source vessel.

5.3 Cumulative Effects on Biological Environment

The Statoil 2010 Chukchi Marine Seismic Survey project will have negligible or minor and short-term direct effects on biological resources and will have no indirect effects on biological resources. The MMS (2007) determined that no significant cumulative effects would result from the planned Lease Sale 193 oil and gas activities when combined with exploration and development of North Slope and Beaufort Sea oil and gas fields. The MMS (2007), however, determined that some significant adverse effects could occur on certain biological resources (spectacled eiders, common eiders, polar bears) in the event of a large offshore oil spill from oil development and production activity. The MMS (2007) further determined an offshore oil spill could affect the availability of bowhead whales as a subsistence resource, if subsistence users believe the whales to be contaminated and therefore unusable as a food source. There is no probability of a large oil spill from the Statoil 2010 Chukchi Marine Seismic Survey since it is not an exploration drilling project or a production activity. The most likely potential effect from a hydrocarbon release would be from an at-sea fuel transfer mishap that would be localized and temporary. Statoil will conduct vessel refueling in Nome, with a contingency of one at-sea refueling event. The seismic survey fleet will employ applicable MARPOL and USCG fuel transfer handling standards to prevent, and minimize if necessary, any adverse effect from a fuel transfer operation. In the remote likelihood of a fuel transfer mishap that releases fuel oil to the marine environment, the expected direct effect will be localized and temporary; and any such release is not expected to result in an adverse cumulative effect on biological resources.

Most direct effects on biological resources from the seismic survey project will be avoidance behavior resulting in a temporary displacement of birds, fish, and marine mammals. Ramp-up procedures will enable fish, birds, and marine mammals to move away prior to the beginning of each day’s seismic survey.

5.3.1 Marine Mammals

The proposed seismic activities' expected effects on marine mammals include temporary displacement of whales and seals within the ensonification zone. Physical effects such as injury or death are not expected from the seismic survey project. Statoil's seismic survey activities are not expected to result in a significant effect on the species or stocks of marine mammals and should not affect the availability of species or stocks for subsistence uses. Baleen whales tend to avoid areas where airguns are in operation. Beluga whales have also shown avoidance of seismic vessels, while seals generally do not react to airgun sounds. The masking effects of pulsed airgun sounds on marine mammal calls and other natural sounds are expected to be limited. Exposure to sufficiently loud sounds can result in a shift in marine mammal hearing threshold. The shifts can be TTS or PTS. The requirement included in the MMPA authorized IHA and LOAs to have onboard MMOs and monitoring safety radii; and the airgun ramp-up provision, coupled with the tendency of marine mammals to avoid the immediate area around operating seismic vessels, will minimize the potential of shifts in hearing threshold to nearby marine mammals. Thus, physical injuries of marine mammals resulting from sounds by Statoil's seismic survey are unlikely and not expected.

5.3.2 Threatened and Endangered Species

The listed or proposed listed threatened and endangered marine mammal species in the project area include the bowhead whale, the humpback and fin whales, the polar bear, and the Pacific walrus. Threatened and endangered birds in the project area include the Steller's and spectacled eiders and the Kittlitz's murrelet. The Statoil 2010 Chukchi Marine Seismic Survey is not expected to have a direct effect on Steller's and spectacled eiders due to the distance from the coast and nearshore molting areas, including the Ledyard Bay Critical Habitat Unit. The Kittlitz's murrelet are likely found in low densities near the project area. The USFWS (2009) concluded that marine seismic surveys in the Alaska OCS would not likely produce any measurable, negative effects on Steller's and spectacled eiders and Kittlitz's murrelets, and that marine seismic surveys in the Alaska OCS would not jeopardize Kittlitz's murrelets habitat.

5.3.2.1 Polar Bears

The Statoil 2010 Chukchi Marine Seismic Survey may have a limited, and temporary, effect on a small number of polar bears. Polar bears are closely tied to the presence of the sea-ice platform. The seismic survey project area will be conducted in open water and away from sea ice, thus reducing the potential of encounters with polar bears. Historical, documented effects on polar bears in Alaska by the oil and gas industry are minimal. The Chukchi Sea OCS oil and gas exploration activities in the 1980s and early 1990s did not result in any population level effects on polar bears (USFWS 2007). The MMS (2007) determined that proposed seismic operations will not be concentrated in any one area for extended periods and will occur in open water; thus, any direct effects on polar bears should be relatively short in duration and is not expected to have any effect on polar bear populations. The USFWS (2009) determined that few polar bears are likely to encounter seismic survey vessels in the project area and those bears that are in the project area may not react to the seismic survey activity. The USFWS (2009) further determined that any adverse effects that do occur are likely to be limited to temporary, minor, behavioral disturbances to a small number of polar bears and that the ITR and LOA criteria will mitigate potential effects.

5.3.2.2 Endangered Whales

Bowhead, humpback, and fin whales are the endangered whale species present in the Chukchi Sea during the time of Statoil's proposed seismic surveys. Bowhead whales are expected to be the most common whale in the area during the seismic project activities. Humpback and fin whales are expected to be much less common in the project area. All endangered whales in the Chukchi Sea are baleen whales, and they react similarly in the presence of seismic sounds. The only expected behavioral reaction of endangered whales to Statoil's seismic survey project is short-term, temporary displacement or avoidance; and any such effect will end upon completion of the seismic survey project. The seismic project is not expected to result in any hearing impairment of endangered whales in the project area, and a temporary and minimal, if any, masking of endangered whale calls in the project area.

Historically, industrial whaling has been the primary factor depressing populations of whales. The MMS (2007) suggested that some investigators have concluded that the bowhead whale populations have largely recovered to numbers representative of their pre-industrial whaling era population. The expected behavioral effects on bowhead whales from Statoil's seismic survey activity will be short-term, temporary displacement or avoidance. Other marine shipping activity in and around the project area may result in similar temporary avoidance disturbance effects. Baleen whales tend to avoid areas where airguns are in operation. The NMFS IHA monitoring, avoidance, and mitigation requirements that require seismic programs to employ MMOs aboard all seismic vessels to monitor the safety radii and employ airgun ramp-up and shutdown procedures will limit effects on endangered whales to a short-term avoidance of the limited area around the seismic operation. The potential masking effects of pulsed sounds from airguns on endangered whale calls and other natural sounds are expected to be limited. The seismic operations are not expected to result in adverse hearing effects on endangered whales. Past experience has shown that whales tend to avoid seismic vessels and their airguns before being exposed to sound levels high enough to experience TTS or PTS, i.e., hearing impairment. The NMFS IHA MMO and airgun ramp-up procedures should further reduce the chance of endangered whale TTS.

5.3.2.3 Pacific Walrus

The Statoil 2010 Chukchi Marine Seismic Survey project may have a negligible to minimal direct effect on the Pacific walrus. The proposed seismic survey project will occur in areas of open water where Pacific walrus densities are expected to be relatively low. Walrus densities during historical Chukchi Sea OCS exploration activities were greater in the project area during heavy ice years (MMS 2009). Seismic activity will not be conducted if there is heavy ice in the project area. If pack ice is present in feeding areas such as the Hannah Shoal area, walrus on ice floes could be affected. Expected effects would be limited to slight changes in walrus distribution, with some walrus avoiding the project area or retreating to the center of the ice floe. All such effects would be minor and temporary, lasting as long as the ice and walrus, which are moving with wind and current, are in the project area (MMS 2009). Statoil will employ monitoring and mitigation measures (MMOs, monitoring safety radii zone, walrus interaction avoidance plans) to avoid and minimize any behavioral displacement effect or potential hearing threshold effect. Vessel movement may temporarily displace walrus from preferred feeding areas or temporarily deflect them from migration routes. Walruses tend to aggregate in large groups and, thus, are vulnerable to disturbance events. Walruses may flee haul-out locations in response to disturbance from aircraft and vessel transiting. Helicopters, which are likely to elicit responses from walruses, will not be used during the Statoil seismic survey operation except in the case of an emergency. Potential effects of vessel movement on walruses will be reduced with mitigation measures requiring vessels to slow their speed or steer around groups of walruses. The MMS (2007) determined that any effects on walruses from seismic operations should be relatively short in duration and should have a negligible overall effect on the Pacific walrus population.

5.4 Cumulative Effects on Socioeconomic Resources

Socioeconomic effects from Statoil's 2010 Chukchi Marine Seismic Survey will be minor and temporary. Very few economic effects are expected for the affected Northwest Alaska Chukchi Sea coastal communities. The seismic source and support vessels will be self-contained, and Nome is the designated port for resupply and crew changes. Statoil's seismic survey may generate a few temporary jobs for residents of the NSB and NWAB, with employment opportunities primarily as MMOs. Past oil and gas exploration activities in the project area have not been shown to have any lasting effects on socioeconomic resources. However, increased NSB and NWAB employment and personal income could be generated with subsequent oil and gas exploration, development, and production activities in the future.

5.4.1 Subsistence

The MMS (2007) concluded that short-term, local disturbance resulting from seismic activities could affect subsistence activities and that long-term, permanent effects would not result, nor would harvest areas become unavailable to subsistence users. The MMS (2007) noted that local perception of subsistence effects vary. Inupiat whalers, for example, have concerns with sounds from seismic activities that may deflect whales farther away from their normal migration routes and drive hunters farther out to sea. The Statoil 2010 Chukchi Marine Seismic Survey project should have no direct effect on the bowhead whale or other subsistence resources. The project area is located far offshore (100 mi or greater from each Chukchi Sea village), away from traditional subsistence areas and subsistence hunting activities. The seismic activity will be conducted during the open water season, after the spring traditional subsistence hunt season, and before the winter traditional subsistence hunt season. Vessel movement supporting the seismic survey between the project area and the shorebase resupply facilities in Nome will be infrequent and, thus, should have negligible effects on subsistence resources. The MMS (2008, 2009) determined that vessel movement sounds could cause a disruption to subsistence harvest, but would not make subsistence resources unavailable to subsistence users. Statoil's seismic vessels will have MMOs onboard and will support marine mammal monitoring and mitigation activities to prevent and mitigate any potential effect to marine mammal subsistence resources.

NSB residents expressed concerns that oil and gas industry activities have cumulative effects on culturally important subsistence activities. The MMS (2007), however, concluded that the effects from exploration activities would be short-term and localized. And since the Statoil seismic survey project will not occur in traditional subsistence areas, the seismic survey activities is not expected to result in any significant effects on subsistence resources or subsistence hunting.

5.4.2 Sociocultural Values and Environmental Justice

The Statoil 2010 Chukchi Marine Seismic Survey project is temporary and short-term and, thus, unlikely to have any long-lasting effect on Inupiat values. However, real or perceived effects from the seismic survey project on the environment or the elements within the environment risk affecting Inupiat sociocultural values. Western science suggests that the seismic survey studies may have temporary effects on wildlife and other aspects of the environment, but traditional and cultural knowledge may suggest otherwise. Many NSB residents may see seismic survey acquisition leading to oil and gas exploration, development, and production activities. The cumulative effects of seismic exploration, other oil and gas activities, and other events and activities, such as climate change and increased marine transiting, are a concern to many NSB residents (MMS 2007). Environmental concerns perceived to directly, indirectly, or cumulatively affect larger issues, including climate change, wildlife effects, air quality, water quality, sea ice depletion, coastal erosion, permafrost degradation, and oil spills (MMS 2007).

Environmental Justice concerns from the Statoil 2010 Chukchi Marine Seismic Survey project are expected to be temporary and minimal, if any at all. The MMS (2007), however, determined that some significant, adverse effects could occur on sociocultural systems and Environmental Justice in the event of a large oil spill from oil development and production activity. As discussed above in Section 5.3, the probability of a large oil spill from the Statoil 2010 Chukchi Marine Seismic Survey is practically zero, since it is not an exploration drilling project or development or production activity, and that any potential hydrocarbon release from the seismic survey project would be from a fuel transfer mishap that would be localized and temporary and, thus, would not have an anticipated effect on Inupiat sociocultural values or Environmental Justice.

5.4.3 Historical and Archaeological Resources

The Statoil 2010 Chukchi Marine Seismic Survey project is highly unlikely to adversely affect any submerged historical or archaeological resources within the project area. The seismic survey project will not physically disturb the seafloor, with the exception of an occasional vessel anchoring. The seismic acquisition project data will be reviewed by the MMS to identify submerged cultural resources and will bolster the baseline cultural resources information in that portion of the Chukchi Sea. The seismic survey will not result in any terrestrial cultural resources effects, as the only land-based activity associated with the project will be refueling and crew supply changes in Nome.

5.4.4 Coastal and Marine Uses and Land Uses

Statoil anticipates that the proposed seismic activities will not have any effects on coastal or marine uses in the NSB and the NWAB, including military activities, marine shipping, commercial fishing, mariculture, and other mineral uses. The proposed seismic survey activity is expected to be at distances great enough to prevent potential conflict with other marine and coastal activities. Statoil further anticipates no effect on land use within the NSB and the NWAB, as the project area is more than 161 km (100 mi) offshore in an area where there are no land masses. Additionally, Statoil plans no shore-based activities, with the exception of resupply and crew change in Nome, during the seismic survey project.

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6.0 MITIGATION MEASURES

The following monitoring, mitigation, and reporting measures will be implemented as part of Statoil's seismic survey project. They have been developed to meet the requirements of:

- 50 CFR 18.114(c)(2) to develop a site-specific plan to monitor and mitigate the effects of the proposed activities on walruses and polar bears and to document the effects on these marine mammals.
- 50 CFR 216.104(11) to identify how proposed activities will be performed to effect the least practicable adverse effect upon species of seals and whales, their stocks, habitat, and availability for subsistence use.
- 50 CFR 216.108 to monitor the effects of activities on marine mammals and document the effects (including acoustical) on marine mammals and document or estimate the actual level of take.

6.1 Mitigation

Potential effects of the proposed 3D seismic acquisition project on marine mammals, fish, marine birds, their habitat, and the subsistence use of these species are expected to be minimal and temporary. Statoil has designed the seismic acquisition project to reduce the potential effect on marine mammals. Although the mitigation measures have been designed to mitigate effects on marine mammals, they are also expected to mitigate effects on other marine life such as fish.

- The size of the 3D seismic acquisition area has been minimized to the smallest area practicable to obtain the required data for a total 3D survey area of 2,385 sq km (915 sq mi).
- The total airgun discharge has been reduced to the minimum volume needed to obtain the required data without compromising data quality. The total volume is 3,000 cu in.
- The airgun array has ten spare airguns to reduce the chance for shutdowns due to equipment failures, thus potentially reducing the total field time.
- An unusually large streamer array (twelve individual streamers) is being deployed, resulting in a larger than normal distance between source lines and fewer transects needed to cover the seismic acquisition area. Because there are fewer transects, fewer shotpoints are needed to collect the required data and the data acquisition can be completed in a shorter time.

Mitigation measures that will be employed include:

- Establishment and maintenance of acoustic safety radii
- Speed and course alterations to maintain safety radii
- Ramp-up, power-down, and shutdown procedures

Vessel-based MMOs will be located on all project vessels and will monitor for the presence of marine mammals in the project area as described below. At least one Alaska Native knowledgeable about marine mammals will be part of the MMO team located on each project vessel. At least one MMO (when practicable, two MMOs) will monitor for marine mammals during daylight operations and during nighttime startups. MMO shifts will be no longer than 4 hours.

In order to mitigate the potential negative effects of the 3D seismic acquisition project on marine mammals and the subsistence use of these species, Statoil will adhere to the following mitigation measures.

6.1.1 Operating Conditions for Support Vessels

Statoil will adhere to the following mitigation measures during seismic acquisition, when mobilizing to the project area, when demobilizing from the project area, and in the performance of any other operations in support of seismic acquisition activities:

- All seismic source and support vessels will be staffed with MMOs who will alert the crew to the presence of marine mammals so that vessel crews can initiate appropriate mitigation measures.
- Vessels will reduce speed when approaching concentrations of marine mammals and maintain the maximum practicable distance from concentrations of marine mammals.
- Vessels will be operated so that they do not separate members of concentrations of marine mammals.
- Vessels will avoid areas of active or anticipated subsistence hunting.

6.1.2 Operating Conditions for Aircraft

Statoil does not anticipate performing aerial surveys as part of the monitoring for its 3D seismic acquisition project. Aerial surveys would be impractical and unsafe due to the location of the survey area, approximately 240 km (150 mi) offshore.

Aircraft are not anticipated to be needed during the Statoil 3D seismic acquisition; however, it is possible that individuals could be transported to or from vessels via helicopter in the case of emergencies. If aircraft are used, they will be operated at the maximum practicable distance from concentrations of marine mammals. Except in emergencies or during low cloud cover, aircraft will not operate lower than 305 m (1,000 ft) altitude.

6.1.3 Additional Mitigation Measures for Seismic Operations

Statoil will adhere to the following mitigation measures during 3D seismic acquisition activities:

- Acoustic safety radii will be established and verified through sound source verification (SSV) upon arrival at the project area. At a minimum, SSV would measure where the received level is:
  - Greater to or equal to 180 dB relative to one microPascal (re 1 μPa)
  - Greater to or equal to 190 dB re 1 μPa
  - Greater to or equal to 160 dB re 1 μPa
- Acoustic safety radii will be monitored by MMOs. MMOs will actively watch for marine mammals, record marine mammal observations, and provide direction to vessel crew regarding mitigation measures (e.g., power down, shutdown) specified below. At least one chase/monitoring vessel will assist in monitoring safety radii immediately prior to and during seismic acquisition operations.
- If a marine mammal is detected outside the exclusion zone radius and appears to be entering the zone radius, the source vessel must alter its speed and/or track to prevent the marine mammal from entering the exclusion zone. If these actions cannot prevent the marine mammal from entering the exclusion zone, power-down procedures will be initiated (addressed below).

- **Ramp-up Procedures—**The following ramp-up procedures will be adhered to for all seismic surveys, including airgun testing, to allow marine mammals to depart the exclusion zone before the seismic data acquisition begins.
  - Visually monitor the exclusion zone and adjacent water for marine mammals for at least 30 minutes before initiating ramp-up procedures. Ramp-up procedures may be initiated if no marine mammals are observed in the exclusion zone during the 30-minute observation period. Ramp-up procedures cannot be performed at night or when the exclusion zone cannot be visually monitored for marine mammals.
  - Ramp-up procedures should be initiated by discharge of a single airgun (preferably the smallest airgun in the array). Ramp-up will continue by gradual activation of additional airguns over a period of time as specified in the applicable permit until the operating energy output is reached.
  - If one airgun has maintained operation during a power-down period (e.g., a mitigation gun), ramp-up to full power will be permissible at night or during poor visibility conditions, based upon the assumption that marine mammals will be alerted by sounds from the mitigation gun and could move away from the airgun array.
- **Power Down/Shutdown Procedures—**Power down/shutdown involves decreasing the number of operating airguns to decrease the size of the safety radii. Power-down/shutdown procedures will be adhered to in the following situations:
  - Immediately power down/shut down the airgun array (and other acoustic sources) whenever marine mammals are sighted approaching close to, entering, or within the permit-stipulated exclusion zone.
  - Permit stipulations will be followed that require power down in the event that aggregations of marine mammals (e.g., twelve or more walruses in water; four or more whale cow/calf pairs) are observed within the 160 dB re 1 μPa safety radii so that the sound pressure level received by the walrus does not exceed 160 dB re 1 μPa.
  - If power down cannot reduce the received sound pressure level to that mandated by permit stipulations (180 dB re 1 μPa for whales and walrus; 190 dB re 1 μPa for polar bear and seals), the sound source must immediately be shut down.
- **Emergency Shutdown Procedures—**If observations are made or credible reports are received that one or more marine mammals are within the seismic survey area and are injured, dead, dying, or indicate acute distress due to seismic sounds, the airgun array should undergo emergency shutdown and the applicable regulatory agency (i.e., NMFS or USFWS) should be contacted immediately.

6.1.4 Mitigation Measures for Subsistence Use of Marine Mammals: POC

Statoil intends to maintain an open and transparent process with all stakeholders throughout the life-cycle of activities in the Chukchi Sea. Statoil began the stakeholder engagement process in 2009 with meetings with Chukchi Sea community leaders at the tribal, city, and corporate level. Statoil will continue to engage with leaders, community members, and subsistence groups (as well as local, state, and federal regulatory agencies) throughout the exploration process.

As part of stakeholder engagement, Statoil is developing a POC for the proposed 2010 3D seismic acquisition. The POC identifies the actions Statoil will take to identify important subsistence activities, inform subsistence users of the proposed survey activities, and obtain feedback from subsistence users regarding how to provide cooperation between subsistence activities and the Statoil project.

A POC is required to comply with OCS Lease Sale 193 stipulations (Stipulation No. 5) and federal regulatory requirements 50 CFR 216.104(a)(12)(ii). The POC also fulfills the requirements of three major federal permits: the NMFS IHA, the USFWS LOA, and the MMS G&G permit.

Statoil met with leadership from the communities of Barrow, Wainwright, Point Lay, Point Hope, and Kotzebue during the last week of October and the first week of November 2009. Statoil met with leaders both in small groups and on a one-on-one basis. These meetings enabled Statoil to introduce themselves and the 2010 3D marine seismic acquisition project to community leaders and to discuss local concerns regarding subsistence activities, timing of operations, and local hire and workforce development.

Based upon these meetings, a draft POC document was developed. Upon completion, the draft POC was submitted to each member of the leadership with whom Statoil met during their October and November leadership meetings, as well as other community members. Statoil also submitted the draft POC to NMFS, USFWS, and MMS as part of the permit application process. Public POC meetings were held in January 2010 in the communities of Barrow, Point Hope, Point Lay, and Wainwright to obtain input from the general public and individual subsistence hunters within these communities.

A final POC that documents all consultations with community leadership, subsistence users groups, individual subsistence users, and community members will be submitted to NMFS, USFWS, and MMS upon completion of consultation. The final POC will include feedback from the leadership meetings and POC meetings. Statoil will continue to document all consultation with the communities and subsistence stakeholders.

6.2 Monitoring

6.2.1 Marine Mammal Observers

Statoil will maintain trained MMOs to carry out the monitoring necessary to perform mitigation as required by the LOA and IHA. The MMO training curricula will be approved by USFWS and the NMFS, and all MMOs will be approved by USFWS and NMFS. MMOs will be required to be present on board the seismic source vessel and support vessels to:

1. Alert the crew to the presence of marine mammals so that appropriate mitigation action can be taken.
2. Carry out the specific monitoring activities necessary to evaluate the effect of activities authorized by the LOA and IHA on marine mammals.
3. Document marine mammal sitings and interactions with seismic vessels.

6.2.2 Acoustic Monitoring

Statoil will participate in an acoustic monitoring project consisting of bottom-mounted, autonomous acoustic recorders. This project will be a continuation of the acoustic monitoring project in cooperation with Shell and CPAI that began in 2009. The main objectives of the project are:

- Develop an understanding of the propagation and attenuation of underwater seismic sounds in the project area;
- Determine the ambient underwater sound levels in the project area;

- Assess the effects of underwater sounds on marine mammals within the project area, particularly migrating bowhead whales.

6.3 Reporting

Statoil will follow permit stipulations regarding required reporting, including the following reporting requirements:

- Statoil will provide reports to NMFS and USFWS regarding the progress of authorized activities, as required by the permits (e.g., prior to the beginning of seismic acquisition activities, periodic progress reports, incidents involving marine mammals, and upon completion of acquisition activities);
- The operator of the seismic vessel will maintain a log of seismic activity noting the date and time of all changes in seismic activity (ramp up, power down, changes in active airguns, etc.) and any corresponding changes in monitoring radii.

Statoil will maintain a table of all marine mammal observations. This information will be provided to USFWS and NMFS and will be used to complete the 90-Day Report at the conclusion of seismic acquisition. The 90-Day Report will describe the operations that were conducted and provide a summary of the monitoring effort and the results of the monitoring effort. Estimates and nature of takes based upon marine mammal sightings will also be included in the 90-Day Report.

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Appendix
Joint Industry Program on Oil Spill Contingency for Arctic and Ice-Covered Waters

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