North Prudhoe Bay Unit
Ocean Bottom Sensor Seismic Survey
Environmental Impact Assessment

BP Exploration (Alaska) Inc.

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ACRONYMS AND ABBREVIATIONS

%...................... percent
3D.................... Three-dimensional
ACP................. Arctic Coastal Plain
ADEC .... Alaska Department of Environmental Conservation
ADF&G .... Alaska Department of Fish and Game
ADNR............. Alaska Department of Natural Resources
AFMP .... Arctic Fisheries Management Plan
ANWR............ Arctic National Wildlife Refuge
ASAMM......... Aerial Surveys of Arctic Marine Mammals
ASL .... above sea level
BCB .... Bering-Chukchi-Beaufort
BLM .... Bureau of Land Management
BOEM .... Bureau of Ocean Energy Management
BOEMRE........ Bureau of Ocean Energy Management, Regulation and Enforcement
BPXA .... BP Exploration (Alaska) Inc.
CAA................ Conflict Avoidance Agreement
CAH................ Central Arctic Herd
CBS.................. Chukchi/Bering Sea
CFR .... Code of Federal Regulations
CPAI .... ConocoPhillips Alaska, Inc.
DGPS .... Differential Global Positioning System
DS.................... Drill Site
EFH................. essential fish habitat
ESA .... Endangered Species Act
°F .... degrees Fahrenheit
FLIR .... Forward Looking Infrared
ft .... feet
ft^2..................... feet squared
GMU............... Game Management Unit
HSSE............... Health, Safety, Security and Environmental
in^3.................... cubic inch
IHA .... Incidental Harassment Authorization
LOA .... Letter of Authorization
mi^2.................. square mile
MACTEC........ MACTEC Engineering and Consulting
MBTA .... Migratory Bird Treaty Act
MMS .... Minerals Management Service
MMPA............ Marine Mammal Protection Act
mph................. miles per hour
MPI .... Main Production Island

NMFS............. National Marine Fisheries Service
NOAA .... National Oceanic and Atmospheric Administration
NPBU............. North Prudhoe Bay Unit
NPFMC .... North Pacific Fisheries Management Council
NPR-A .... National Petroleum Reserve-Alaska
NSB .... North Slope Borough
OBC................ ocean bottom cable
OBS .... ocean bottom sensor
OCS................ outer continental shelf
OCSEAP......... Outer Continental Shelf Environmental Assessment Program
oz.................... ounce
PBU .... Prudhoe Bay Unit
PSO .... Protected Species Observers
PTS................. Permanent Threshold Shifts
PVATF........... permanent vertical array test facility
rms .... root mean squared
SBS .... Southern Beaufort Sea
SDI .... Satellite Drilling Island
SEL................. sound exposure level
SRB&A........... Stephen R. Braund and Associates
TDS .... total dissolved solids
TERA .... Troy Ecological Research Associates
TTS................. Temporary Threshold Shifts
TZ................... transition zone
UB .... unconsolidated bottom
USGS.............. United States Geological Survey
ULSD .... ultra-low sulfur diesel
URS................. URS Corporation
USACE .... United States Army Corps of Engineers
U.S.C. .... United States Code
USDOI .... United States Department of the Interior
USFWS .... United States Fish and Wildlife Service
Y-K................. Yukon-Kuskokwim

1. INTRODUCTION

BP Exploration (Alaska) Inc. (BPXA) plans to conduct a three-dimensional (3D) ocean bottom sensor (OBS) seismic survey with a transition zone (TZ) component on state and private lands, and federal and state waters in the Prudhoe Bay area of the Beaufort Sea during the open water season of 2014. The main survey will be conducted between July and September 2014. The survey area lies mainly within the Prudhoe Bay Unit (PBU) and also includes portions of the Northstar, Dewline, and Duck Island Units, as well as non-unit areas (Figure 1).

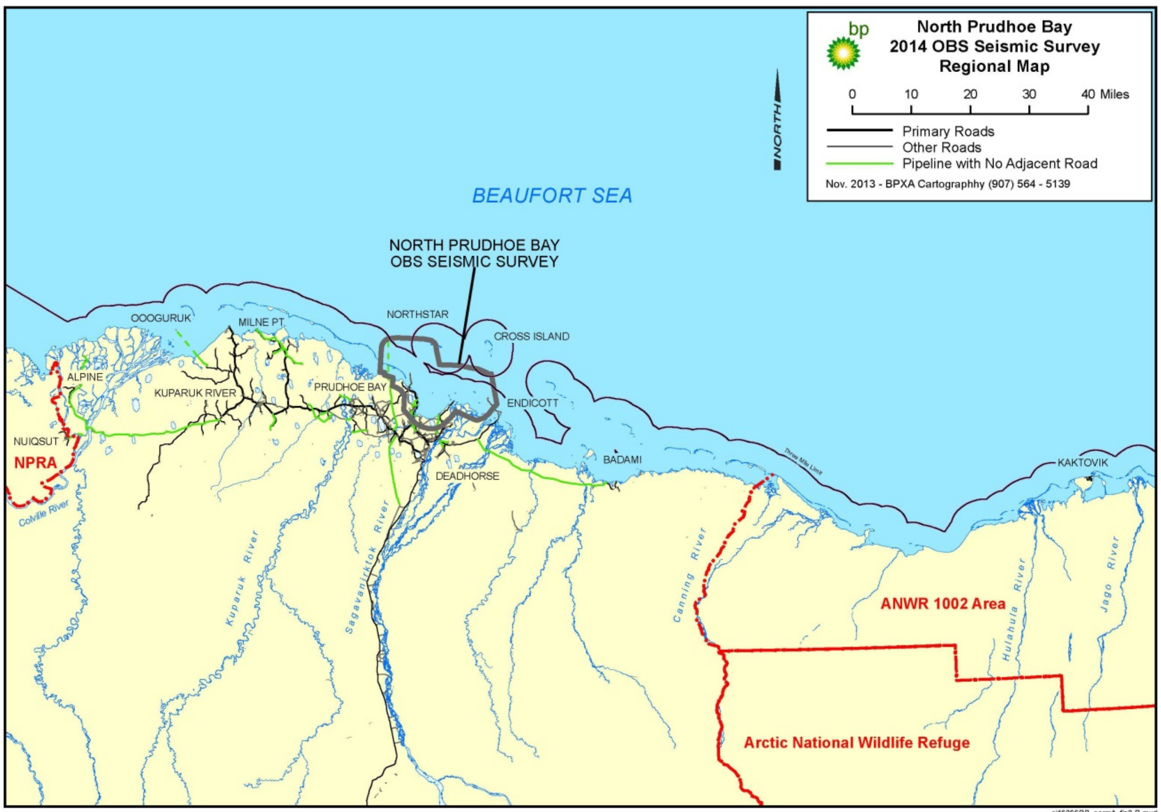

FIGURE 1: OVERVIEW OF THE EASTERN BEAUFORT SEA WITH THE OUTLINE OF THE PRUDHOE BAY SEISMIC SURVEY AREA

BPXA initially requested permits for this activity in early 2013 and notified agencies on 28 February 2013 that the survey would not be conducted in 2013. The proposed 2014 OBS seismic survey has been optimized for completion in one OBS season.

1.1. Purpose

The purpose of the proposed survey is to obtain current, high-resolution seismic data to image the existing reservoirs. This data will increase BPXA's understanding of the reservoir, allowing more effective reservoir management. Existing datasets of the proposed survey area include the 1985 Niakuk and 1990 Point McIntyre vibroseis on ice surveys. A complete set of OBS data has not previously been acquired within the proposed survey area.

1.2. Location

The general location of the proposed seismic survey in the Prudhoe Bay area, Beaufort Sea, Alaska is shown in Figure 2.

Data acquisition (source operation and receiver placement) will occur over approximately 190 square miles (mi^2). The area is comprised of approximately 129 mi^2 of water depths greater than 3 feet (ft), 28 mi^2 of water less than 3 ft, and 33 mi^2 of land. Activity outside the 190-mi^2 area may include source vessel turning while using mitigation guns, vessel transit, and project support and logistics. The approximate boundaries of the total surface area are between 70°16′N and 70°30′N and between 147°53′W and 148°45′W and include state and federal waters, as well as state and private lands.

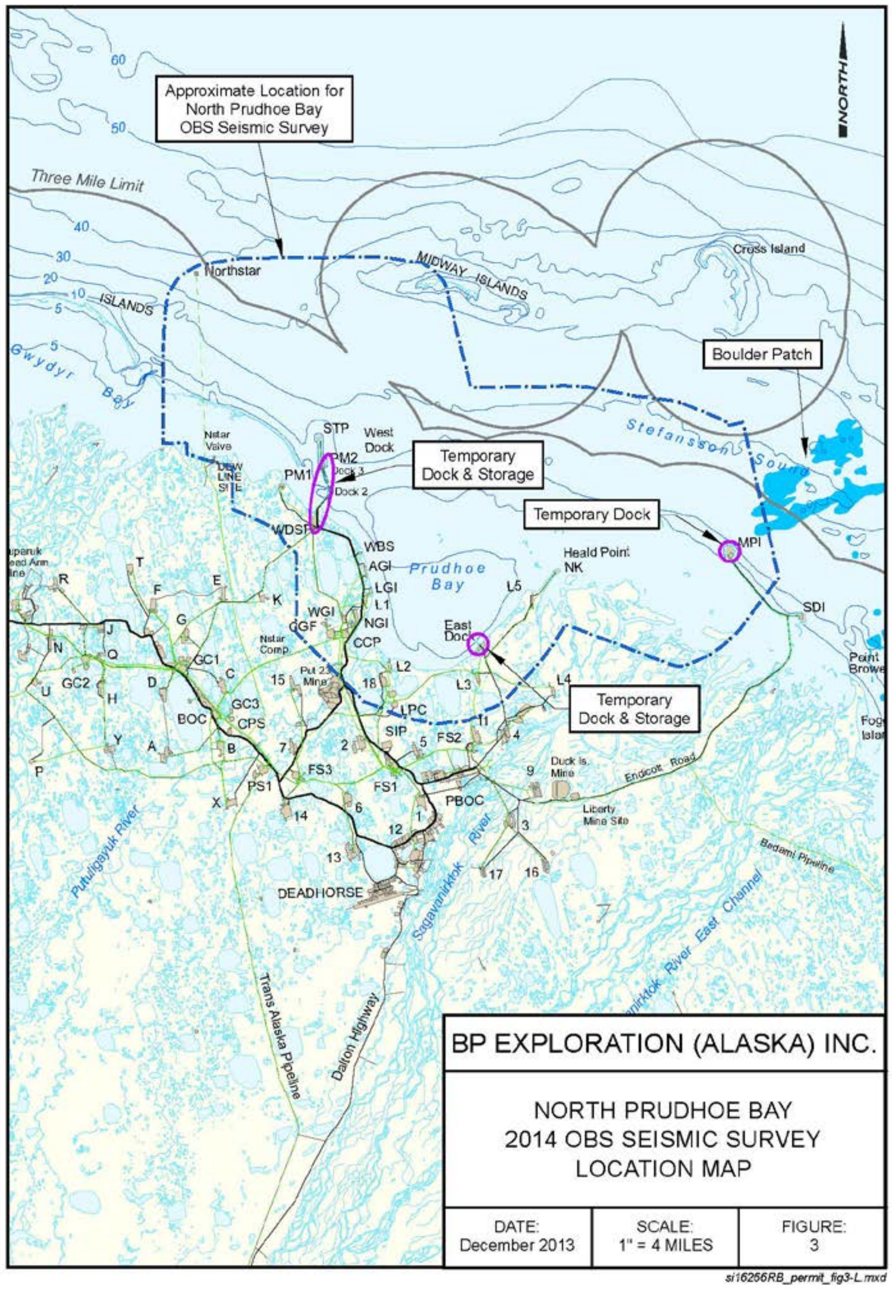

FIGURE 2: APPROXIMATE BOUNDARY OF THE PROPOSED NORTH PRUDHOE BAY SEISMIC SURVEY AREA

1.3. Schedule

The project is planned to commence with mobilization of equipment to Deadhorse in late May/early June 2014. Some site preparation activities, including installation of receivers in the Sagavanirktok River Delta (as described in Section 6.3), may occur in April 2014 while the delta is still ice covered. The planned start date of receiver deployment is approximately 1 July 2014, with seismic data acquisition beginning when open water conditions allow. This has typically been around 15 July. Seismic data acquisition may take approximately 45 days to complete, which includes stand-by for weather and other circumstances. Seismic data acquisition will occur on a 24-hour per day schedule with staggered crew changes. Receiver retrieval and demobilization of equipment and support crew will be completed by the end of September.

To limit potential impacts to the bowhead whale fall migration and subsistence hunt, airgun operation dates will be in accordance with the dates agreed upon in the Conflict Avoidance Agreement (CAA), historically ending 25 August. Receiver and equipment retrieval and crew demobilization would continue after airgun operations end.

1.4. Description of Activity

The activities associated with this project include mobilization of equipment and personnel, housing and logistics, temporary support facilities (i.e., tents, connex, enviro-vacs), seismic data acquisition, and project demobilization.

1.4.1. Equipment Mobilization

Mobilization, demobilization, and support activities are primarily planned to occur at West Dock, East Dock and Endicott. Other existing pads within the PBU area may be utilized for equipment staging or support as necessary.

Vessels are expected to be transported to the North Slope by truck. They will be prepared at the seismic contractor's base in Deadhorse, West Dock, or East Dock. Vessel preparation will include assembly of navigation and source equipment, testing receiver deployment and retrieval systems, loading recording and safety equipment, and initial fueling. Once assembled, the systems, including airguns, will be tested within the project area.

1.4.2. Housing and Logistics

Approximately 220 people will be involved in the operation including seismic crew, management, mechanics, and Protected Species Observers (PSO). Most of the crew will be accommodated at BPXA operated camps or Deadhorse. Some offshore crewmembers will be housed on vessels.

Personnel transportation between camps, pads, and support facilities will be by trucks and crew transport buses via existing gravel roads. Shallow watercraft such as Zodiac-type vessels and ARKTOS™ will be used to transport equipment and crews to shallow water and surf zone areas of the survey area not accessible by road; ARKTOS™ will not be used in vegetated areas, including tundra. Helicopters will be used to transport equipment and personnel to onshore areas (tundra and delta) where crews on foot will deploy equipment. Trucks may also be used on the existing road system to transfer survey equipment and crews to the onshore portions of the survey area accessible by road and pads. Helicopter operations will be supported in Deadhorse.

Up to 10,000 gallons of fuel (mostly ultra-low sulfur diesel [ULSD] fuel and small quantities of gasoline) may be temporarily stored on existing pads to support survey activities. Fuel will be transported to locations to refuel equipment. The vehicle transporting fuel (helicopter, boat, tracked buggy, or truck) to locations off pads will supply the necessary quantity of fuel at the time of transfer. Fueling of equipment may occur in floodplains and near water to accommodate marine and surf zone operations. All fueling will occur in accordance with applicable regulations and BPXA spill prevention practices.

The potential winter drilling site preparation work would be fueled by a mobile tundra travel approved fueler.

1.4.3. Support Facilities

West Dock, Endicott, and East Dock, as well as other existing PBU infrastructure will be utilized for seismic staging, crew transfers, resupply, and support activities. Crew transfers and re-supply may also occur at other nearby vessel accessible locations (e.g., by beaching) if needed. For protection from weather, vessels may anchor near West Dock, near the barrier islands, or other nearshore area locations.

Receivers (i.e., nodes placed into cache bags) to be transported by helicopter via sling-load to the on-site project area for on-foot deployment may be temporarily staged on tundra adjacent to pads. These staging areas are not expected to exceed 200 ft by 200 ft and will be shifted as practicable to minimize tundra disturbance.

Helicopter support for equipment and personnel transport is scheduled to take place one shift per 24-hour day. The helicopter will be based at the Deadhorse airport. A few staging areas may be strategically located at existing pads or gravel locations in the PBU to minimize flight time and weather exposure.

A temporary flexi-float dock may be located at West Dock to provide support for vessel supply operations, personnel transfers, and refueling. The dock will be a maximum of 170 ft by 30 ft, and will be comprised of sections that will be fastened on location and secured with spuds to the seafloor. A smaller temporary dock (up to 100 ft by 20 ft) may also be used at Endicott during some of the eastern operations if needed for additional support operations. Minimal and temporary disturbance to marine sediments are expected when docks are placed and removed.

1.4.4. Demobilization, Site Restoration, and Rehabilitation

Equipment will be retrieved as part of the operations and during demobilization. Receiver retrieval and demobilization of equipment and support crew will be completed by the end of September. BPXA does not expect site restoration and rehabilitation to be necessary in the course of this work.

1.5. Seismic Survey Details

1.5.1. *Equipment and Vessels*

Equipment will include geophysical equipment such as geophones/receivers, airguns, nodes and batteries, helicopters, tracked drills, and vessels. The vessels anticipated to be used for data acquisition are shown in Table 1. In the event a specific vehicle or vessel is not available, a vehicle or vessel with similar parameters would be used. Any substitution will be in accordance with permit requirements.

TABLE 1: SUMMARY OF VESSELS AND OTHER EQUIPMENT INVOLVED IN PROPOSED NORTH PRUDHOE BAY 2014 OBS SEISMIC SURVEY

Vessel Type	Number (approx.)	Dimensions (up to/approx.)	Main activity	Frequency
Offshore and Surf Zone				
Source Vessel: Main	1	90 × 25 ft	Seismic Data Acquisition	24-Hour Operation
Source Vessel: Small	2	70 x 16 ft	Seismic Data Acquisition	24-Hour Operation
Receiver Boats	4	85 X 24 and 32 x 14 ft	Deploy and Retrieve Receivers in Offshore Zone	24-Hour Operation
Crew Transport, HSE and Support Vessels	2	45 × 14 ft	Transport Crew and Supplies	Typically Twice Daily
Support Vessel	1	116.5 × 24 ft 23 × 15 ft	Crew support - floating platform if needed.	24-Hour Operation
Surf Zone and On-shore				
ARKTOS™	2		Deploy and Retrieve Receivers in Surf Zone and Non-Vegetated Onshore Areas	24-Hour Operation
Utility type vehicle*	Up to 6		Deploy and Retrieve Receivers in Surf Zone and Non-Vegetated Delta Areas Transport fuel and water for drilling	24-Hour Operation
Zodiacs	Up to 3		Transport Crew and Supplies	24-Hour Operation
Airboats	Up to 2		Transport Crew and Supplies	24-Hour Operation
Northstar Hovercraft**	1		Transport Crew and Supplies	As Needed

*Utility type vehicles include: tracked or wheeled buggy, catamaran, or similar equipment in combination.

**Hovercraft will be used opportunistically as needed and as available for use.

1.5.2. *Survey Preparation*

Surveyors will deploy up to three navigation positioning base stations (survey control) onshore or on an island and may mark receiver locations in advance of the layout crews. Scouting of the project area and collecting bathymetry information necessary to identify site-specific conditions such as water depth in near-shore areas will be performed before receiver deployment.

Navigation will be accomplished with the use of a Differential Global Positioning System (DGPS). This navigation system remotely links the operating systems located on vessels. The navigation system will connect to the base stations (survey controls) installed as part of survey preparation. The instrument navigation system will display known obstructions, islands, identified areas of sensitivity, along with pre-plotted source and receiver line positions; this information will be updated as necessary. The asset monitor will update the positions of each vessel in the survey area every few seconds providing the crew a quick display as to each vessel's position relative to the various display items.

Tide gauges will also be temporarily installed in the operation area. Tide gauges will be used to provide real-time water depth to facilitate planning. The tide gauge information will be input into the navigation system to provide real-time assessment.

1.5.3. *Receiver Deployment and Retrieval*

The survey area is separated into three different zones based on the different types of receivers that will be used and the method of receiver deployment and retrieval for that zone. Deployment and retrieval methods have been designed to facilitate complete equipment retrieval at the end of the survey.

1.5.3.1. Offshore Zone

The offshore zone is defined as waters of 3 ft or deeper. Receiver boats will be used for the deployment and retrieval of the receivers (marine nodes) that will be placed in lines on the ocean bottom at 110 ft spacing. Acoustic pingers will be deployed on every second node to determine exact positions of the receivers.

Receivers will not be placed east of the Endicott Main Production Island, and will therefore not be placed in mapped concentrations of the Boulder Patch.

1.5.3.2. Surf Zone

The surf zone includes waters up to 6 ft deep along the coastline, non-vegetated tidelands, and lands within the river delta areas that are intermittently submerged with tidal, precipitation, and storm surge events. ARKTOS™ and utility type vehicles with an approximately 4-inch diameter bit will be used to either drill or flush the receivers to approximately 6 ft. Small vessels will then attach autonomous nodes to the receivers. The nodes will be protected from the water by placement on either specially designed floats anchored to the bottom or on support poles. Support poles will primarily be used in water less than 18 inches deep and in tidal surge areas to ensure that the nodes stay above surface waters and prevent them from becoming inundated as a result of fluctuating water levels. Receivers that are installed in the seabed may require flushing using warm water to assist with removal.

1.5.3.3. Onshore Zone

The onshore zone is the vegetated area from the coastline inland. Autonomous node receivers with geophones will be used in this area. Helicopters will be the main method used to transport land crews and equipment. Equipment will be bagged, with each bag holding several nodes. Multiple bags will be transported via sling load from the staging area to the receiver lines and temporarily cached. Bag drop zones will be 500 to 1,000 ft apart and will be cleared for the presence of nesting birds prior to use. Crews on foot will walk from bag to bag and lay out the equipment at the surveyed location. Vessels may also be used to transport personnel and equipment to a staging area on the beach and vehicles may be used to transport personnel and equipment along the road system. Zodiac-type boats may be used in large lakes to deploy marine nodes. Boats, nodes, and crews will be transported via helicopter to and from the lakes.

Nodes will be located on the ground surface and the geophone(s) will be inserted approximately 3 ft below ground surface. Geophone installation will be either by hand using a planting pole or will be inserted into approximately 1.5-inch diameter holes made with a hand-held drill. Support poles may be placed in lake margins and marshy areas of tundra as needed to ensure the nodes stay above surface waters and prevent them from becoming inundated as a result of fluctuating water levels. On completion of recording operations in a particular area, land crews will retrieve the nodes.

If conditions allow, an advance crew may install geophones in the Sagavanirktok River Delta portion of the survey area in late winter. This crew would work for up to 30 days, beginning in April, until tundra closure. Two tracked utility vehicles would drill in receivers and a support vehicle would provide logistics. Approximately 15 people may work two shifts during a 24-hour per day period. The DGPS location of the geophones will be recorded and survey lathe or markers would be used to assist in marking the location. The receivers would be connected to recording nodes during the main OBS survey time (July - August).

In December 2013, an aerial survey using Forward Looking Infrared (FLIR) to detect maternal Polar Bear dens was conducted. During the survey, no polar bear dens were identified in the project area. If a den is discovered at a later date it will be immediately reported to USFWS. Any occupied dens will be avoided by a one-mile radius in accordance with the Letter of Authorization (LOA) from USFWS and BP’s Polar Bear Interaction Plan.

1.6. Recording

Data will record autonomously and may be periodically checked for quality control by crews. Land nodes will have a battery pack attached. The offshore nodes have internal batteries.

1.7. Permanent Vertical Array Test Facility

Additional seismic data will be collected from the permanent vertical array test facility (PVATF) located on land near East Dock. The PVATF is a cased borehole, which was installed and instrumented with geophones in 1985 on ConocoPhillips Alaska, Inc. (CPAI) fee simple land (ADL 42749) near East Dock. The geophones in the borehole will be connected to a cable and recording nodes for the duration of the survey. Data collected from the PVATF will be processed with the OBS data.

1.8. Source Vessel Operations

A total of three seismic source vessels will be used during the proposed survey. The source vessels will carry an airgun array that consists of two sub-arrays, however, it is possible that one of the source vessels will tow only one sub-array. The discharge volume of the sub-array will not exceed 620 cubic inch (in^3). Each sub-array consist of eight airguns (2 x 110, 2 x 90, 2 x 70, and 2 x 40 in^3) totaling 16 guns for the two sub-arrays with a total discharge volume of 2 × 620 in^3, or 1240 in^3. The 620 in^3 sub-array has an estimated source level of ~218 decibels referenced to 1 microPascal root mean squared (dB re 1 μPa rms) at 1 meter from the source. The estimated source level of the two sub-arrays combined is ~224 dB re 1 μPa rms (Table 2). In the shallowest areas only one sub-array may be used for a given source vessel. Table 2 summarizes the acoustic properties of the proposed airgun array. The smallest gun in the array (40 in^3) or a separate 10 in^3 airgun will be used for mitigation purposes.

The airgun subarrays will be towed at a distance of approximately 50 ft (15 m) from the source vessel's stern at depths ranging from approximately 3 to 6 ft, depending on water depth and sea conditions. The source vessels will travel along pre-determined lines with a speed varying from 1 to 5 knots, mainly depending on the water depth.

To limit the duration of the total survey, the source vessels will be operating in flip-flop mode (i.e., alternating shots); this means that one vessel discharges airguns when the other vessel is recharging. In some instances, only one source vessel will be operating, while the second source vessel will be engaged in refueling, maintenance, or other activities that do not require the operation of airguns. The expected shot interval for each source will be 10 to 12 seconds, resulting in a shot every 5 to 6 seconds due to the flip-flop mode of operation. The exact shot intervals will depend on the compressor capacity, which determines the time needed for the airguns to be recharged. Data will record autonomously on the nodes placed offshore, in the surfzone, and onshore and may be periodically checked for quality control.

TABLE 2. PROPOSED AIRGUN ARRAY CONFIGURATION AND SOURCE SIGNATURES AS PREDICTED BY THE GUNDALF AIRGUN ARRAY MODEL FOR 2 M DEPTH.

ARRAY SPECIFICS	620 IN^3 ARRAY	1240 IN^3 ARRAY
Number of guns	Eight 2000 psi sleeve airguns (2 x 110, 2 x 90, 2 x 70, and 2 x 40 in^3) in one array)	Sixteen 2000 psi sleeve airguns (4 x 110, 4 x 90, 4 x 70, and 4 x 40 in^3), equally divided over two sub-arrays of eight guns each
Zero to peak	6.96 bar-m (~237 dB re µPa @ 1 m)	13.8 bar-m (~249 dB re 1µPa @ 1 m)
Peak to peak	14.9 bar-m (~243 dB re µPa @ 1 m)	29.8 bar-m (~243 dB re 1µPa @ 1 m)
RMS pressure	0.82 bar-m (~218 dB re µPa @ 1 m)	1.65 bar-m (~224 dB re 1µPa @ 1 m)
Dominant frequencies	Typically less than 1 kHz	Typically less than 1 kHz

2. PHYSICAL ENVIRONMENT

2.1. Geology

The project is within the Arctic Coastal Plain (ACP) physiographic province. This region is characterized by gently rolling topography, many shallow lakes and ponds, and poorly drained soils. When viewed from the air, the surface appears as contiguous, irregular polygons, which have been created by ice formation in the surface and subsurface soils.

The project area is within the permafrost zone, where the subsurface soils below approximately 2 ft are continuously frozen. Surface deposits consist of recent unconsolidated marine silts, sands, clay, and outwash gravels, of the perennially frozen Gubik Formation, which overlies Cretaceous or Tertiary rocks in the coastal plain (Black 1964).

Surface layer soils consist of peat underlain by silt and silty loam over layers of sand and gravel. Because of the flat topography, natural soil erosion is minor.

2.1.1. Soils

Soils in the project area are underlain by permafrost, which exists at varying depths to approximately 2,000 ft. Snow and ice typically cover soils for most of the year. Decomposition rates are slow under Arctic environmental conditions, and organic matter accumulates over the mineral soil and parent materials as thick peat layers, particularly in low-lying areas (Nowacki et al. 2001). Cold temperatures and frozen conditions slow the process of soil formation, resulting in minor profile increases (Brady and Weil 1999).

In summer, the active layer thaws, typically within a few feet of the ground surface. Thaw bulbs are permanently unfrozen soils found in permafrost and are likely to be present within the project area below lakes and river channels and in areas disturbed by human activities (Rawlinson 1983). Regardless of thaw bulbs and the active layer, the presence of permafrost inhibits water drainage during the summer thaw, and combined with flat topography results in poorly drained soils that remain continuously wet (United States Department of the Interior [USDOI] and Bureau of Land Management [BLM] 2005) when they are not frozen.

2.2. Climate

The project is located in the Arctic costal climate zone (Alaska Department of Environmental Conservation [ADEC] 2012). This zone is characterized by long, frigid winters and short, cool summers (MACTEC Engineering and Consulting [MACTEC] 2011). In the summer, the sun is above the horizon for 2 months continually and below the horizon for 2 months during the winter. The area is relatively flat and more than a quarter of the area is covered by freshwater lakes (URS Corporation [URS] 2005;

Veltkamp and Wilcox 2007). Temperatures are below freezing most of the year, with the annual average temperatures below 14 degrees Fahrenheit (°F) (Veltkamp and Wilcox 2007). February tends to be the coldest month with average temperatures around -21°F, and July is the warmest with average temperatures of 46°F (MACTEC 2011). Sea ice formation in this area typically begins in October, and is present through June, with breakup starting around April (MACTEC 2011).

2.2.1. Precipitation

Annual precipitation for the area is less than 10 inches total (ADEC 2012). Most of this precipitation falls as snow (MACTEC 2011). Snow covers the ground most of the year, though the depth of the snow varies by location (MACTEC 2011; Veltkamp and Wilcox 2007). The relative humidity is typically around 80 percent (%), but it is highest during the summer (Veltkamp and Wilcox 2007).

2.2.2. Wind

Wind speeds average 12 miles per hour (mph), and the prevailing directions are northeasterly and easterly (MACTEC 2011). Maximum wind speeds in the area are around 56 mph (Veltkamp and Wilcox 2007). The winds are calm less than 10% of the time (Veltkamp and Wilcox 2007).

2.2.3. Climate Change

Arctic temperatures have fluctuated in the last few centuries and currently are in a warming trend (URS 2005). This warming has affected the Arctic environment by reducing the amount of Arctic sea ice 15 to 20% in the last 30 years, causing the melting of permafrost in some locations (URS 2005). This is likely due to the increases in greenhouse gases, caused by the activities of humans, particularly the burning of fossil fuels (Intergovernmental Panel on Climate Change 2007).

2.2.4. Ambient Air Quality

Numerous ambient air monitoring projects have shown that the area is in attainment with the National Ambient Air Quality Standards (MACTEC 2011). Due to the constant winds and flat topography of the North Slope of Alaska, emissions are dispersed quickly. The most apparent problems are a widespread Arctic haze at higher elevations and smog from local sources (MACTEC 2011). The Arctic haze is typically present in the winter and spring, and can reduce visibility from the normal 50 miles to less than 5 miles (URS 2005). This phenomenon was first observed in the 1950s, long before the development of the North Slope, and is believed to be due to long-range transport of pollution from burning fossil fuels in Europe (URS 2005). Sources of emissions include drill rigs, oil and gas production facilities, vehicle traffic, and diesel generators.

2.3. Hydrology

Hydrology on the North Slope is heavily influenced by the Arctic climate, and the underlying layer of permafrost. Rivers in the vicinity of Prudhoe Bay cross the ACP in complex channels and form large complex deltas at their outfall to the Arctic Ocean. The low relief of the plain results in low-gradient, meandering and braided systems. Overland flows that are unconfined by defined channels are also prominent, especially during spring breakup, and can convey substantial discharge (Hinzmann et al. 1993).

Hydrologic conditions of the project area follow the pattern of the surrounding the ACP. The annual hydrograph is dominated by spring flooding, following ice breakup. Fall rains also raise stream levels; however, during the remainder of the year, conditions are at or near base flow. Stream systems are very “flashy,” which means water level stages rise and fall quickly in response to precipitation events. This phenomenon happens because surface run-off is prevented from percolating downward by an impermeable permafrost layer and instead rapidly fills stream channels and is quickly transported downstream.

In spring, during breakup, ice jams can dam river channels and cause flooding. Ice can cause a variety of hydrologic/surface flow conditions that are difficult to predict and may change over time and year to year.

2.3.1. Sagavanirktok River and Delta

The southeast portion of the proposed North Prudhoe Bay Unit (NPBU) seismic survey area includes approximately 190 mi^2 of the Sagavanariktok (Sag) River Delta. The Sagavanirktok River drains the north slope of the Brooks Range and originates from several lakes located in the foothills. The Sagavanirktok River has a meandering pattern and deposits alluvial sediments (sand and gravel) at point bars along the inside bends of the riverbanks. The floodplain is approximately 41 miles wide in the proposed project area. The Sagavanirktok River is one of the largest rivers on the North Slope and has one of the largest delta areas of rivers on the ACP. The river is frozen for more than half of the year. Breakup and peak discharge occur during a 3-week period in late May. Because the region is underlain by continuous permafrost, the river is effectively isolated from deep groundwater (McNamara 1997).

2.3.2. Channel Patterns

Channel patterns are formed during high water flow during summer rainfall events. The highest flows are generally in late spring and are fed by ice and snow melt. Although the spring flows are higher (overbank flows occur annually), they are less likely to carve new channels because the riverbanks are still frozen during spring (Minerals Management Service [MMS] 2007a). Wide fluctuations in seasonal flow are often intensified by shallow permafrost conditions.

In the spring, initial snowmelt from the upper basin flows over the frozen river surface and ponds behind snowdrifts and icings. As breakup progresses, these obstacles thaw or are overtopped, and the melt water is released downstream until it ponds at snow or ice barriers further downstream. This storage-and-release process produces peak stream discharge (MMS 2007a). River flows are minimal in winter. Spring breakup flooding begins in May, and flows continue through the summer and stop at freeze-up in early October.

2.3.3. Groundwater

Groundwater is limited in the ACP. Impermeable permafrost exists 2 to 6 ft below the ground surface and is continuous throughout the ACP. Permafrost can extend to depths of 2,000 ft (Sloan 1987; Lachenbruch et al. 1988). Because of this limitation, groundwater within unfrozen soil can sometimes rise above the surface of the ground, causing sheet flow, which can occur from early May to late September. Groundwater, known as suprapermafrost groundwater, exists within the "active layer" (the seasonal thaw zone of soil) and is connected to and part of the surface water.

Suprapermafrost groundwater is present in localized unfrozen layers within the permafrost. It is also found beneath deep rivers and lakes, which do not freeze to the bottom in winter. Large rivers and lakes deeper than 6 ft do not freeze to the bottom in winter, but instead transfer heat downward, allowing a layer of unfrozen sediments to develop (Sloan 1987). These groundwater layers may be "open," where they are connected to surface waterbodies, or "closed," where they are isolated from surface water. Both the open and the closed types of shallow groundwater could potentially be found in the project area. Groundwater found in confined "closed" taliks within the permafrost can result from groundwater flow or when lakes fill in with sediment, reducing the heat input and allowing the surface to freeze over and encase the unfrozen zone. Dissolved salts within the groundwater minimize freezing conditions, but also make the water potentially harmful to surface vegetation and unsuitable for drinking (BLM and MMS 2003; USDOI and MMS 2007a).

2.3.4. Lakes

The ACP is dominated by many shallow lakes and ponds ("thaw lakes") that develop from small ponds in low-centered ice-wedge polygons (Sellman et al. 1975). Some small ponds have coalesced over time into larger lakes. There are several ponds and a few lakes in the project area.

Thaw lakes range in depth from just over 3 ft to almost 20 ft (United States Army Corps of Engineers [USACE] 1999) and are classified as "shallow" or "deep" depending on extent of freezing. Ice cover generally extends to about 6 ft deep, which is the defining boundary between shallow and deep. Shallow lakes are underlain by permafrost, while deep lakes are underlain by a thaw depression in the permafrost (Sellman et al. 1975).

Regional lakes are recharged by rainfall and snowmelt in their basins and by flooding from nearby streams. Some lakes are recharged annually by flooding streams, while other lakes have been known to have residence life spans as long as 25 years (USDOI and BLM 2003).

2.3.5. *Water Quality*

Most fresh water on the ACP is pristine, soft, and dilute of calcium-bicarbonates. Near the Beaufort Sea coast, salt concentrations are greater than bicarbonate concentrations (USDOI and BLM 1998). The water chemistry of lakes and ponds is variable according to the distance from the Beaufort Sea, frequency of flooding, and their connection to, or isolation from, river channels (termed “tapped” or “perched”). Lake water generally has lower total dissolved solids (TDS) than river water, but even river water is low in TDS and hardness (USACE 1999).

The Arctic freeze-thaw cycle affects water quality in ponds and lakes. Water shallower than 6 ft usually freezes solid (Craig 1989), and solutes and particulates are excluded downward into the sediment. These materials are slowly released after the pond thaws. Deeper waters remain unfrozen, and concentrations of dissolved materials in the liquid water increase (Miller et al. 1980).

River turbidity peaks during breakup in May and June, and then decreases sharply later in the summer (USDOI and BLM 1978). North Slope streams are usually near oxygen saturation during the summer. During the winter, deeper waters in streams and lakes can become temporarily supersaturated with oxygen, as the dissolved oxygen is excluded from crystallizing ice (USDOI and BLM 1978), but this is followed by depletion of oxygen later in winter.

Fresh water in the Arctic tundra is described as weakly buffered (USDOI and BLM 1978). This means that alkalinity increases in deep unfrozen water during winter. The hydrogen ion concentration values of rivers and streams are in the range of 6.5 to 8.5 (USDOI and BLM 1978), which is generally less acidic than in lakes and ponds. Generally, fresh water found on the ACP is low in trace metal content in comparison to most temperate waters (Prentki et al. 1980).

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3. BIOLOGICAL ENVIRONMENT

3.1. Vegetation and Wetlands

The NPBU has an irregular coastline that contains many small bays, lagoons, spits, beaches, and barrier islands. The wetland types in the project area include estuarine and marine wetlands at the sea/land boundary, particularly in the eastern portion of the project area, and freshwater emergent wetlands located more inland (Figure 3) (National Wetland Inventory 2013; Cowardin et al. 1979). These wetland types are summarized in Table 3. A discussion of these wetlands (with notations that correspond to the Attribute Codes in the table) follows.

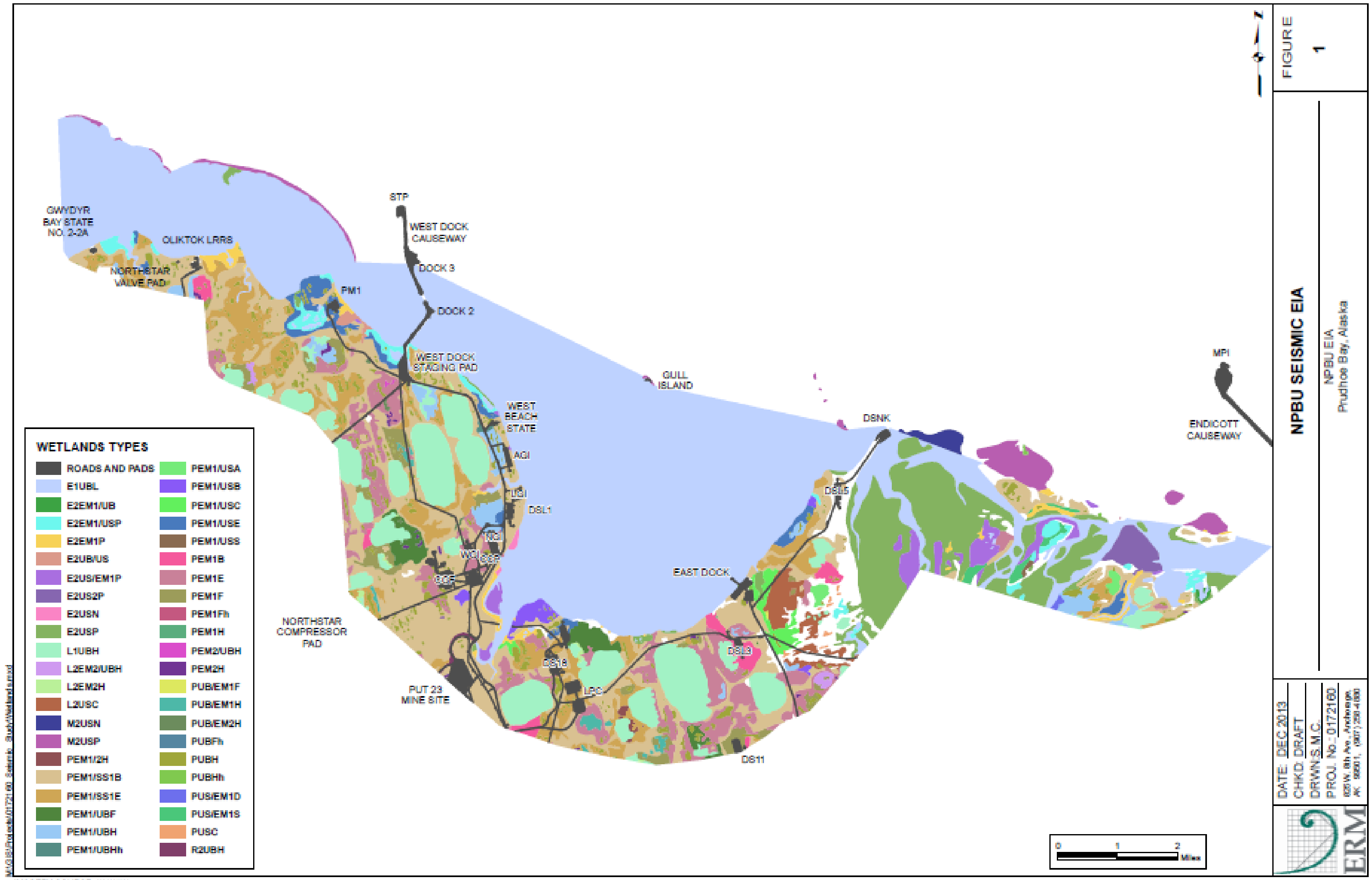

FIGURE 3: WETLAND TYPES AT THE EASTERN PORTION OF THE PROJECT AREA

Estuarine Deepwater/Subtidal Systems: The Estuarine Subtidal System (E1) describes deepwater/subtidal (L) habitats and adjacent tidal wetlands that are influenced by water runoff from land and are often semi-surrounded by land. They are located along low-energy coastlines and they have variable salinity. These habitats have continuously submerged substrate (i.e., are below extreme low water) with an unconsolidated bottom (UB). Vegetative cover is less than 30%.

Estuarine and Marine Intertidal Systems: The Estuarine Intertidal (E2) and Marine Intertidal (M2) Systems are characterized by intertidal habitats and are influenced by water runoff. They are often semi-enclosed by land. They are located along low-energy, brackish environments with variable salinity. The intertidal subsystem includes the areas that vary from extreme low water to extreme high water, such as mud and sand flats. Flooding ranges from irregular (P) (less than daily) to regular (N) (tidal water alternately floods and exposes land surface at least once daily). The vegetation on these sites are erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants species that normally remain standing at least until the beginning of the next growing season. Dominant species on more saline sites include *Carex* and *Puccinellia* species. On lower saline areas, *Poa* spp., *Arctagrostis latifolia*, *Dupontia fisheri*, and bryophytes are usually present.

Palustrine System: The Palustrine System (P) consists of Freshwater emergent (EM) wetlands that are not influenced by ocean-derived salinity. This system includes all nontidal wetlands dominated by shrubs, persistent emergents, mosses, or lichens; examples include moist tundra, wet tundra, tussock tundra, meadow, and marshes. Sites lacking this vegetation are also included as palustrine if they exhibit all of the following characteristics: 1) are less than eight hectares (20 acres); 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 6.6 ft in the deepest part of the basin; and 4) have a salinity due to ocean-derived salts of less than 0.5 parts per thousand.

There are several classes, and class combinations, of the palustrine system located within the project area, but all include emergent vegetation. Emergent vegetation is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. Most of this vegetation is persistent (1), and present for most of the growing season in most years. A few of the wetland polygons have non-persistent (2) vegetation, where the plants die back each year. These palustrine wetlands are usually dominated by perennial plants. The dominant class, at least in the western part of the site, is an emergent/scrub-shrub (EM/SS) combination. The substrate these areas are saturated (B) to the surface for extended periods during the growing season, but surface water is seldom present. Herbaceous species commonly found in this emergent/scrub-shrub class include *Eriophorum vaginatum*, *Carex* spp., *Pedicularis* spp., *Arctogrostis latifolia*, and *Saxifraga* spp., while shrubs commonly include *Salix* spp.

There are several ponds within the Palustrine System with UB that are permanently flooded (H). Some have persistent vegetation (e.g. *Carex aquatilis*); others have non-persistent vegetation (e.g. *Arctophila fulva*). Some areas in this system are seasonally flooded/saturated (E) with surface water that is present for extended periods, especially early in the growing season and when surface water is absent; substrate remains saturated near the surface for much of the growing season. These areas are dominated by *Arctophila fulva* and *Carex* spp. Other areas have an UB, and a vegetative cover less than 30%. These areas can be permanently flooded or semi-permanently flooded (F). These areas may have a mix of persistent and non-persistent vegetation, such as *Carex aquatilis* and *Arctophila fulva*, respectively.

Palustrine areas with an unconsolidated shore (US) can be temporarily flooded (A), saturated (B), saturated/flooded (C), seasonally flooded/saturated (E), or semi-permanently flooded (F). This class includes beaches, bars, and flats that are immersed by fresh water tides for brief periods during growing season, but the water table usually lies well below the soil surface for most of the growing season. These sites support emergent vegetation such as *Carex* spp., *Deschampia caespitosa*, *Chamerion latifolium*, and *Dupontia fisheri*.

Lacustrine System: The Lacustrine System (L) includes wetlands with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees, shrubs, persistent emergents, emergent mosses, or lichens with greater than 30% coverage; and 3) total area exceeds eight hectares (20 acres). The limnetic (1) subsystem extends outward from a littoral boundary and includes all deep-water habitats within the Lacustrine System, while the littoral (2) subsystem extends from shoreward boundary to 6.6 ft below annual low water or to the maximum extent of nonpersistent emergents. *Salix* spp., *Arctophila fulva*, *Hippurus vulgaris*, and *Clatha palustris* are common in the lacustrine littoral subsystem.

Riverine System: The Riverine System (R) includes all habitats contained in natural or artificial channels periodically or continuously containing flowing water, or channels that form a connecting link between the two bodies of standing water. Upland islands or Palustrine wetlands may occur in the channel, but they are not part of the Riverine System. The subsystem Lower Perennial (2) occurs in the project area, which is characterized by a low gradient and slow water velocity. There is no tidal influence, and there is continual water flow throughout the year. The substrate consists mainly of sand and mud. The river in the project area has an UB, a vegetative cover, less than 30% and is permanently flooded (H).

TABLE 3: WETLAND TYPES AND ACRES IN THE NPBU PROJECT AREA

WETLAND TYPE	COWARDIN CODE	ACRES	WETLAND TYPE	COWARDIN CODE	ACRES
Estuarine and	E1UBL	22,881.9	Freshwater	PEM1/SS1B	7,603.8

WETLAND TYPE	COWARDIN CODE	ACRES	WETLAND TYPE	COWARDIN CODE	ACRES
Marine Deepwater	Subtotal	22,881.9	Emergent Wetland	PEM1/SS1E	2,571.5
Estuarine and Marine Wetland	E2USP	3,344.9		PEM1E	2,418.2
	M2USP	654.9		PEM1F	659.1
	E2US/EM1P	552.2		PEM1/UBH	610.7
	E2EM1/USP	474.4		PEM1/USE	549.3
	E2EM1P	339.6		PEM1/UBF	420.1
	E2US2P	288.9		PEM1B	381.7
	M2USN	132.2		PEM1/USC	225.5
	E2UB/US	55.0		PEM1/USB	198.0
	E2USN	23.5		PUS/EM1S	145.3
	E2EM1/UB	20.0		PEM1/USA	94.0
	Subtotal	5,885.6		PEM2H	64.6
Freshwater Pond	PUBH	1,092.8		PEM1/2H	32.6
	PUB/EM1H	128.1		PEM1/USS	15.0
	PUBF	13.2		PUS/EM1D	15.0
	PUB/EM2H	18.6		PEM2/UBH	6.6
	PUB/EM1F	4.9		PEM1H	0.7
	Subtotal	1,257.6		Subtotal	16,011.7
Lake	L1UBH	3,798.6	Riverine	R2UBH	38.2
	L2USC	410.7		Subtotal	38.2
	L2EM2/UBH	60.6	Other	PUSC	21.0
	L2EM2H	50.4		Subtotal	21.0
	Subtotal	4,320.3	**TOTAL ACRES**		50,416.3

3.2. Boulder Patch

The Boulder Patch was discovered in the Stefansson Sound by the United States Geological Survey (USGS) in the early 1970s. Dunton et al. (1982) mapped the Boulder Patch while cataloging its biological community and physical and chemical characteristics. The area has been studied, monitored extensively, further defined, and mapped (Toimil and England 1980; Lee and Toimil 1985; Gallaway et al. 1988; Dunton et al. 1992; Coastal Frontiers Corporation and LGL Ecological Research Associates 1998; and Konar and Iken 2005). The Boulder Patch rock concentration between 10 to 25% covers an estimated area of 12.7 mi^2 in Stefansson Sound; areas of greater rock cover, more than 25%, is estimated at 13.9 mi^2 (Gallaway et al. 1999) (Figure 4). The Boulder Patch is comprised of rocks ranging from pebble to cobble size (pebble is ~0.2 to 2.5 inches and cobbles is 2.5 to 10 inches); however, larger boulders up to 6.6 ft across and 3.3 ft high can be encountered (Aerts 2007). A detailed discussion on the geology and geomorphology of the Boulder Patch is provided in Dunton et al. (1982). Water depths in Stefansson Sound do not exceed 32.8 ft, and range from 9.8 to 29.5 ft within the Boulder Patch (Dunton et al. 1982).

Species composition and biomass in the Boulder Patch is correlated to percent rock cover. For example, isolated patches of marine life can be found in areas where rocks are widely scattered (10 to 25% rock cover); while in areas with denser rock cover (> 25%), a richer flora and fauna community exists. These communities include extensive beds of the kelp, *Laminaria solidungula*, sponges, bryozoans, and hydrozoans. More than 150 species of macroalgae, invertebrates, and fishes were found in the Boulder Patch in the late 1970s (Dunton et al. 1982; Dunton and Schonberg 2000). Dunton et al. (2009) detected a total of 156 species of macroalgae and invertebrates during sampling studies in 2005 and 2006.

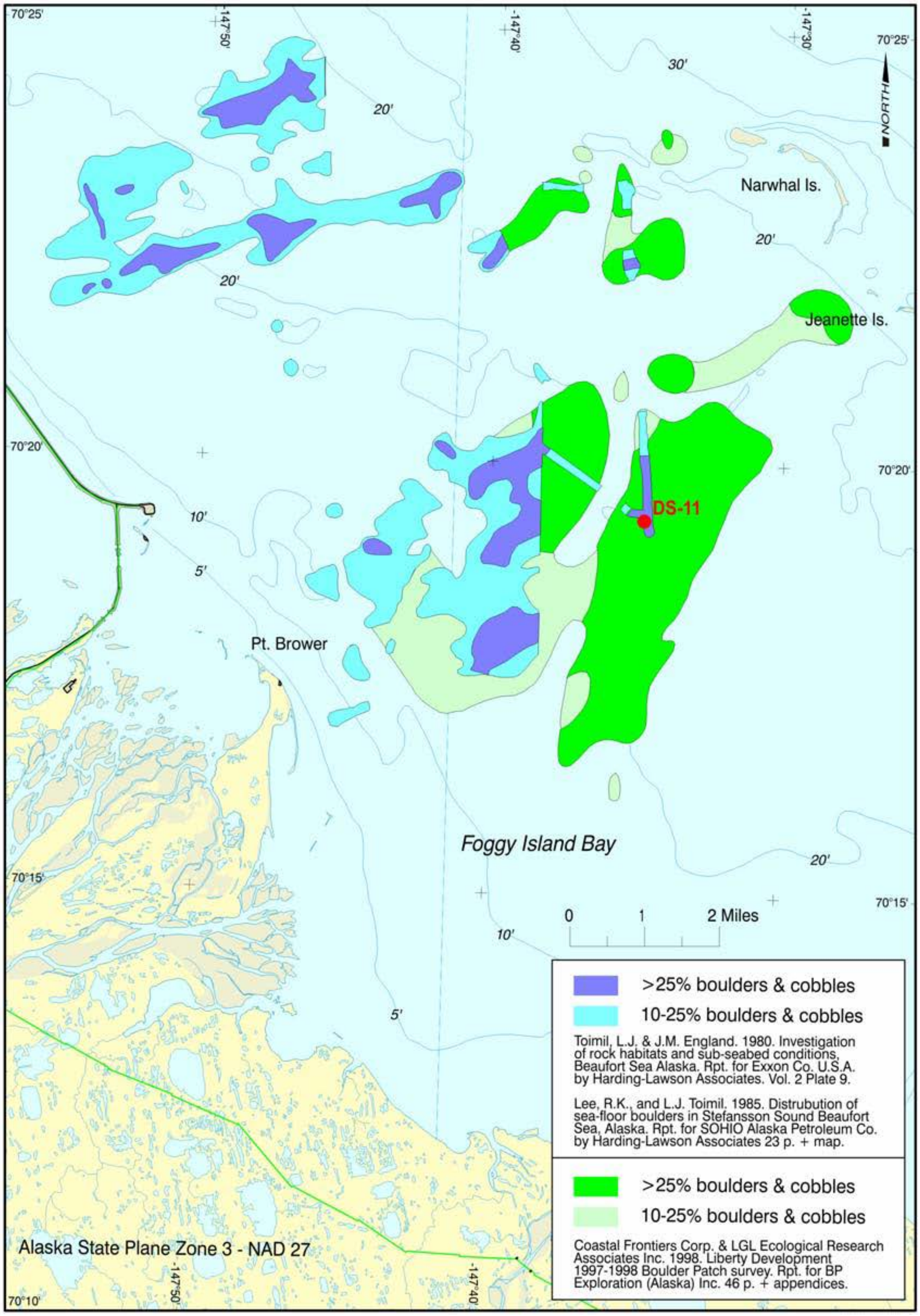

FIGURE 4: THE STEFANSSON SOUND BOULDER PATCH AREA. NOTE THAT THE AREAS ARE APPROXIMATIONS OF THE ACTUAL BOULDER PATCH

3.2.1. *Kelp Community*

The kelp community found in the Boulder Patch is not common in Arctic waters of Alaska. Dunton et al. (2009) collected a total of 15 macroalgal species in the Boulder Patch during more recent studies (Table 4). Detections for the Boulder Patch area included the brown algae, *Sphacelaria plumosa* and *Sphacelaria Arctica*, and the red algae, *Rhodomela tenuissima* and *Scagelia cf americana*. They also found infestation, with what has been identified so far as an endophytic Chlorochytrium, of the red alga *Phyllophora trucata*. The Boulder Patch kelp community serves both as food and shelter for a diverse assemblage of marine invertebrate fauna (Dunton et al. 1992).

TABLE 4: MACROALGAL RECORDS FROM THE BOULDER PATCH

Division	Species
Chlorophyta (green algae)	*Chaetomorpha melagonium* (Weber et Mohr) Kützing
Rhodophyta (red algae)	*Phycodrys riggii* NL Gardner
	Phyllophora truncata (Pallas) Zinova
	Dilsea socialis (Postels et Ruprecht) Perestenko
	Odonthalia dentata (Linnaeus) Lyngbye
	Rhodomela sibirica Zinova et KL Vinogradova
	Rhodomela tenuissima (Ruprecht) Kjellman
	Ahnfeltia plicata (Hudson) Fries
	Scagelia cf americana (Harvey) Athanasiadis
	Liththamnium sp.
Ochrophyta (brown algae)	*Laminaria solidungula* (C Agardh)
	Laminaria saccharina (C Agardh)
	Alaria esculenta (Linnaeus) Greville
	Sphacelaria plumosa Lyngbye
	Sphacelaria Arctica Harvey

Source: Dunton et al. 2009

Polar marine plants have a variety of adaptive responses that help compensate for lower irradiances at higher latitudes. The brown algae *L. solidungula* has been found to thrive at low-light levels and is well adapted to the Arctic (Hooper 1984; Dunton and Jodwalis 1988). Kelp biomass was reported by Dunton et al. (1982). More current information (Dunton et al. 2009) indicates biomass sampled at long-term monitoring station Drill Site (DS-11) (an area with > 25% rock cover) ranged from 5 to 45 g m-2 (mean 23 g m-2) compared to a range of 0.5 to 2.7 g m-2 (mean 1.7 g m-2) at long-term monitoring station E-1 (an area with 10 to 25% rock cover). The range in biomass at DS-11 is within the estimates reported by Dunton et al. (1982).

Water transparency, as influenced by turbidity and seasonality, is a very important factor influencing kelp growth as it influences the amount of photosynthetic active radiation available for plant growth (Aumack et al. 2007). Periods of decreased water transparency in summer and large patches of turbid ice in winter can cause low or undetectable levels of photosynthetic active radiation (Dunton et al. 1992) and hence limit kelp growth (Aumack et al. 2007). Detailed discussions of photosynthetic production and plant growth can be found in (Dunton et al. 1982; Aumack 2003; Aumack et al. 2007; Dunton and Schell 1986; Dunton 1984). Dunton et al. (2009) found that, in general, the majority of the Boulder Patch, including areas with dense kelp populations (>25% rock cover), was found predominantly in clear offshore waters where attenuation measurements were consistently less than 1.0 m-1; attenuation coefficients were highest in shallower water depths as compared to the deeper water sites.

The accumulation of sediment in the Boulder Patch is also an important factor in limiting growth, settlement, or recolonization; excessive accumulation of sediment may lead to smothering or attachment preclusion (Dunton et al. 1982). The predominantly easterly wind-driven currents in summer help prevent sedimentation in the Boulder Patch (Barnes et al. 1977; Matthews 1981). Storms and associated shifts in wind-induced currents during the open water period also prevent the burial of the rich biological community by lifting inorganic solids from the Boulder Patch and re-suspending them into the water column.

Kelp contributes up to 75% of the total productivity in the Boulder Patch system (Dunton et al. 1982). The energy is transported to higher trophic levels either directly as food or indirectly through bacterial transformation of particulate detritus. Invertebrates will shift their diet to an increased dependence on kelp carbon during the dark winter period during the absence of phytoplankton food sources. For example, up to 50% of mysid crustracean body carbon, a key prey species for birds, fish and marine mammals, was found to be derived from kelp detritus during the ice-covered season (Dunton and Shell 1986, 1987).

3.2.1.1. Fauna Community

The kelp canopy serves as a habitat for a variety of animals. The major faunal groups in the Boulder Patch (by weight) are fishes, sponges, mollusks, crustaceans, cnidarians and bryozoans, many of which are suspension and filter feeders that are sensitive to high levels of turbidity and siltation (Dunton and Schonberg 2000). Invertebrates belonged to eight major phyla as detected during more recent studies: Porifera, Cnidaria (Anthozoa, Hydroidea), Mollusca (Polyplacophora, Gastropoda, Bivalvia), Annelida (Polychaeta), Arthropoda (Pycnogonidae, Amphipoda, Isopoda, Cumacea, Decapoda, Cirripedia, Copepoda, Insecta, Acari), Bryozoa, Echinodermata (Asteroidea), and Tunicata (Ascideacea). Average invertebrate biomass (across all sites) was very similar between both years (0.55 ounce [oz.] wet/10.8 feet squared [ft^2] in 2005; 0.52 oz. wet/10.8 ft^2 in 2006). Invertebrate biomass in both years was clearly dominated by sponges, bryozoans, and hydrozoans (Dunton et al. 2009).

Only a few species graze directly on the kelp plants, such as the chiton Amicula vestita, which constitutes the greatest percentage of molluskan biomass. Several species of bottom dwelling fish are present in the Boulder Patch such as fourhorn sculpin, great sculpin, snailfish, prickleback, eelpout, and Arctic flounder. Arctic cod and crustaceans, such as amphipods, isopods, and mysids, are common in the water column adjacent to the Boulder Patch community (Dunton et al. 1982).

The rich infauna, animals that live within the bottom substratum rather than on its surface, depends on the shelter provided by the rocks and on detrital material that accumulates under the rocks in the Boulder Patch. The restriction of the fauna to the upper 5 centimeters of the sediment exposes this community to naturally occurring physical perturbations, including ice gouging and frazil ice formation in the sediments (Dunton and Schonberg 2000). Mollusks (mainly bivalves) and polychaetes have been documented as core contributors to infaunal species biomass (Dunton and Schonberg 2000 and Dunton et al. 2009). The sampled biomass for the remaining taxonomic groups differed between studies. The difference is likely due to the very low presence and patchy distribution of other taxa.

3.2.1.2. Recolonization of Boulder Patch Communities

Recovery of the benthic communities on the Boulder Patch area is a slow process in the Arctic (Dunton et al. 1982; Konar 2007). Factors influencing recovery include the stability of the substratum, temporal variability in the composition and abundance of larvae and spores, biological interactions such as predation/herbivory, and competition for space. Studies indicate that first colonizers appear in early winter after a stripping or major removal event. Low levels of sedimentation during this time period may allow for successful attachment to the rock substrate in the Boulder Patch. Periodic inundation by sediment in the Boulder Patch adversely affects the process of recolonization by effectively blocking larvae or spores from reaching the rock surface, or by smothering epilithic biota with a stature less than 0.039 or 0.118 inches (Dunton et al. 1982; Konar 2007).

3.3. Birds

Approximately 70 bird species occur regularly within the project area, both on and off-shore (Rodrigues and Aerts 2007); 30 species of seabirds (Laridae and alcidae), loons (Gaviidae), waterfowl (Anatidae), shorebirds (Scolopacidae), raptors (Accipitridae), passerines (Order Passeriformes), ptarmigans (*Lagopus* spp.), and others are common in the Prudhoe Bay oil fields (Sanzone et al. 2010). Nearly all of these species are migratory and are present only during the summer breeding season from approximately late May and June through October. Some of the resident species that may overwinter on the ACP include raptors, owls (Strigidae), ptarmigan (*Lagopus* spp.), black guillemot (*Cepphus grille*), and common raven (Corvus corax). For those species that are seasonal visitors, migration to wintering grounds can take place as early as July or as late as November (USDOI and BLM 2004).

The ACP provides a diversity of bird habitat that includes large rivers, deltas, barrier islands and lagoons, wetlands, and many lakes and ponds (USACE 1999). These areas are used for molting, nesting, brood rearing, foraging, and as migration staging areas (USDOI and BLM 2004). Bird habitats found within the project area includes several types of tundra described as dry, moist, wet, flooded, and sparsely vegetated. Higher nest densities occur in drier areas (moist or wet tundra) and in areas of extensive micro-relief (e.g., polygon rims).

Waterfowl (ducks [dabblers and divers], geese, sea ducks [scoters, eiders, and long-tailed ducks], and swans) are abundant within the area of the proposed seismic survey area. More waterfowl species and individuals are likely to occur in the project area than for any other group (Rodrigues and Aerts 2007).

Loons and seabirds nest predominantly in freshwater habitats, although some, such as Arctic tern (*Sterna paradisaea*), may also nest in marine habitats along the shore of barrier islands or the mainland coast. Breeding shorebirds and passerines occur within the on-land portion of the NPBU project, but most are not likely to occur in offshore locations. An exception is the red phalarope (*Phalaropus fulicaria*), which may occur along the coast or within the marine waters of the survey area after the breeding season. The red phalarope is not a species likely to be affected by seismic activities and is not discussed further.

The presence of waterfowl, loons, and seabirds is discussed briefly below, focusing on the species that are most abundant in the survey area, or for which the survey area is important for nesting or other activities, including molt migration. Two species listed as threatened under the Endangered Species Act (ESA) of 1973 (the spectacled and Steller's eiders), which could occur on land during the nesting season, as well as in marine waters of the proposed survey area, are discussed below.

3.3.1. Waterfowl

Waterfowl will be present within the survey area throughout the entire period of the proposed seismic survey. The most abundant species identified are the long-tailed duck (*Clangula hyemalis*), common eider (*Somateria molissima*), lesser snow goose (*Chen caerulescens* subsp. *caerulescens*), black brant (*Branta bernicla*), and tundra swan (*Cygnus columbianus*) (Rodrigues and Aerts 2007; Sanzone et al. 2010). Other waterfowl species that may also be common within or adjacent to the survey area include scoters (*Melanitta* spp.), scaup (*Aythya* spp.), northern pintail (*Anas acuta*), red-breasted merganser (*Mergus serrator*), and king eider (*Somateria spectabilis*).

Most waterfowl, including common eider, lesser snow goose, and brant, nest on terrestrial habitats associated with freshwater lakes, ponds, and associated tundra, and therefore will be present during seismic activities. These species may also be fairly common or abundant in the marine waters of the project area during the post-breeding period.

3.3.1.1. Long-tailed Duck

Long-tailed duck is the most abundant species in the proposed seismic survey area and may comprise 80% of the total number of birds (Fischer and Larned 2004). Although long-tailed ducks are relatively abundant, there has been concern for this species, as well as other sea ducks, due to regional population declines (Wilbor 1999; Suydam et al. 2000; Mallek et al. 2007).

Long-tailed ducks nest on tundra habitats. Non-breeding birds and unsuccessful breeders will move to offshore areas in the lagoon systems formed between the mainland and barrier islands to undergo a molt migration. These individuals enter the lagoon systems in late June after onset of incubation. Females with broods remain on tundra ponds and lakes until the first stages of freeze-up, when they move to coastal lagoons to feed until fall migration in late September or early October (Johnson and Richardson 1981). During their molt migration, long-tailed ducks are flightless, flocking into large concentrations numbering several thousand. These individuals gather along the lee sides of barrier islands, mainland bays, and spits in the late afternoon, and feed throughout open-water habitats during much of the day (Figure 5) (Johnson 1984; Flint et al. 2004).

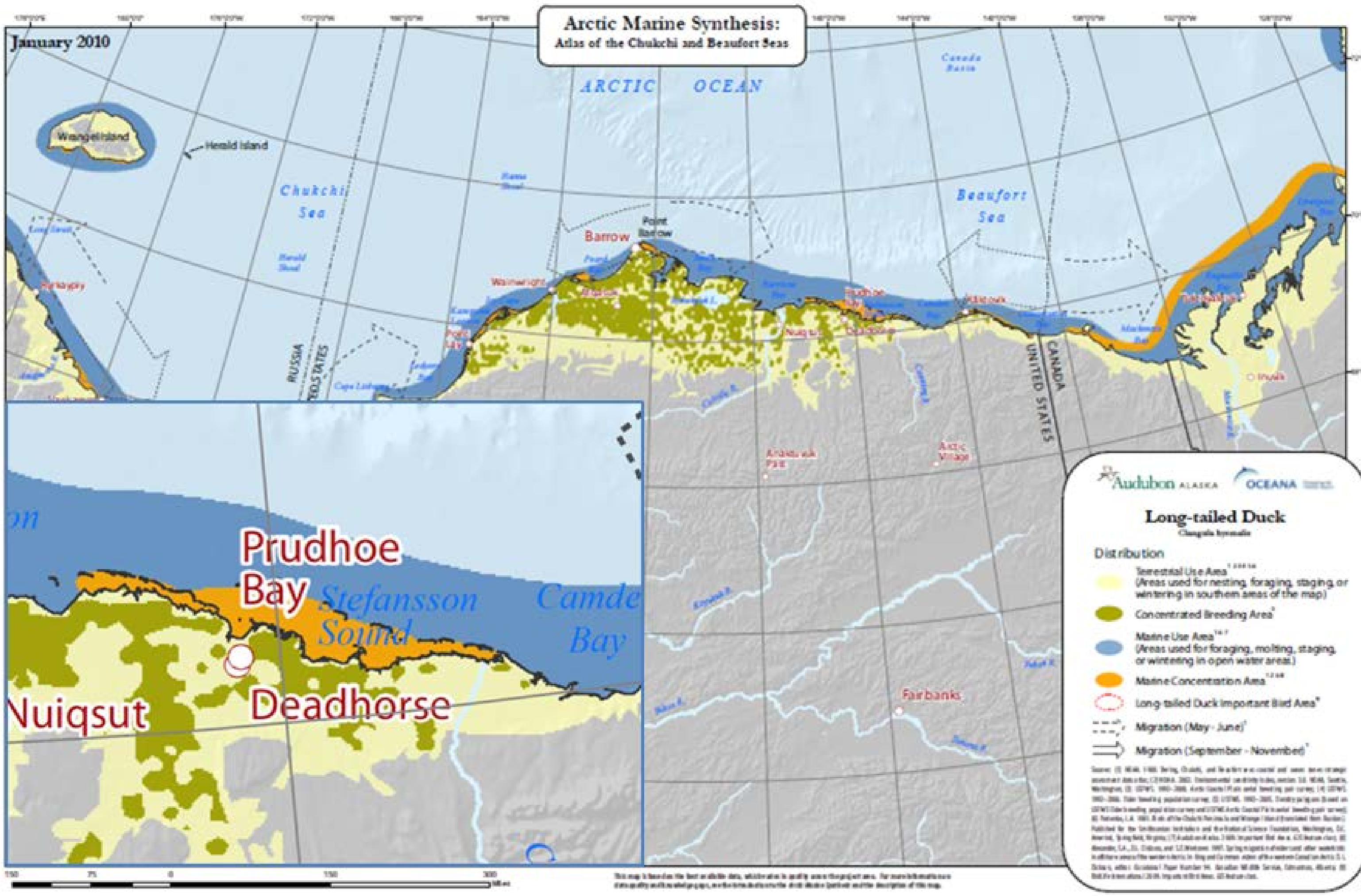

FIGURE 5: BREEDING DISTRIBUTION OF LONG-TAILED DUCK ON THE ACP

Waterfowl show high fidelity for traditional molting sites (Kumari 1979). Long-tailed duck density is consistently high in the lagoon system from mid-July to mid- to late August (Johnson et al. 2005). During aerial surveys conducted from 1998 through 2001 in July and August, Noel et al. (2002a) reported concentrations of long-tailed ducks within the proposed survey area in the lagoon system west of the Endicott causeway. Long-tailed ducks also occur in lower densities in open-water habitats in the central portion of the lagoon systems. However, long-tailed ducks appear to concentrate along the barrier islands and mainland shore in the late afternoon. Dau and Bollinger (2009) surveyed the Alaska Coastal Plane for breeding waterfowl and reported the following observations (Table 5). The segments were flown on 1 July to 5 July 2009.

TABLE 5: BREEDING WATERFOWL ON THE ARCTIC COASTAL PLAIN

Species	Reindeer / Argo Islands	Duck / Gull Islands	Cross Island	Narwhal Island
Arctic Tern	2	--	--	3
Common Eider Hen	--	14	2	6
Common Eider	1	52	44	31
Glaucous Gull	--	49	3	6
Long-tailed Duck	--	2	69	83
Northern Pintail	--	30	--	--
Pacific Loon	--	--	1	--
Red-breasted Merganser	--	30	--	--
Sabine's Gull	--	150	1	--
Surf Scoter	--	--	7	10
White-winged Scoter	--	--	--	1

Source: Dau and Bollinger 2009

3.3.1.2. Common eider

Common eiders (*Somateria mollissima*) nest on barrier islands and along the mainland shore in areas where accumulated driftwood provides cover (Johnson et al. 1993; Noel et al. 2005; Dau and Larned 2005; Kendall 2005). Common eiders arrive in the project area in mid- to late May, but do not initiate nesting until mid- to late June. Most males depart the project area after onset of incubation, although some may remain to molt. The incubation period is ~26 days and most clutches hatch by mid-July. Common eiders may occur in flocks with long-tailed ducks during molt migration. Brood-rearing flocks have been reported in the lagoon systems in July and August.

Common eiders are known to nest at several locations within the proposed seismic survey area, including the Endicott causeway and Duck Island 1 and 2 located south of the Satellite Drilling Island (SDI) (see Figures 2 and 4). Small numbers of common eiders have also been reported nesting on Howe Island.

Common eiders began colonizing the Endicott causeway after its construction in 1984-1985 (Johnson 1990), and the number of nest sites on the causeway steadily increased to 20 and 19 nests in 1990 and 1991, respectively (Johnson et al. 1993). In 1992, only three common eider nests were reported on the causeway, none of which were successful. A dramatic increase in predation pressure from Arctic foxes was thought to be the cause of the decline in nests and the poor success in 1992 (Johnson et al. 1993). Surveys have been conducted sporadically since 1992 and common eiders have continued to nest on the Endicott causeway in small numbers (e.g., Noel et al. 2001, 2002b). No surveys of the Endicott causeway for common eider nests have been conducted in recent years.

The man-made Duck Island 1 and 2, located south of the SDI, has been surveyed sporadically for nesting common eiders (Johnson et al. 1993; Noel et al. 2002b). Johnson et al. (1993) reported that Duck Island 1 and 2 was constructed in summer 1978 to support oil-well drilling and was abandoned in 1985. A large amount of driftwood accumulated on the island and it became an important area for common eider nesting. Noel et al. (2002b) reported at least 22 active common eider nests on Duck Island 1 and 2 in 2001 (Figure 6). No surveys of Duck Island 1 and 2 for common eider nests have been conducted in recent years.

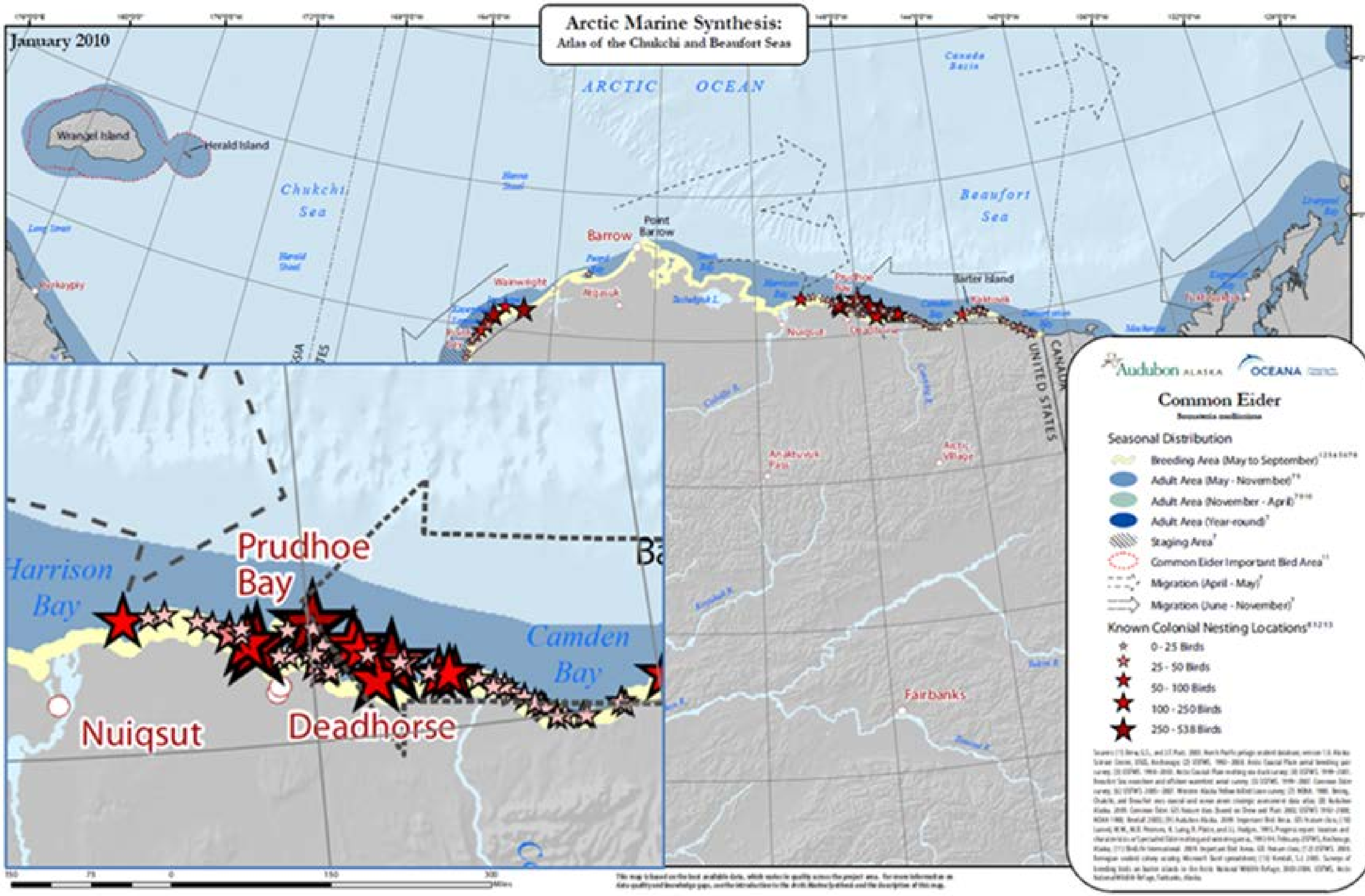

FIGURE 6: BREEDING DISTRIBUTIONS OF COMMON EIDER ON THE ACP

3.3.1.3. Lesser Snow Goose

The Sagavanirktok River Delta population of lesser snow geese (*Chen caerulescens* subsp. *caerulescens*) was, until recent years, the only established nesting colony of this species in the United States and remains the only nesting colony in proximity to an active oilfield. Most of the Sagavanirktok River Delta population nests on Howe Island near the eastern edge of the proposed survey area. Snow geese were first observed nesting on Howe Island in the early 1970s, and the colony has steadily increased in size although heavy predation by Arctic fox and grizzly bears caused total failure of the colony during some years in the early to mid-1990s (Johnson and Noel 2005; Rodrigues et al. 2007). Predation pressure has not been a factor negatively impacting the Howe Island colony in recent years. BPXA has conducted annual nest surveys of Howe Island as part of its long-term monitoring program. A total of 761 nests were recorded during the 2007 monitoring study, which was the highest nest count ever recorded on the island (Rodrigues et al. 2007). Monitoring studies in 2009 were incomplete; unusually low productivity was attributed to predation and major weather events (Sanzone et al. 2010).

Lesser snow geese arrive on Howe Island in late May and establish nest sites quickly. Eggs are laid in early June and incubation continues through June. Brooding of hatched young begins on Howe Island occur in early to mid-July. Adults with broods swim from Howe Island to the mainland along the Endicott road and occupy traditional brood-rearing areas in the Sagavanirktok River Delta within a few days of hatching. These brood-rearing areas are characterized by escape habitat near large waterbodies with adjacent feeding areas (Wilkinson et al. 1994). Through July and into August, brood-rearing flocks may range west to the east shore of Prudhoe Bay, and east at least as far as Tigvariak Island. Brood-rearing flocks may inhabit locations immediately adjacent to the proposed seismic activities along the mainland shore through August.

3.3.1.4. Tundra Swans

Tundra swans (*Cygnus columbianus*) nest throughout Alaska in the Arctic wetlands (Limpert and Earnst 1994) and the nearshore coastal waters of the Beaufort Sea (MMS 2003; MMS 2007b), generally mate for life, and are sensitive to disturbance within their nesting territories. Tundra swans are one of the first birds to arrive on the ACP each spring. Within the Prudhoe Bay area, the tundra swan is documented as a common breeder, often arriving in mid-May when ice and snow are still present. Swans soon begin nesting after arrival (Hohenberger et al. 1994). Nests are typically placed on elevated grassy hummocks (Armstrong 2008; Ehrlich et al. 1988).

In the Kuparuk oilfield, tundra swans tend to select nest sites less than 328 ft from large lakes and often return to the same nest location each summer. After incubating their eggs for approximately 30 days, they hatch a brood of one to five cygnets. Both parents guard their young until they fledge just before fall migration in early October, around the time of freeze-up. The highest breeding densities of tundra swans on the North Slope occur near the Colville and Sagavanirktok River Deltas, both within the developed oilfield region (CPAI 2005).

Aerial surveys in the region indicate that the tundra swan breeding population has steadily increased from estimates in the 1970s. A comprehensive aerial survey was conducted in 1992 and estimated 1,100 breeding and non-breeding swans in the region during mid-June, and 1,800 adults and young during mid– to late July. Since 1992, swan populations have continued to increase, at least in the parts of the North Slope oil fields where annual aerial surveys for nesting and brood-rearing swans are conducted. Forty-two nests were found in the PBU in 2009 (Sanzone et al. 2010).

3.3.1.5. Black Brant

Black Brant (*Branta bernicla*) occur in the vicinity of the seismic program. Brant typically nest on barrier islands, offshore spits or islands in large river deltas, and near the coast (Derksen et al. 1981). The largest concentrations of colonies and nests have been located in the Sagavanirktok River Delta, Prudhoe Bay, and Kuparuk areas (Stickney and Ritchie 1996).

3.3.1.6. Loons

Loons are diving birds that feed on fish and invertebrates. Loons nest on islands or along the shore of freshwater tundra ponds, but may feed in marine waters during and after the breeding season. Three species of loons may occur within the survey area during the open-water period. The Pacific loon (*Gavia pacifica*) is the most abundant loon species in the Prudhoe Bay area. However, red-throated loons (*G. stellata*) generally nest at locations within two miles of the coast and utilize marine habitats for feeding more regularly than Pacific loons.

Yellow-billed loon (*G. adamsii*) is the least abundant loon species in the Prudhoe Bay area and is currently under consideration for listing under the ESA (USFWS 2007). Yellow-billed loons are most abundant in the central ACP at locations west of Teshekpuk Lake and near the southeast end of the lake (Figure 7) (Larned et al. 2006). The project area is located near the eastern edge of the range of yellow-billed loons where densities are low. Yellow-billed, as well as Pacific and red-throated loons, could occur in low densities in the project area during the entire period for which seismic activities are proposed.

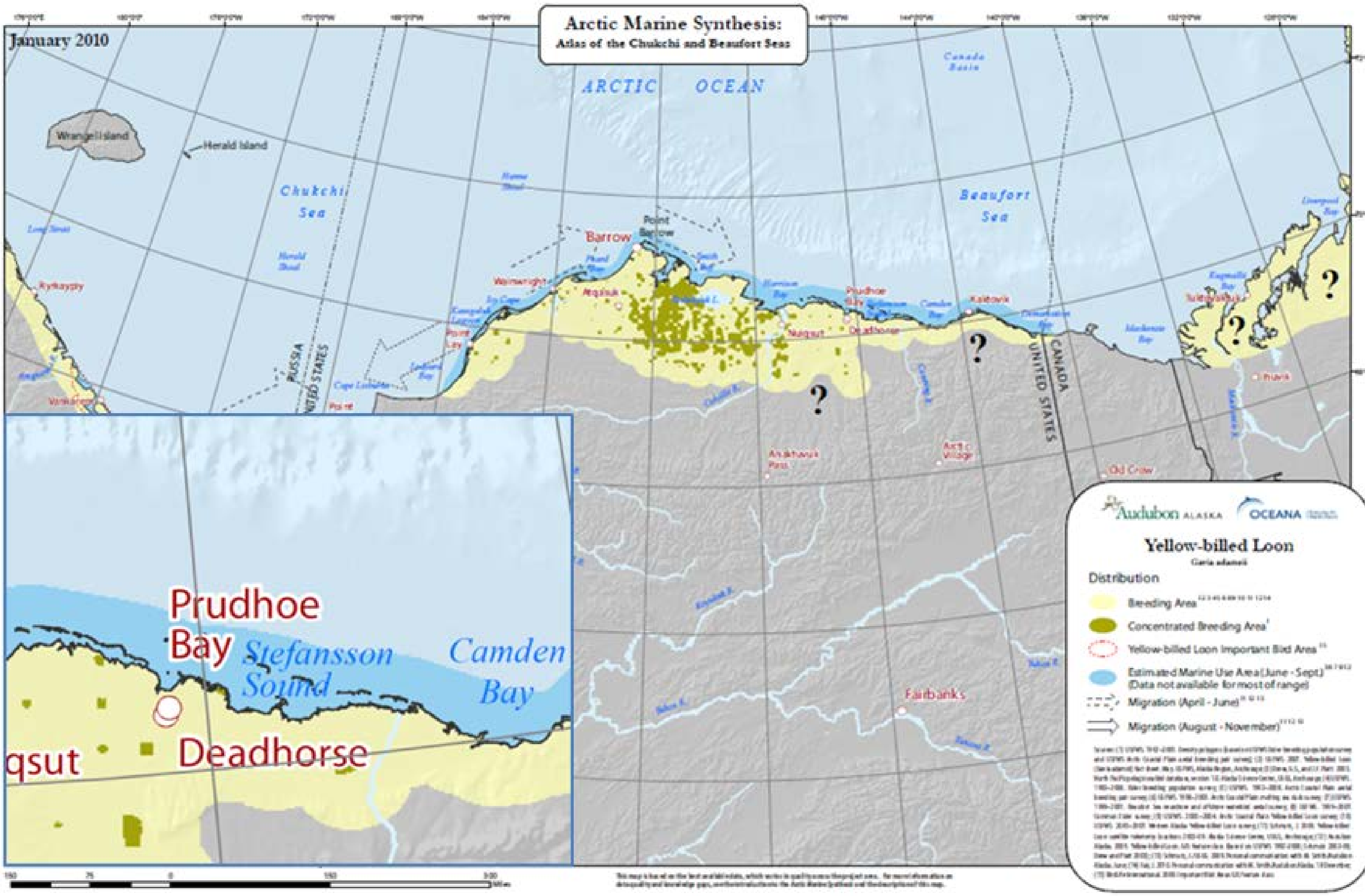

FIGURE 7: BREEDING DISTRIBUTIONS OF YELLOW-BILLED LOON ON THE ACP

3.3.2. Seabirds

During the summer open-water season, there are a variety of species of sea birds that may occur in the Prudhoe Bay project area. Seabirds, including jaegers, gulls, terns and guillemots may occur in low densities within the proposed survey area during the open-water period. The glaucous gull (*Larus hyperboreus*) is the most abundant gull species in the survey area although the Sabine's gull (*Xema sabani*), Arctic tern (*Sterna paradisaea*), parasitic jaeger (*Stercorarius parasiticus*), and black-legged kittiwake (*Rissa tridactyla*) also occur, especially during fall migration in August and September. The black guillemot (*Cepphus grille*) is a year-round resident of the Arctic. These birds are adapted to spend a majority of time at sea, generally only coming ashore during the breeding season (Butler and Buckley 2002).

Glaucous gulls nest on the barrier islands, Howe Island, Duck Island 1 and 2, and on islands in tundra lakes and ponds. Egg-laying begins in mid-June but may continue into late June (Johnson and Herter 1989). Hatching occurs by mid-July. Glaucous gulls are most abundant along the shores of barrier islands and the mainland, but may also occur in open-water habitats of the survey area.

Arctic terns nest in low densities on barrier islands, and small nesting colonies are sometimes located in marshy areas along the shores of tundra ponds. Arctic terns are probably most abundant in the survey area during fall migration as they pass through the area in August and September.

Jaegers are pelagic for most of the year, but nest on tundra habitats across Alaska's ACP. The parasitic jaeger (*Stercorarius parasiticus*) is the most abundant jaeger species in the project area, but pomarine (*S. pomarinus*) and long-tailed (*S. longicaudus*) jaegers may also occur in the area.

Black guillemots nest and breed on rocky islands and cliffs that provide protection from predators. This species is ice-dependent and concentrates at ice edges to feed (Butler and Buckley 2002). In northern Alaska, where there are low coastal tundra bluffs, the species nests in driftwood piles and manmade structures. At the end of the breeding season, both adults and young move closer to shore, sometimes several miles into the mouths of coastal rivers. Black guillemots generally feed near shore, diving to the seabed where they probe for small fish, crustaceans, mollusks, and marine worms in the shallow water (Butler and Buckley 2002; Cairns 1987).

3.3.3. Shorebirds

Shorebirds are the most abundant and diverse avian fauna of the ACP (Johnson and Herter 1989; Bart et al. 2012), with many species exhibiting restricted breeding ranges solely within the Arctic (Poole 2005). Shorebirds exhibit unique life history characteristics (e.g., specialized feeding, long-distance migrations, and diverse habitat associations). Numerous shorebird species, including those that nest within the ACP, have shown significant declines in recent years (Brown et al. 2001; Morrison et al. 2001;

Morrison et al. 2006; Bart et al. 2007), with nine species considered of high conservation concern or highly imperiled on a global or national scale (United States Shorebird Conservation Plan 2004).

Two potential threats to shorebird breeding habitat in the ACP are direct habitat loss and habitat modification due to climate change and development.

3.3.3.1. Plovers

The American golden plover (*Pluvialis dominica*) is a common breeder along the coast and inland of Prudhoe Bay (Hohenberger et al. 1994; Sanzone et al. 2010). The black-bellied plover (*Pluvialis squatarola*) and semipalmated plover (*Charadrius semipalmatus*) have the potential of occurring within the project area but are listed as uncommon breeders (Armstrong 2008; Hohenberger et al. 1994). Neither species have been detected during the long term monitoring studies at Prudhoe Bay (Sanzone et al. 2010).

3.3.3.2. Sandpipers

Semipalmated sandpiper (*Calidris pusilla*), ruddy turnstone (*Arenaria interpres*), Baird's sandpiper (*Calidris bairdii*), pectoral sandpiper (*Calidris melanotos*), dunlin (*Calidris alpina*), stilt sandpiper (*Calidris himantopus*), buff-breasted sandpiper (*Tryngites subruficollis*), red-necked phalarope (*Phalaropus lobatus*) and red phalarope (*Phalaropus fulicaria*) are listed as common breeders along the coastline, river banks, and/or outer islands of Prudhoe Bay (Hohenberger et al. 1994; Sanzone et al. 2010). In addition, long-billed dowitcher (*Limnodromus scolopaceus*) nesting has been detected during long-term monitoring at Prudhoe Bay (Sanzone et al. 2010).

Species preferring dry tundra and dunes for breeding and nesting include the ruddy turnstone, Baird's sandpiper, stilt sandpiper, and buff-breasted sandpiper. Those species preferring wet tundra for breeding and nesting include semipalmated and pectoral sandpipers, dunlin, long-billed dowitcher, and red-necked and red phalaropes (Armstrong 2008; Ehrlich et al. 1988) (Table 6).

TABLE 6: NESTS (NEST DENSITY, NESTS/0.39 MI²)

Species	2003	2004	2005	2006	2007	2008	2009
Semipalmated Sandpiper (*Calidris pusilla*)	19 (15.8)	18 (15.0)	33 (27.5)	26 (20.8)	25 (20.8)	20 (16.7)	20 (16.7)
Pectoral Sandpiper (*Calidris melanotos*)	13 (10.8)	8 (6.7)	17 (13.3)	19 (15.8)	12 (10.0)	6 (4.2)	8 (6.7)
Lapland Longspur (*Calcarius lapponicus*)	15 (12.5)	17 (14.2)	19 (15.8)	32 (25.0)	16 (11.7)	21 (15.8)	28 (23.3)
Red-necked Phalarope (*Phalaropus lobatus*)	5 (4.2)	8 (6.7)	5 (4.2)	13 (10.8)	10 (8.3)	11 (9.2)	6 (5.0)
Red Phalarope (*Phalaropus fulicaria*)	11 (9.2)	5 (4.2)	5 (4.2)	8 (6.7)	4 (3.3)	4 (3.3)	6 (5.0)
Dunlin (*Calidris alpina*)	3 (1.7)	3 (2.5)	2 (1.7)	3 (2.5)	1 (0.8)	1 (0.8)	5 (4.2)

Stilt Sandpiper (*Calidris himantopus*)	4 (3.3)	5 (4.2)	3 (2.5)	4 (3.3)	1 (0.8)	7 (5.8)	6 (5.0)
Long-billed Dowitcher (*Limnodromus scolopaceus*)	3 (2.5)	1 (0.8)	0	0	1 (0.8)	4 (3.3)	3 (2.5)
Ruddy Turnstone (*Arenaria interpres*)	0	0	1 (0.8)	0	0	0	0
American Golden-plover (*Pluvialis dominica*)	1 (0.8)	1 (0.8)	0	2 (1.7)	0	0	0
Buff-breasted Sandpiper (*Tryngites subrufi collis*)	1 (0.8)	0	0	2 (1.7)	0	2 (1.7)	0

Source: Sanzone et al. 2010

All bird species discussed are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (amended in 1936 and 1972), which prohibits the taking of migratory birds, unless authorized by the Secretary of Interior. Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) provides for the conservation of migratory birds and their habitats, and requires the evaluation of the effects of federal actions on migratory birds, with an emphasis on species of concern. Federal agencies are required to support the intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory birds when conducting agency actions (66 Code of Federal Regulations [CFR] 3853, 17 January 2001).

3.3.4. Threatened and Endangered Species

The USFWS administers the 1973 ESA for terrestrial and avian wildlife. The National Marine Fisheries Service (NMFS) administers the ESA for threatened and endangered marine mammals. An "endangered species" is a population of organisms at risk of becoming extinct either because individuals within the population are few in number, or are threatened by environmental change or predation patterns. A "threatened" status is defined as a species that is likely to become endangered in the foreseeable future. Currently, 21 species of wildlife managed under the USFWS and the NMFS are listed as threatened or endangered in Alaska (USFWS and NMFS 2011). While there are no known endangered bird species in the NPBU project area, two bird species listed as threatened under the ESA could potentially occur in the project area: the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*). A third species, the yellow-billed loon (*Gavia adamsii*), is a candidate for listing under the ESA and could occur in the project area.

3.3.5. Steller's Eider

The Alaska breeding population of Steller's eider (*Polysticta stelleri*) was listed as a threatened species on 11 June 1997 (62 CFR 31748 - 31757). Listing was based on:

- Recognition as a distinct population segment;
- Substantial decrease in nesting range in Alaska;

- Reduction in the number of nesting eiders in Alaska; and
- Vulnerability of extirpation to the remaining breeding population.

Specific reasons for the listing of the Alaskan nesting population of eiders included habitat loss, hunting pressure, increased predation resulting from the shift of the Arctic fox prey base, lead poisoning, and marine ecosystem changes. The threatened status of Steller’s eider directed the USFWS designation of critical habitat on 2 February 2001 (66 CFR 8850 - 8884).

3.3.5.1. Population Status and Trends

Three breeding populations of Steller’s eiders are recognized: the Russian-Atlantic, Russian–Pacific, and Alaskan. The majority of the world’s Steller’s eiders nest in Arctic-coastal Russia. The preponderance of the Steller's eider breeding population in Alaska nests on the ACP, primarily in the Barrow area (Quakenbush et al. 2002) (Figure 8).

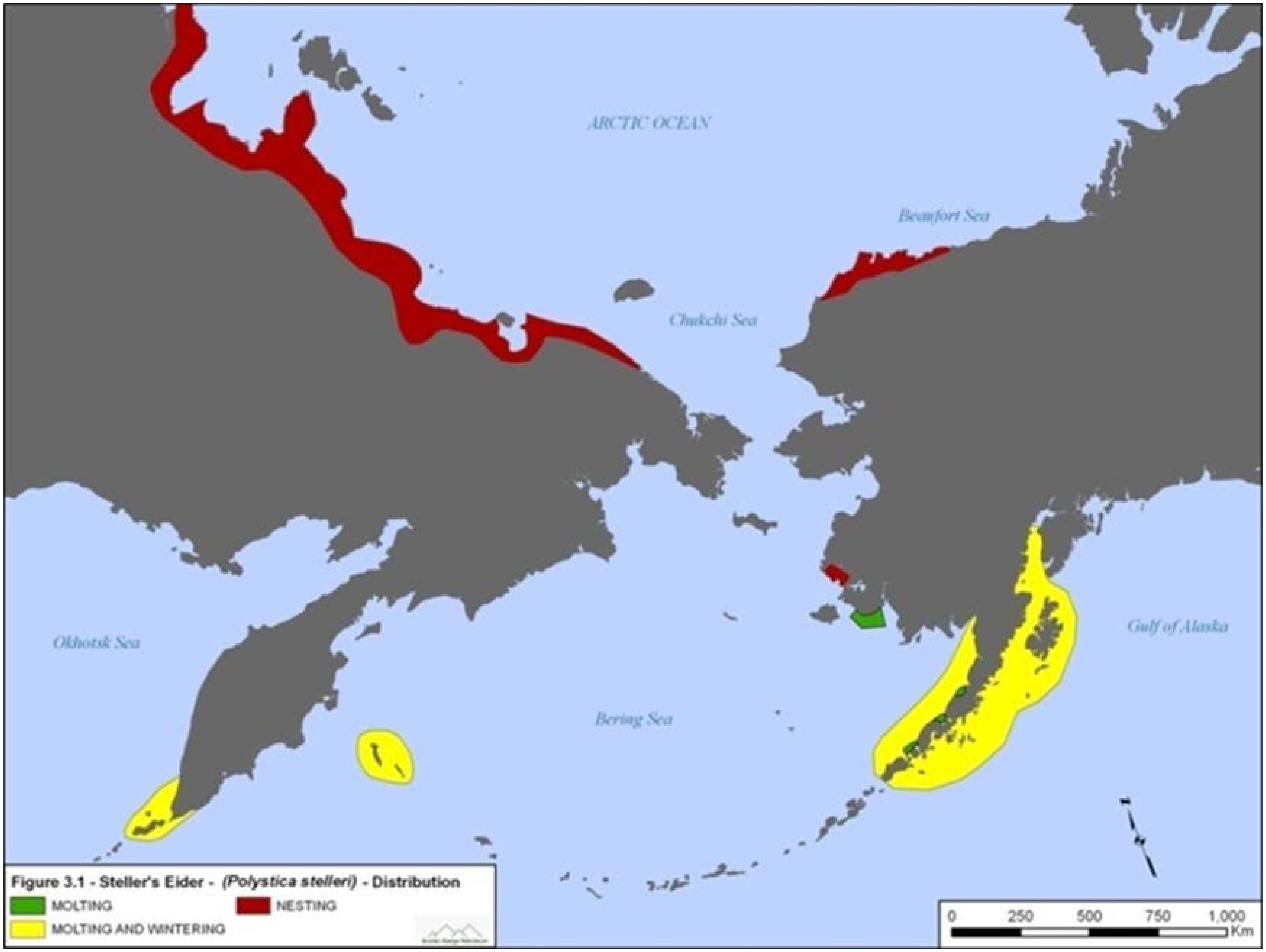

FIGURE 8: STELLER'S EIDER DISTRIBUTION

Aerial surveys conducted within the last two decades confirm current breeding distributions (e.g., Larned et al. 2012; Safine 2011; Obritschkewitsch and Ritchie 2011). The historic breeding range of the Alaska-nesting population of Steller's eiders encompassed the ACP from Wainwright to Demarcation Point and the coastline of the Yukon-Kuskokwim (Y-K) Delta (Gabrielson and Lincoln 1959; Kertell 1991; Quakenbush and Cochrane 1993; Flint and Herzog 1999; Quakenbush and Suydam 1999). Formerly common breeders on the Y-K Delta, Steller's eiders have experienced dramatic and continued decline in numbers (Quakenbush et al. 2002).

No recent sightings have been reported east of the Sagavanirktok River and only a few sightings have occurred between the Colville and Sagavanirktok Rivers (Quakenbush et al. 2002). With the exception of a single inland sighting near the Colville River, nesting observations have not been reported east of Cape Halkett (Quakenbush et al. 2002). The extent to which Steller's eiders use offshore Beaufort Sea habitat is unknown. Annual indicated breeding-pair surveys conducted by the USFWS on the North Slope disclose an average density estimate of 0.0025 birds/0.39 mi^2 for surveys between 1992 – 2006 and 2007 – 2010; approximately six times lower than that found in the Barrow area (Larned et al. 2011). Fluctuations and/or shifts in annual distributions, coupled with aerial survey detectability difficulties, obfuscate density estimates for the Alaskan Steller's eider population (Obritschkewitsch and Ritchie 2009). Larned et al. (2011) did not observe Steller's eiders near the project area during their eider surveys in 2010 (Figure 9).

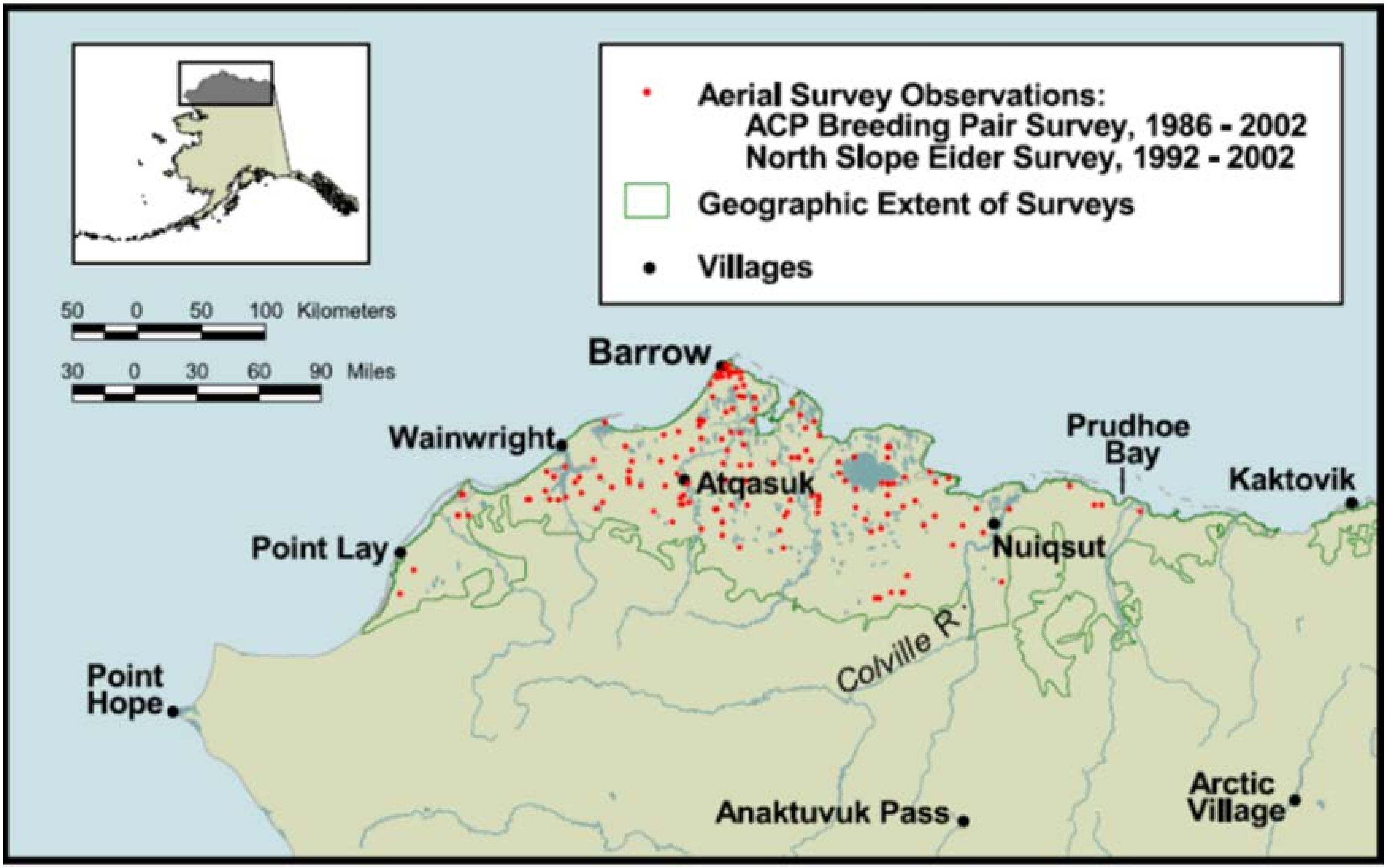

FIGURE 9: DISTRIBUTION OF STELLER'S EIDER ON THE ACP, NORTHERN ALASKA. LOCATIONS ARE DERIVED FROM THE USFWS AERIAL SURVEYS, AND INCLUDE ALL "ON-TRANSECT" OBSERVATIONS.

3.3.5.2. Spring Migration

Prior to migration, Steller's eiders form large flocks, staging in estuaries along the northern side of the Alaska Peninsula, including several areas used during molt and winter; then generally move east across Bristol Bay, following the coastline where they spend days or weeks feeding in Northern Kuskokwim Bay, as well as other nearby areas (USFWS 2002a). The majority of the world population then crosses the Bering Strait to breeding grounds in Siberia, while the remaining Steller's eiders continue north to the ACP (Gill et al. 1978). Little conclusive evidence exists for migration routes to northern Alaska; however, it is hypothesized that Steller's eiders follow offshore ice leads through the Bering Strait as early as mid-May and reach Point Barrow by early June (Steffen Oppel, University of Alaska-Fairbanks, unpublished data, USFWS 2010a). Annual spring Steller's eider estimates have ranged between 54,888 (2010) to 137,904 (1992), with a mean of 82,925; the 2011 spring survey estimate was 81,925 (Larned 2012).

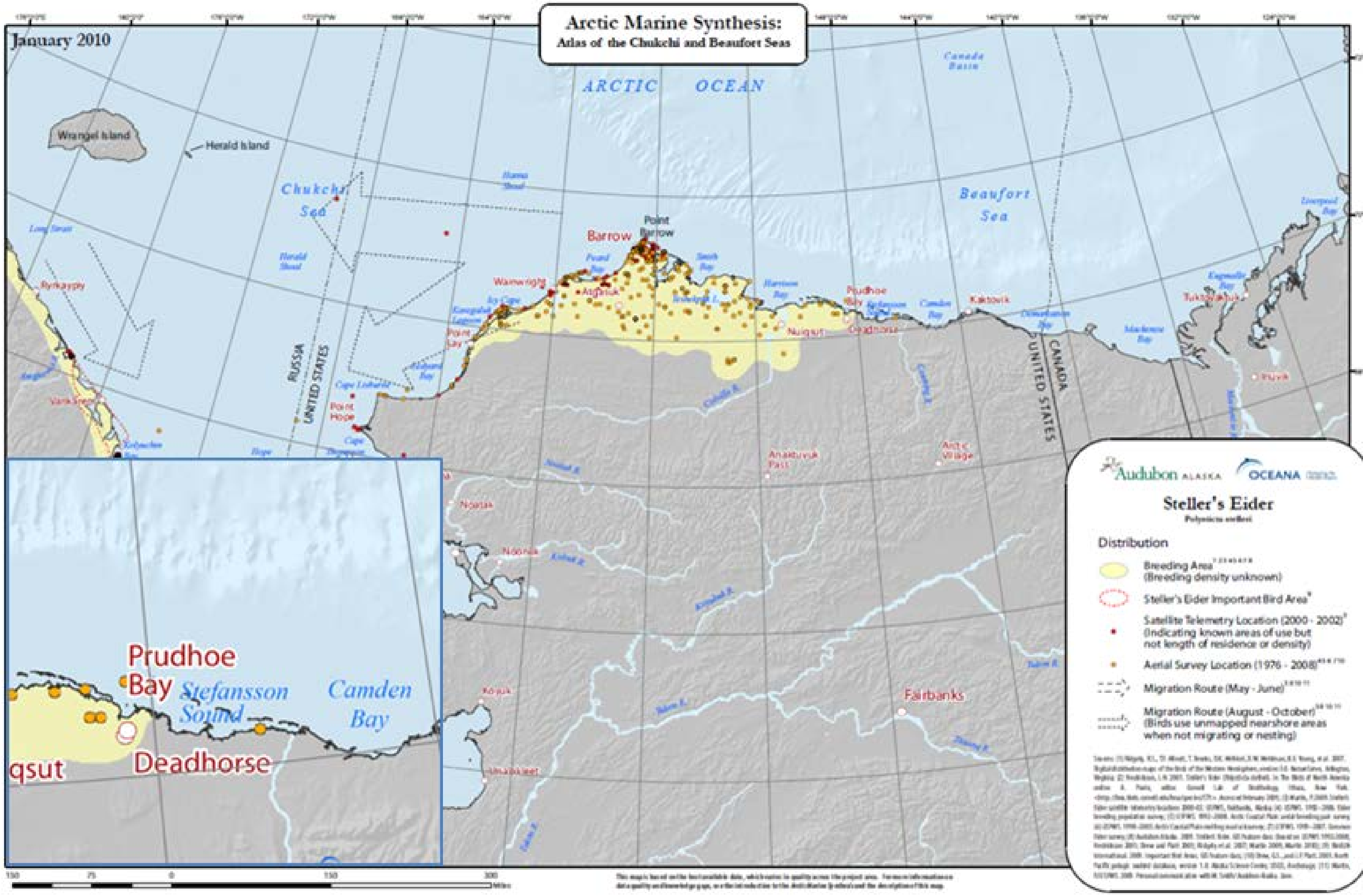

FIGURE 10: BREEDING DISTRIBUTION OF STELLER'S EIDER ON THE ACP

3.3.5.3. Nesting

Steller's eiders arrive on the North Slope in early June in mixed flocks. Typically, breeding pairs disperse to nesting sites about a week after arrival on the tundra (Quakenbush et al. 2004). The Barrow area is the center of abundance and primary nesting location for Steller’s eider in northern Alaska (Quakenbush et al. 2002). Nesting effort varies widely from year to year (Quakenbush and Suydam 1999), and may be related to annual fluctuations of lemming (Subfamily Arvicolinae) populations. High densities of lemmings provide an alternate prey source for predators, including the Arctic fox (*Alopex lagopus*), snowy owl (*Bubo scandiacus*), and pomarine jaeger (*Stercorarius pomarinus*); the latter avian species, while defending their own nests, may also afford protection to eiders nesting in close proximity (Quakenbush et al. 2004). Although cyclic lemming abundance may affect Steller’s eider nesting near Barrow, other unpredictable events, such as habitat conditions, weather, and the perseverance of sea ice, potentially contributes to annual nesting variability (Quakenbush et al. 2004).

Steller’s eider nests are located on tundra habitats often associated with polygonal ground both near the coast and at inland locations. Emergent *Carex* and *Arctophila* provide import areas for feeding and cover. Males may remain on the breeding grounds for 2 weeks after the onset of the 24-day incubation period (Fredrichsen 2001). Nest clutch sizes range from 5 to 8 eggs, averaging 5.4 (Quakenbush et al. 2004). Nest success is variable, and ranges between 0 to 87.5% (Obritschkewitsch et al. 2001, 29%; Rojek 2007, 87.5%). Incubation ranges between 24 (Quakenbush et al. 2004) and 27 days (Fredrickson 2001). Nest predators include jaegers, common ravens, glaucous gulls, and Arctic foxes. Avian predators, including snowy owls, peregrine falcons, and gyrfalcons, have been the predominant natural cause of adult Steller’s eider mortality. Steller’s eider broods apparently are less mobile than those of spectacled eiders and remain in ponds with emergent *Carex* and *Arctophila* within about 1,000 ft of the nest site.

After hatching, broods move to adjacent ponds containing emergent vegetation, principally areas containing *Carex* spp. and *Arctophila fulva* (Rojek 2005; Quakenbush et al. 1998). Young feed on insect larvae and other wetland invertebrates. Broods may travel up to several miles from the nest prior to fledging (Quakenbush et al. 1998; Rojek 2005). Fledging occur 32 to 37 days post-hatching (Obritschkewitsch et al. 2001; Quakenbush et al. 2004; Rojek 2005).

3.3.5.4. Post-nesting Period

Steller’s eiders’ time of departure from breeding grounds is dependent on breeding status and gender. After nesting, male birds typically depart nesting areas in late June or early July during egg incubation (Quakenbush et al. 1995; Obritschkewitsch et al. 2001). Females of failed or abandoned nests may remain on or near the breeding grounds longer, before returning to the Chukchi Sea. Martin (personal communication, 6 July 2012) tracked a female Steller’s eider of an abandoned nest in 2000; data indicate that the female remained in the Barrow area until late August. Females and fledged young leave the breeding grounds in early to mid-September (USFWS 2008). Female birds and young congregate with males in nearshore marine waters of southwest Alaska where they reunite with the Russian Pacific population (USFWS 2002a). Individuals of this species undergo a 3-week complete molt; the molting period for the species as a whole can last from late July until late October (Petersen 1981). The entire Pacific wintering population molts in remarkable concentrations at four core areas along the north side of the Alaska Peninsula: Izembek and Nelson lagoons, Port Heiden, and Seal Islands (Gill et al 1981; Petersen 1981; Metzner 1993), characterized by extensive shallow areas with eelgrass (*Zostera marina*) beds and intertidal mud and sand flats where marine invertebrates can be foraged (Petersen 1980, 1981; Metzner 1993). A portion of the population remains in molting areas throughout winter, while the majority disperses to the coastal waters of the eastern Aleutian Islands, the south side of the Alaska Peninsula, and as far east as the Cook Inlet (USFWS 2002a).

Over-wintering Steller's eiders will typically be found in shallow waters of 30 ft or less, and therefore within 400 yards of shore, unless the shallows extend farther offshore as in bays, lagoons, or near reefs (USFWS 2002a).

3.3.5.5. Non-breeding Season

Steller's eiders are thought to be episodic breeders. Rojek (2008) found that eiders studied in the Barrow area nested 10 years, but did not nest in 7 years of the study. Coulson (1984) determined that non-breeding years are common in long-lived eider species; eiders will often forgo breeding when body conditions are inadequate. However, reasons for non-breeding years may be more complex.

During non-breeding years, satellite-transmitter fixed males and females were found to remain in the Barrow area until July prior to initiating fall migration. Males departed the area in early July, and females departed by late July (Martin, personal communication, 7 July, 2012). Fall migration varies in duration and location. Martin (personal communication, 7 July 2012) found that the north coast of the Chukotka and Bering Strait regions were utilized the most, comprising 76% of the total 365 migration stopover use-days (n = 13 birds). Satellite-tracked birds from Barrow molted in the southeast Bering Sea from Nunivak Island to the Alaska Peninsula; Cape Avinof (Kuskokwim Shoals) was the most frequently used area, with seven of the 13 individuals tracked to this area (Martin, personal communication, 7 July 2012).

3.3.5.6. Factors Affecting Population Status

Causes of Steller's eider declines are unknown. Several potential threats have been theorized, including contamination-induced habitat loss, lead poisoning through lead shot ingestion (USFWS 1997), predation, subsistence hunting, global climate change, and limitations due to specialized feeding behavior.

3.3.5.7. Toxic Contamination of Habitat

The presence of lead shot in the nesting and nearshore habitat used for foraging on the ACP has been cited as a potential threat to the Steller's eider (Trust et al. 1997; USFWS 1997). The primary cause of exposure is from lead shot ingestion (see Section 3.3.5.9. Over Harvesting). Lead shot was commonly used by sport hunters until 1991, when it was banned. Remnant lead pellets remain in the environment indefinitely and are mistakenly ingested by eiders as a grit source. Lead poisoning could be a contributing factor in adult survival and reproduction rate.

Hazards for marine distributed Steller's eiders include marine vessel transport, commercial fishing, and environmental pollutants (USFWS 2002a). Exposure to petroleum, heavy metals, and other contaminants has been suggested as a contributing factor to declining eider populations. The majority of the Alaska Steller's eider population spends their winters in shallow, near-shore waters extending from the Aleutian Islands to Cook Inlet. Harbors and bays in these areas are subject to heavy maritime traffic and industrial activity related to the commercial fishing and seafood processing industry. Estimates of at least 18,000 gallons of petroleum products were spilled from 1995 to 2000, and an estimated 4,800 gallons are expected to be continually spilled annually in these waters (USFWS 2002a). Studies have linked exposure to these contaminants to chromosomal damage and decline in survival rate (USFWS 2002a).

3.3.5.8. Predation

In the 1950s, goose populations on the Y-K Delta declined by nearly half (Kertell 1991). Prior to this population reduction, Steller's eiders were known to nest in association with large goose colonies on the Y-K Delta. Kertell (1991) theorizes that by nesting close to these goose colonies, eiders reduced the risk of predator exploitation. A shift in prey availability resulting from the goose population declines increased predation by Arctic foxes and is cited as a possible contributing factor to the decline of Y-K Delta breeding Steller's eiders (Kertell 1991).

Many speculate that human habitation artificially elevates predator populations by providing easy access to food, as well as predator denning and nesting habitats in and around villages and towns on the North Slope. High predator numbers in turn, have contributed to increasing predation on species, including Steller's eiders (Quakenbush et al. 1995; Obritschkewitsch et al. 2001).

3.3.5.9. Over Harvesting

Subsistence harvest and sport hunting of waterfowl is federally regulated by the MBTA. Under the act, sport hunting of Steller's eiders was banned in 1991 due to dramatic declines in eider populations (USFWS 1997). Subsistence hunting remained legal until 1994. Following continued population declines, Steller's eider was placed on the closed season species list, thereby prohibiting all hunting of the species under the MBTA (USFWS 1997).

Steller's eiders are currently considered a non-harvestable species [73 CFR 13788 - 13794, 14 March 2008]. This final rule establishes regulations that outline what bird species may be harvested, when, and by what means. These regulations were developed by the USFWS, the Alaska Department of Fish and Game (ADF&G), and Alaska Native representatives in an effort to stem population declines of Steller's eiders.

3.3.5.10. Habitat Loss and Disturbance

Effects of gas/oil development on the North Slope and village expansion (e.g., Barrow), were cited as potential threats to Steller's eider (USFWS 1997). Barrow is currently the core area of the breeding distribution of Alaska Steller's eiders. Breeding habitat and disturbance are both considerations with the expansion of the city and human population; habitat reduction and increased disturbance being the result. BLM (2007) has estimated that Barrow could expand to 3,600 acres by 2040. Oil and gas development is slowly creeping westward across the ACP and into the National Petroleum Reserve-Alaska (NPR-A). Scientific, field-based research is also increasing across the ACP; studying the effects of climate change on various species and ecosystems has potential for disturbance of breeding eiders.

3.3.5.11. Climate Change

Climate change threats to the Steller's eider are yet unclear. Mismatched timing of migration and prey availability at breeding sites (Callaghan et al. 2004), and changes to population cycles of lemmings to which Steller's are thought to be linked (Quakenbush et al. 2004; Callaghan et al. 2004) may be factors that will have significant impacts to the small breeding population in Alaska.

3.3.5.12. Critical Habitat

The USFWS designated critical habitat for the Steller's eider in 2001 (66 CFR. 8850 – 8884). Critical habitat includes the Y-K Delta nesting areas and the Kuskokwim Shoals fall molting and spring staging area. Other critical habitat includes molting and staging lagoons along the north coast of the Alaska Peninsula, including the Seal Islands, Nelson Lagoon, Port Moller, and Izembek Lagoon. A map of critical habitat for Steller's eiders is presented in Figure 11. Currently, there are no critical habitat designations for Steller's eiders on the North Slope of Alaska.

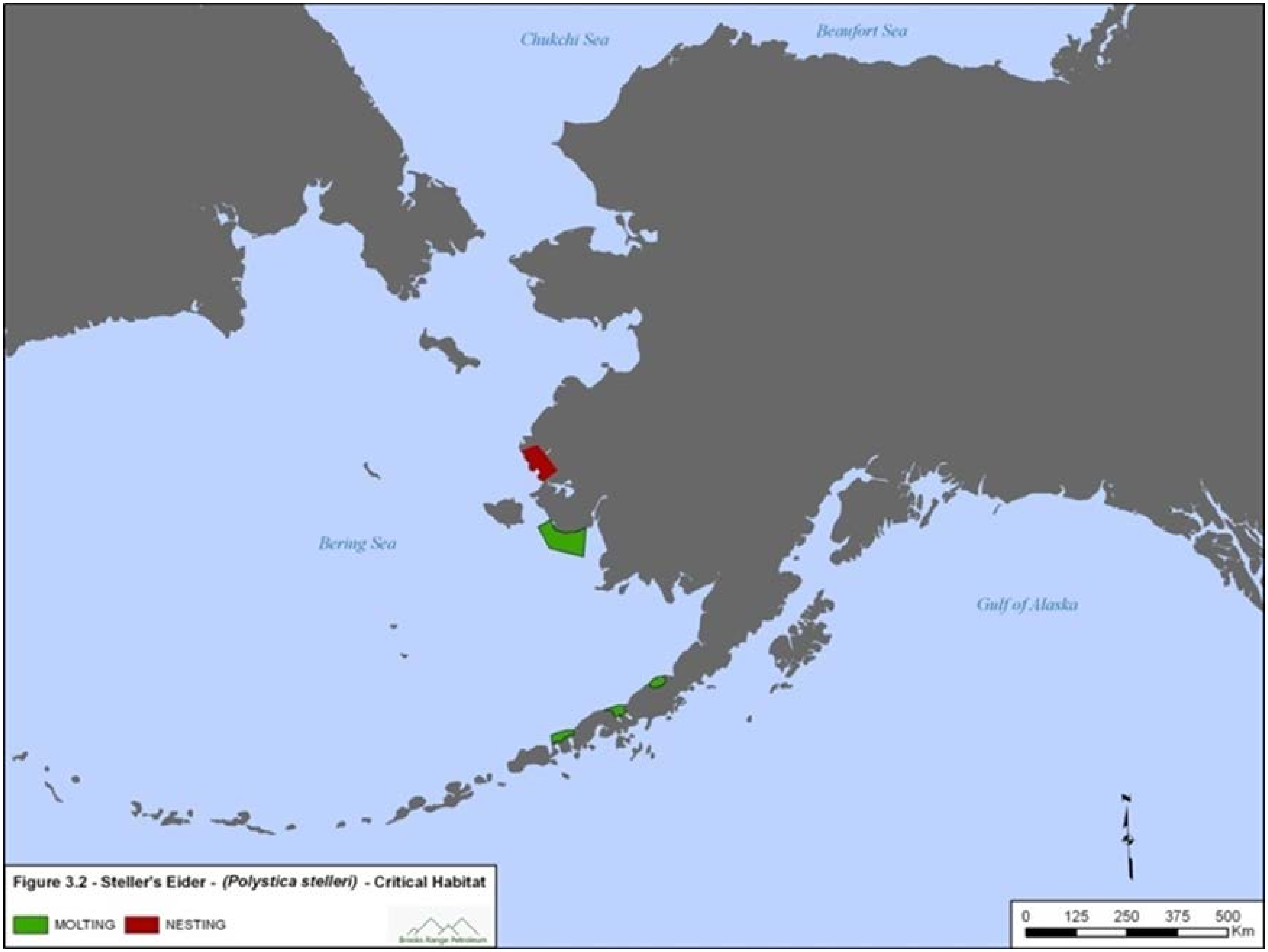

FIGURE 11: STELLER'S EIDER CRITICAL HABITAT AREAS.

3.3.5.13. Recovery Plan

In September of 2002, the USFWS issued a Recovery Plan for the Alaska-breeding population of Steller's eider. The plan is intended to provide strategies which ultimately will lead to the delisting of the species under the ESA (http://ecos.fws.gov/docs/recovery_plans/2002/020930b.pdf).

The Steller's eider Recovery Plan includes:

- Prevention of further declines in Steller's eider breeding populations in Alaska;
- Protection of current Alaska-breeding populations and their habitat;
- Identification and remedy of causes and recovery obstacles; and
- Determination of size, trends and distribution of Alaska-breeding subpopulations.

3.3.6. *Spectacled Eider*

The world's nesting populations of spectacled eider (*Somateria fischeri*) was listed as a threatened species on 10 May 1993 (58 CFR 27474 - 27480). This listing was based on the species' substantial decline of 94 – 98% on its nesting range in Alaska, and the continued annual decline of roughly 14%. Critical habitat was designated for the spectacled eider on 6 February 2001 (66 CFR 9146 - 9185). Historically, spectacled eiders nested from the Nushagak Peninsula in the southwest, north to Barrow, and east to the Canadian border (Bent 1925; Baily 1948; Dau and Kistchinski 1977; Garner and Reynolds 1987; Johnson and Herter 1989). They also nested along large portions of the Arctic-coast of Russia (Dementev and Gladkov 1952; Portenko 1972; Kistchinski 1973). Globally, three primary nesting grounds remain: the coast of the Y-K Delta primarily between Kigigak Island and Kokechik, the ACP (primarily between Cape Simpson to the Sagavanirktok River), and the ACP of Russia (USFWS 2001). A small number of birds also nest on St. Lawrence Island (Fay 1961) (Figure 12).

3.3.6.1. Population Status and Trends

Historic Standard ACP comprehensive waterfowl surveys have been conducted by the USFWS since 1986, of which spectacled eiders have been a part. Anticipating the listing of the spectacles eider, USFWS initiated "Eider" ACP aerial surveys to assess the size and distribution of the annual breeding population. Surveys initiated in 1992 have been flown annually, and have provided specific spectacled eider breeding distribution data for the ACP (Larned et al. 2009).

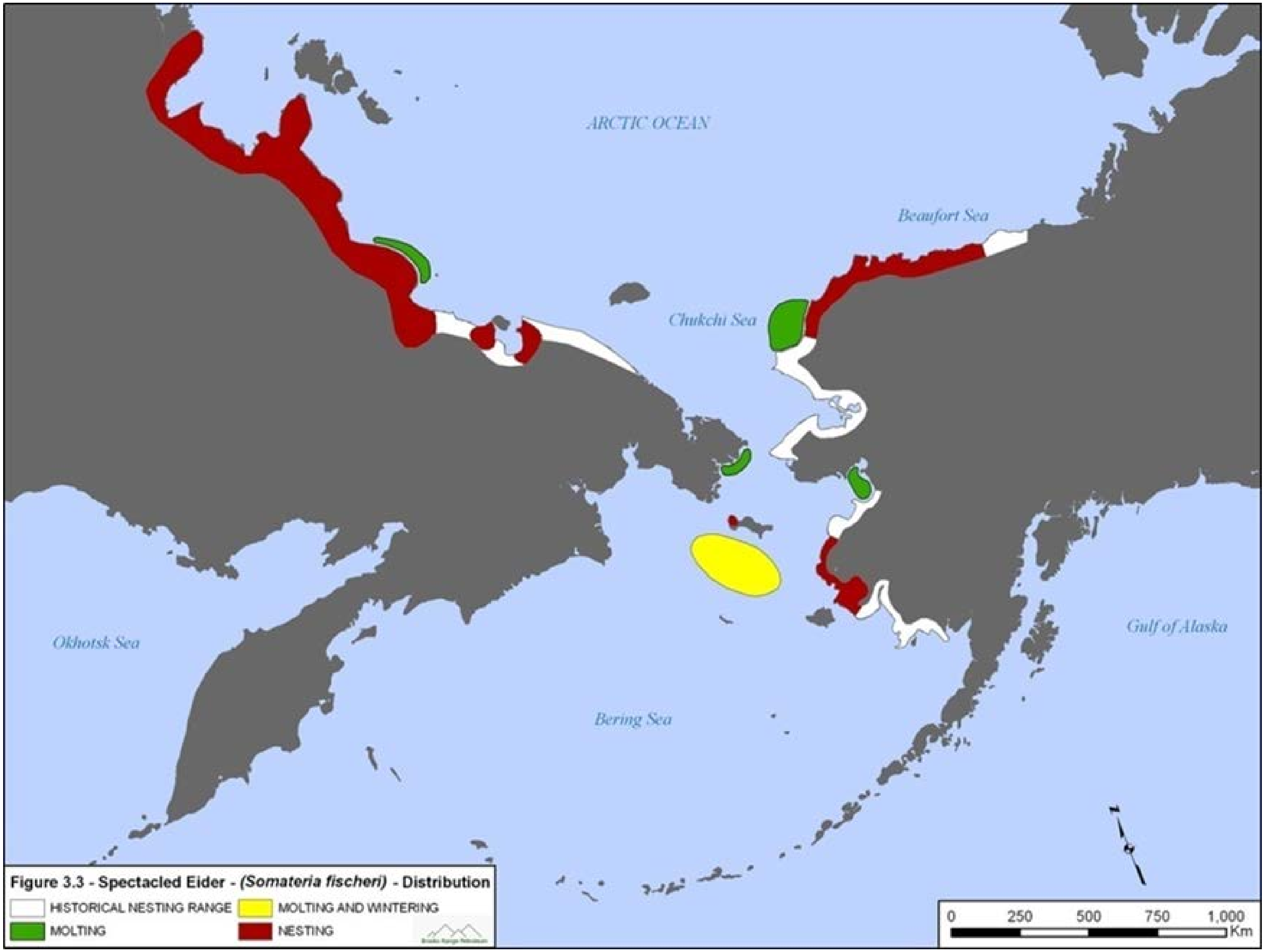

FIGURE 12: SPECTACLED EIDER DISTRIBUTION

Historically, half the estimated world population of spectacled eiders nested in the Y-K Delta; between the 1970s and 1992, the Y-K Delta spectacled eiders underwent a precipitous decline for reasons not determined (Stehn et al. 1993; Ely et al. 1994). Platte and Stehn (2009) have produced data from ground-based and aerial surveys that now indicate that the coastal Y-K Delta spectacled eider population has increased slightly. The North Slope population has fluctuated since 1993 between an estimated 4,676 to 9,186 birds (Larned et al. 2009). Overall, the ACP spectacled eider population declined between 1993 and 2009 (n=17 years), with an annual population growth rate of 0.985 (Larned et al. 2010).

The largest breeding population of spectacled eiders is thought to be located in Arctic-Russia. Hodges and Eldridge (2001) estimated the Russian population to be more than 140,000. The worldwide population may number nearly 370,000 birds (USFWS 2012).

Generally, spectacled eider densities decrease from west to east across the ACP, although localized areas of higher density occur near the Colville River and Prudhoe Bay (Larned et al. 2006) (Figure 13). Spectacled eider density ranged from 0.02 to 0.44 birds/0.39 mi^2 at locations relatively close to the project area (Table 7). Troy Ecological Research Associates (TERA) (2000) reported few spectacled eiders east of the Badami oil field during aerial surveys in 1999.

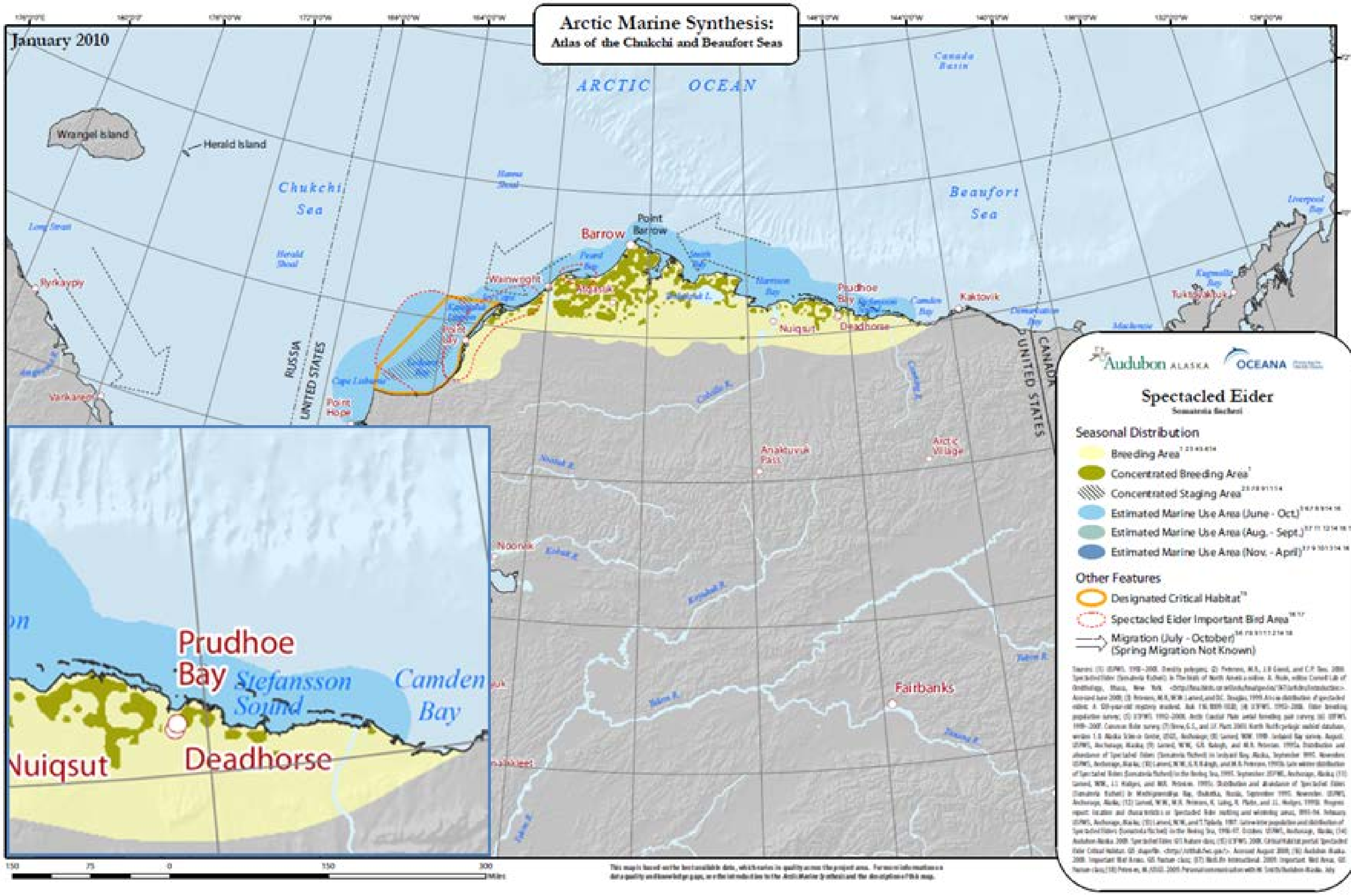

FIGURE 13: BREEDING DISTRIBUTIONS OF SPECTACLED EIDER ON THE ACP

TABLE 7: SPECTACLED EIDER DENSITIES REPORTED AT VARIOUS LOCATIONS NEAR THE PROPOSED PROJECT AREA

Location	Density (birds/0.39 mi^2)	Reference
Eastern NPR-A	0.02-0.04	Burgess et al. 2003a
Colville River Delta	0.2	Burgess et al. 2003b; Johnson et al. 2003a
Kuparuk Oil Field	0.08	Anderson et al. 2003
Milne Point Area	0.22-0.44	TERA 1997
Prudhoe Bay Area	0.18-0.38	TERA 1996
Sagavanirktok River Delta	0.04-0.32	TERA 1996
Kadleroshilik River Area	0.12-0.22	TERA 1995
Shaviovik River Area	0.08-0.14	TERA 1995

Note: 0.39 mi^2 = 1 square kilometers a standard unit of measurement for the cited studies.

The distribution and abundance of spectacled eiders were studied within a 212.4 mi^2 area located in the Prudhoe Bay oil field (TERA 1992, 1993, 1995, 1996 and 1997). Based on the 1991 survey, a conservative estimate of 122 pairs bred within the PBU. The abundance of the spectacled eider in the Prudhoe Bay area appears to have decreased by approximately 80% since 1981, and is similar to the decline on the Y-K Delta in western Alaska. The concordance of population trends in both regions suggests that the cause of the decline is due to some common factor and is thus likely operative where the populations occur together, presumably on their wintering area or during migration (TERA 1992). The distribution of spectacled eiders is not uniform within Prudhoe Bay; highest densities occur in the southwestern and central portions of the oil field (TERA 1992). TERA (1992) determined that oil-related activities did not appear to have a substantive role in determining the distribution of breeding spectacled eiders within the oil field. They did surmise that some distributional influences, on a scale of perhaps 820 ft, were present. The study revealed eiders may be attracted to facilities during pre-breeding and brood-rearing periods; however, they avoid facilities during nesting. In 1992, an estimated 133 pairs bred within the PBU (TERA 1993).

The Kuparuk River Unit has been monitored for avian species from 1988 to 1999 and again from 2000 to 2009. Spectacled eiders were monitored for distribution, abundance and productivity. Nine spectacled eider nests were located in the Kuparuk River Unit in 2009, with a mean of 11.2 nests annually between1993 and 2009 (Stickney et al. 2010).

3.3.6.2. Spring Migration

Spring migration routes of spectacled eiders are not well known. Small numbers have been counted along with other eider species migrating past Point Barrow headed to nesting grounds in late May and early June (Suydam et al. 2000). Accounts by Myers (1958) reported spectacled eiders as the most abundant species migrating along river systems south of Barrow.

3.3.6.3. Nesting

Spectacled eiders arrive on the ACP breeding grounds in late May or early June (Kistchinski and Flint 1974; Anderson and Cooper 1994, Smith et al. 1994). Nesting occurs north of a line connecting the mouth of the Utukok River to a point on the Shaviovik River roughly 15 miles inland from the mouth (USFWS 2012). Spectacled eider breeding densities vary along the ACP and are depicted in Figure 14. Overall densities during the eider breeding population surveys on the ACP have ranged between ~0.174 and 0.305 birds/0.39 mi^2 between 1993 and 2006 (Larned et al. 2006). The density during the 2006 breeding population survey was 0.219 birds/0.39 mi^2.

In general, breeding spectacled eiders nest near large, shallow, productive thaw lakes, often with convoluted shorelines and/or small islands (Larned and Balogh 1997), and nest sites are often located within 3.3 ft of a lakeshore (Johnson et al. 1996). Spectacled eiders on the Colville River Delta nest in salt-killed tundra, aquatic sedge with deep polygons, and patterned wet meadow, although only salt-killed tundra seems to be preferred based on an analysis of habitat selection (Johnson et al. 2002; Johnson et al. 2003a). Complex shorelines and small islands are characteristic of preferred nesting habitat (Larned and Balogh 1997). Spectacled eider nests have been found near polygon ponds, polygon series, and polygon series complexes within 3.3 ft of the edge of the waterbody in the Colville River Delta (Bart and Earnst 2005). At Prudhoe Bay, the highest densities of spectacled eider occurred in ponds with emergent vegetation (sedge or Arctophilla) and impoundments. Non-pond habitats were also used both early in the year when they are flooded and for nesting. Hatching success in the Prudhoe Bay area averaged approximately 40% (TERA 1992). In the Kuparuk oil field, nests were observed in basin wetland complexes and aquatic emergent vegetation (both aquatic grass and aquatic sedge) (Anderson et al. 2003). Nests have also been found along the tops of elevated perimeters on permanent water polygons containing emergent sedge or grass (Rothe et al. 1983; North 1990) and on the edges of deep open lakes (Bergman et al. 1977; Derksen et al. 1981). Spectacled eiders on the ACP nest mainly in areas near the coast rather than at inland locations (Derksen et al. 1981; Burgess et al. 2003b). Of 62 nests reported in the Colville River Delta, none were further than 8.1 miles from the coast (Burgess et al. 2003b).

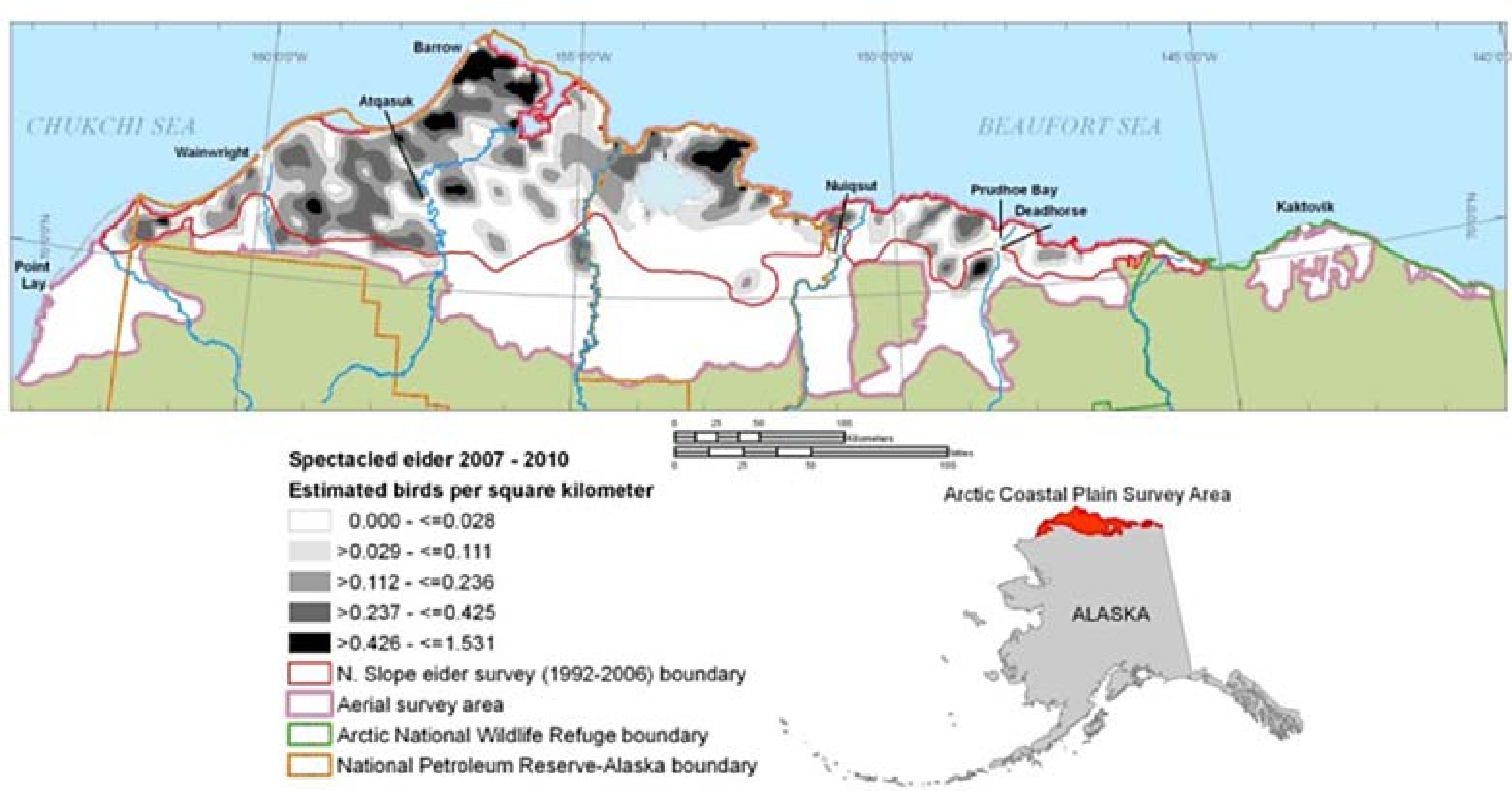

FIGURE 14: SPECTACLED EIDER DENSITY DISTRIBUTION OBSERVED ON AERIAL TRANSECTS ON THE ACP. FROM LARNED ET AL. 2011.

Based on a small sample size of band returns, there is some evidence that spectacled eider males, as well as females may exhibit both breeding site and mate fidelity (TERA 1997). Spectacled eiders lay eggs in the second week of June; clutch sizes vary among years and study sites (Petersen et al. 2000). Average clutch size on the Colville River Delta was reported as 4.32 (sample size (n) = 22) (Bart and Earnst 2005). Johnson et al. (2008) reported an average clutch size of 4 (sample size (n) = 40) on the Colville River Delta CD-3 oil well pad. Incubation lasts 20 to 25 days and eggs hatch in mid- to late July (Moran 1995; Warnock and Troy 1992). Fledging occurs about 50 days after hatching.

Broods are reared in shallow ponds and lakes with emergent vegetation, in basin wetland complexes, as well as on deep, open lakes (Dau 1974; Kistchinski and Flint 1974; Derksen et al. 1981; Warnock and Troy 1992; Anderson and Cooper 1994; Anderson et al. 1995). Schmidt-Nielsen and Kim (1964), Baudinette et al. (1982), and Moorman (1990) all found that spectacled eider broods may exhibit deleterious physiological effects when freshwater is not available. Nesting and brooding areas provide eiders with dietary requirements including mollusks, insect larvae from the Orders Diptera (craneflies and midges) and trichopterans (caddisflies), crustaceans, emergent plants, and seeds (Kondratev and Zadorina 1992). Broods are quite mobile and may move as much as 0.5 to 2 miles from the nest site within the first few days after hatching (TERA 1996). TERA (1996) reported that some broods moved to areas previously used for feeding by females prior to the onset of incubation. In the Y-K Delta, Grand et al. (1994, cited in TERA 1995) reported that 1 spectacled eider brood moved as far as 8.7 miles from the nest site. In most cases, brood-rearing apparently does not occur in ponds adjacent to nest sites even if suitable habitat is present (TERA 1995), indicating that not only is the nest site location important, but spectacled eiders may also require a much larger area in the general vicinity of the nest site for brood-rearing. Most broods are raised within 3.1 miles of the nest site (Dau 1974; Harwood and Moran 1993; Moran and Harwood 1994). After an initial post-hatch dispersal in the Prudhoe Bay area, there was a tendency for broods to settle into a particular area for a time, and then abruptly move to a new area. After fledging (approximately 50 days post-hatching), females and young move from freshwater to marine habitats where they eventually rejoin males and molt at fall migration staging areas (Dau 1974; Kistchinski and Flint 1974).

3.3.6.4. Post-nesting Period

Most males depart the breeding grounds in mid-June after the onset of incubation, moving to coastal bays and lagoons to molt and stage for fall migration. Important molting and staging areas include Harrison Bay, Simpson Lagoon, Smith Bay, Peard Bay, Kasegaluk Lagoon, Ledyard Bay, and eastern Norton Sound (LGL 1992; Larned et al. 1995; Petersen et al. 1999; TERA 2000; Troy 2003). TERA (2000) and Troy (2003) reported that some males may travel overland to the Chukchi Sea, but that some birds also remain about 6.2 miles offshore in Harrison Bay for 7 to 10 days before continuing their fall migration to molting areas such as Ledyard Bay in the Chukchi Sea. Based on satellite telemetry data, males moving overland along the coast directly to the Chukchi

Sea departed the breeding grounds earlier than those that lingered in the Beaufort Sea (Troy 2003). However, Petersen et al. (1999) reported that molt and fall migration occurred in offshore waters and found no evidence that spectacled eiders nesting on the ACP migrate over the coastal plain in the fall. Fischer et al. (2002) reported that spectacled eiders were generally uncommon in offshore surveys from Harrison Bay to Brownlow Point, with small numbers occurring in July and August in Harrison Bay. During this time, Simpson Lagoon and Harrison Bay may be important staging areas for several weeks (TERA 2000; Petersen et al. 1999).

Successful females and young of the year begin to depart the breeding grounds in late July and movement continues until the end of August. Early departing females may be non-breeders or have had failed nesting attempts. Troy (2003) reported that female spectacled eiders use Beaufort Sea waters from east of the Sagavanirktok River, west to Barrow, and beyond to the Chukchi Sea. Spectacled eiders have been reported during migration in the offshore waters of the Beaufort Sea near the mouth of the Colville River, Harrison Bay, and Smith Bay, and near the coast in the area northwest of Teshekpuk Lake. Arrival onto molting areas, departure from molting areas to winter areas, and arrival onto wintering areas follow a similar pattern; males are followed by unsuccessful females, which are followed by successfully breeding females (Petersen et al. 1999). More female than male spectacled eiders may migrate through the offshore marine waters of the Beaufort Sea as more open water exists in offshore areas when females depart, rather than earlier in the year when males migrate, which allows for more extensive use of marine habitats by later migrating birds. TERA (2000) reported that the average distance offshore for migrating males was 6.3 miles compared to 13.5 miles for migrating females.

3.3.6.5. Non-breeding Season

Satellite tracking led to observations of large concentrations of spectacled eiders located southwest of St. Lawrence Island in the Bering Sea; the area is now thought to support the majority of the world's population of wintering spectacled eiders (Petersen et al. 1999). Based on the USFWS aerial survey counts, the population was estimated at 363,030 individuals (Larned and Tiplady 1999).

In early winter, spectacled eiders have been observed south of St. Lawrence Island, moving farther offshore as winter progresses (Petersen et al. 1999). Their late winter habitat is associated with ice cover as the birds search for open water. Flocks gather in ice-free openings (Petersen and Douglas 2004). In winter, they forage for mollusks, crustaceans, and invertebrates, such as clams, in the open ice leads, to depths of 147 to 230 ft (Lovvorn et al. 2003). In spring, food availability is important, especially for females requiring nutrients for egg-laying and incubation (USFWS 2012). Female spectacled eiders do not feed substantially while on the breeding grounds, thus producing eggs and incubating while surviving off body reserves from spring foraging (Korschgen 1977; Drent and Daan 1980; Parker and Holm 1990).

3.3.6.6. Factors Affecting Population Status

The reasons behind declines in spectacled eider breeding populations are unknown; however, a combination of contributing factors likely include habitat loss, hunting, predation, lead poisoning, ecosystem change, contamination, parasites, disease (Stehn et al. 1993), and research activities (Bart 1977; Gotmark 1992). On the ACP, historical data are lacking and the extent of declines there, if any, are difficult to assess. On the Y-K Delta, a number of potential factors that may have contributed to the spectacled eider population decline have been identified, but the relative importance of each has not been determined. Possible factors that may affect spectacled eiders are discussed below. It is possible that a single factor alone may not be the cause of the spectacled eider population decline, and that the decline may have resulted from a combination of factors.

3.3.6.7. Toxic Contamination of Habitat

The presence of lead shot in the nesting and nearshore habitat, used for foraging on the ACP, has been cited as a potential threat to the spectacled eider (Wilson et al. 2004). The primary cause of exposure is from lead shot ingestion (see Section 3.9.6.9 Over Harvesting). Lead shot was commonly used by sport hunters until 1991, when it was banned. Remnant lead pellets remain in the environment indefinitely and are mistakenly ingested by eiders as a grit source. Lead poisoning could be a contributing factor in adult survival and reproduction rate. Spent lead shot remains in the sediments available to eiders for prolonged periods as ice, which underlies most breeding habitat, retards shot sinking to lower depths. Lead shot used for upland bird hunting, sold in rural communities near eider habitat, may continue to be a source of contamination to spectacled eiders (USFWS 2010a).

Hazards for marine distributed spectacled eiders include marine vessel transport, commercial fishing, and environmental pollutants (USFWS 2002b). The majority of the world population of spectacled eiders spends the winter at one location off St. Lawrence Island. Large oil spills in eider habitat, although low in probability, would be devastating if occurring near molting or winter areas (USFWS 2010a).

Future offshore oil and gas development may pose a threat to spectacled eiders. In the outer continental shelf (OCS) waters, proposed lease sales could result in active exploration and development within spectacled eider wintering, migration, and molting habitat. State-controlled, nearshore marine waters may also be leased and developed.

Along Alaska's North Slope, a small portion of spectacled eiders breeding range has been altered by oil and gas development. Potential threats from development include contamination from accidental spills, off-road vehicle use, wetland filling, and indirect effects of human presence. While the extent of spectacled eider nesting habitat impacted by oil and gas development is presently small, industrial development could expand in the future.

Petroleum products spilled into the Bering Sea may enter benthic or pelagic food chains. Other proposed oil and gas leasing and development in state and OCS waters could impact eiders due to disturbance and oil spills. Production of oil in the OCS of the Bering and Chukchi seas would substantially increase the probability of oil spills from platforms, pipelines, and tankers. Increases in shipping activity and offshore development may put eiders at risk from oil spills during critical migration, wintering, and molting periods, when they are highly concentrated or in flightless flocks. Similar impacts could occur with state leases in nearshore marine waters.

3.3.6.8. Predation

Tundra nesting birds are subjected to predation pressure from Arctic and red foxes, grizzly bears, gulls, jaegers, common ravens (*Corvus corax*), and snowy owls (*Nyctea scandiaca)*; (Day 1998). Some predators, such as ravens, gulls, Arctic foxes, and bears may be attracted to areas of human activity where they find anthropogenic sources of food and denning or nesting sites (Eberhardt et al. 1982; Day 1998; Burgess 2000; Powell and Bakensto 2009). The availability of anthropogenic food sources associated with villages or North Slope development, particularly during the winter, may increase winter survival of Arctic foxes and contribute to increases in the Arctic fox population. Anthropogenic sources of food at dumpsters and refuse sites may also help to increase populations of gulls and ravens above natural levels. Major negative impacts have occurred at the Howe Island goose colony in the Sagavanirktok River Delta from predation by Arctic fox and grizzly bears during some years (Johnson et al. 2000), and Arctic foxes and glaucous gulls (*Larus hyperboreus*) are predators of common eider and brant (*Branta bernicla*) eggs and young on the barrier islands (Noel et al. 2002b). Increased levels of predation due to elevated numbers of predators could impact nesting and brood-rearing spectacled eiders.

3.3.6.9. Over Harvesting

Spectacled eiders in Alaska have been taken in low numbers for subsistence and by sport hunters. However, range-wide and local effects of this harvest are not well known (USFWS 1993). Sport harvest had been limited to few birds taken by collectors on St. Lawrence Island. In 1991, the United States sport and subsistence hunting on spectacled eiders were closed. Subsistence harvest of eider eggs and adults occurs in coastal areas during the spring and fall. Subsistence harvest reports with information on spectacled eider harvest are available primarily for the Y-K Delta, Bristol Bay, and Alaska Peninsula (Alaska Migratory Bird Co-Management Council 2006). Few data are available from the North Slope villages; however, Braund (1993a and 1993b) reported 155 spectacled eiders taken at Wainwright during 1988 - 1989, and two reported from Barrow. Native Alaskans harvest some eggs during the nesting season (USFWS 1993) and may have some impact to the population (USFWS 2010a).

3.3.6.10. Habitat Loss and Disturbance

Habitat destruction on the ACP was not identified as a significant factor resulting in the decline of spectacled eiders (USFWS 1993) and remains a non-significant threat to eider populations (USFWS 2010a). Breeding habitat encompasses vast expanses of coastal tundra and ponds that remain predominantly unaltered and uninhabited. Section 7 evaluations under the ESA will evaluate and manage the effect of future development on the species.

Oil and gas development activities, including air and boat traffic, have the propensity to disturb spectacled eider foraging success, thereby altering energetic costs; the severity of disturbance and resulting effects depend on the duration (USFWS 2010a). Construction and operational activities may have long-term effects on the population. Land-based developments increase collision risks, especially during poor light conditions. Lighting and proximity of structures to habitats used by eiders are all factors to consider concerning collision risks (USFWS 2010a).

Commercial shipping traffic is also expected to increase adding to possible disturbance effects to eiders discussed above (USFWS 2010a).

Scientific, field-based research is increasing across the ACP; studying the effects of climate change on various species and ecosystems has potential for disturbance to breeding eiders.

3.3.6.11. Climate Change

Climate change effects to spectacled eiders include changes in habitat and food sources. Mismatched timing of migration and prey availability at breeding sites (Callaghan et al. 2004) could result in lower productivity. Ocean acidification may also affect the food sources eiders rely on, causing disruption to body condition and productivity. Eiders prey sources include calcifying invertebrates such as bivalves.

Sea ice is required for resting and to conserve energy, and open water is required for diving and foraging while at sea. Changes to these platforms may affect productivity (USFWS 2010a).

3.3.6.12. Critical Habitat

The USFWS designated spectacled eider critical habitat for molting areas in Ledyard Bay and Norton Sound, breeding areas in the Y-K Delta, and wintering areas in the Bering Sea south of St. Lawrence Island (66 CFR 9146 - 9185) (Figure 15). Critical habitat for spectacled eider has not been established on the ACP.

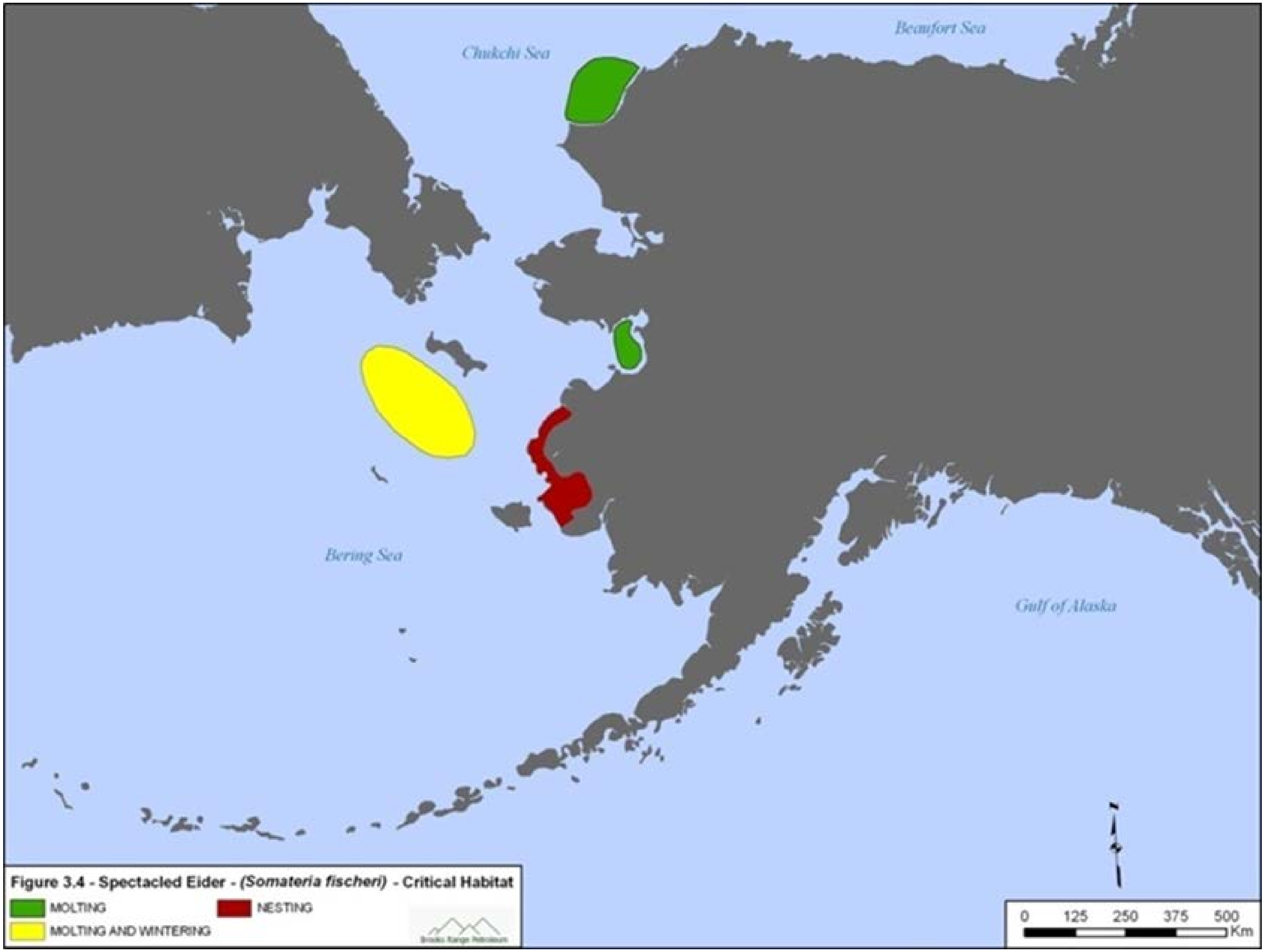

FIGURE 15: SPECTACLED EIDER CRITICAL HABITAT AREAS.

3.3.6.13. Recovery Plan

In 1996, the USFWS finalized a recovery plan, (http://ecos.fws.gov/docs/recovery_plan/960812.pdf), which provided strategies to recover the Alaska-breeding population to pre-ESA status (USFWS 2002b). The causes for the decline of the spectacled eiders population are not well defined. Possible factors may be similar to those affecting Steller's eiders, as well as other factors, such as impacts from human development and other mechanisms described above.

This recovery plan includes the following actions:

- Coordination of recovery and management plans between government agencies and native and other non-governmental organizations;
- Increasing efforts to reduce mortality of existing populations;
- Quantification and monitoring of existing breeding populations;
- Identification of molting, migration, and wintering area habitats;
- Continued research of demography and biology of the species and development of demographic models; and
- Determination of obstacles to recovery and causes of decline (USFWS 1996).

3.3.7. Factors Affecting Both Species

3.3.7.1. Collisions with Manmade Structures

Flight characteristics of eiders over water place them at risk for collisions with man-made structures (Day et al. 2005). Johnson and Richardson (1982) reported that 88% of eiders in their study flew below 32.8 ft, and greater than 50% below 16.4 ft. High intensity lights on vessels attract seabirds, including eiders, and result in collisions with the vessel and rigging, especially in poor weather condition (Russell 2005). Collisions by eiders with fixed objects, including towers and antennas in the winter range and along migration routes, depend on the proximity of the structure to migration flight paths.

3.3.7.2. Stochastic Events

Eider demographics may be susceptible to stochastic events due to random or unpredictable changes in factors such as weather, food supply, and populations of predators (Goodman 1987). Small populations have more difficulty surviving the combined effects of demographic and environmental stochasticity, but larger populations, such as spectacled eider, that depend on the stability of a relatively small area for wintering can also be affected. Disruption of food resources and parasite infections are known to have caused mass mortalities in common eiders (Camphuysen 2000). Severe weather can be a threat to Arctic sea ducks, and mass eider mortalities have been recorded after late spring storms on the Arctic Ocean (Barry 1968).

3.3.7.3. Parasites and Disease

Persson et al. (1974) concluded that parasites were an important mortality factor for common eiders in Sweden. In Scotland, Mendenhall and Milne (1985) found that renal and intestinal coccidiosis caused a 20 to 45% loss of common eider ducklings. Although some information exists on helminth worms found in spectacled eiders, the effects of this parasite on population declines are not certain (Schiller 1955; Dau 1978). Disease epidemics have not been reported for spectacled eiders, although avian cholera has been attributed with the loss of common eiders in eastern North America (Reed and Cousineau 1967; Korschgen et al. 1978).

3.3.7.4. Contamination

Contaminants, such as petroleum-based compounds, have the potential to affect the growth, reproduction, and development of animals at different age classes. Other potential elements that may impact spectacled eiders include mercury and zinc (Stout et al. 2002). Harbors and bays are subjected to heavy maritime traffic and industrial activity related to the commercial fishing industry.

3.3.7.5. Effects of Research Activities

Research has suggested scientific studies may affect eider nesting grounds by inadvertently attracting predators to nests and broods, causing increased mortality rates to eider eggs and chicks (Bart 1977; Gotmark 1992). The USFWS (2010) has determined that although a variety of research activities will be, and have been conducted on eiders in Alaska, disturbance and predation resulting from such activities do not pose population-level effects.

3.3.7.6. Lead Poisoning

Regulations requiring the use of non-toxic shot for hunting waterfowl, cranes, and snipe in Alaska were implemented in 1991 (50 CFR part 20.134). Although banned, some coastal residents of Alaska still use lead shot for hunting waterfowl. Often, residual lead shot remains on the tundra or in shallow ponds for years, posing a prolonged risk to eiders. Studies by the USGS state that up to 50% of the successfully breeding female eiders in one area of the Y-K Delta may be exposed to lead (Flint et al. 1997). Wilson et al. (2004) found lower levels in ACP breeding populations.

3.4. Mammals

3.4.1. Terrestrial Mammals

Terrestrial mammals that may occur in the project area include caribou (*Rangifer tarandus*), muskox (*Ovibos moschatus*), moose (*Alces alces*), grizzly bear (*Ursus arctos*), Arctic fox (*Alopex lagopus*), red fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), gray wolf (*Canis lupis*), Arctic hare (*Lepus Arcticus*), coyote (*Canis latrans*), and small mammals, such as the Arctic ground squirrel (*Spermophilus parryii*), ermine (*Mustela ermine*), least weasel

(*Mustela nivalis*), and microtines (USDOI and BLM 1998). These species occur across the North Slope and in many other parts of Alaska.

3.4.1.1. Caribou

The project area falls within the documented range of the Central Arctic Herd (CAH). The CAH summer range extends from Fish Creek, just west of the Colville River, east to the Katakturuk River, and from the Beaufort Sea coast inland south approximately 29.8 miles (Lenart 2005a; Arthur and Del Vecchio 2004). The CAH caribou winter in the northern and southern foothills and mountains of the Brooks Range (Lenart 2005a). Some caribou of the Porcupine Caribou Herd may occur on the coastal plain further east near Liberty during summer; however few calve there or use the area after calving (Griffith et al. 2002). The CAH calving occurs in early June, usually within 18.6 miles of the Beaufort Sea coast. The CAH traditionally calves in two main areas, located east (between the Sagavanirktok and Canning rivers) and west (between the Colville and Kuparuk rivers), respectively, of the western-most channel of the Sagavanirktok River (Arthur and Del Vecchio 2004; Lenart 2005a; Cronin et al. 1997). The project is near the eastern calving and post-calving ranges of the CAH. Parturition rates are a parameter studied as part of the ADF&G management of the CAH. The ADF&G has determined that overall, high parturition rates have contributed to the increase in population size since 2000, and that there are no significant differences in rates between the east and west calving grounds (Lenart 2011a). Arthur and Del Vecchio (2009) have determined high fidelity to specific calving areas for the CAH.

Typically, the CAH post-calving movements during the summer are influenced by insect abundance, which depends on temperature and wind speed (Dau 1986). Generally, when temperatures are >55°F and wind speeds are <15 mph, caribou are found on large gravel bars or along the coast. Caribou tend to move inland on cooler, windy days. The most consistent pattern of caribou distribution within this area during July is the use of riparian and coastal insect-relief habitats, typically sandbars, spits, river deltas, gravel river bars, and some barrier islands by large groups (mean group size 50 to 500) of caribou (Noel and Cunningham 2003).

The CAH increased from 5,000 animals in the 1970s, to 13,000 in the early 1980s to 23,000 in the early1990s, and then declined to 18,000 in the mid-1990s. The decline in the mid-1990s has been attributed to decreased productivity related to changes in calving distribution and increased energy expenditure during the insect season for cows in the eastern portion of the calving range caused by oil field infrastructure (Cameron et al. 2005). However, other factors may be responsible for the changes in herd numbers (e.g., winter mortality, emigration/immigration [Cronin et al., 1997; Cronin et al. 2000]). The CAH was last estimated at 70,034 caribou in July 2010, a 4% increase from the July 2008 estimate of 66,772, for an overall 120% increase during 2002 - 2010 (Lenart 2011a). This increase has been attributed to high parturition rates, high early summer calf survival, and low adult mortality (Lenart 2011a).

Wolves, grizzly bears, and golden eagles prey on caribou, although predation during calving and post-calving may be low for the CAH (Murphy and Lawhead 2000). Winter mortality may have been higher in the 1990s because more CAH caribou wintered south of the Brooks Range where wolves are more abundant and snowfall is heavier (Lenart, 2005a). Harvest and hunting pressure on the CAH increased in the early 1990s due to hunting restrictions on interior Alaska herds and increased access to the CAH with the opening of the Dalton Highway to public traffic. Total reported harvest has increased from an average of about 331 in the 1990s to about 470 in the 2000s, with an estimated (reported) harvest of 799 to 984 in 2009 to 2010 (Lenart 2005a and Lenart 2011a).

3.4.1.2. Muskoxen

Muskoxen were extirpated from northern Alaska by the late 1800s (Allen 1912, Lent 1998). From 1969 to 1970, 64 muskoxen from Greenland were reintroduced to northeastern Alaska, mostly in the Arctic National Wildlife Refuge (ANWR), but some also near the Kavik River (Jingfors and Klein 1982). Since that time, the population has expanded its range east into Canada, west into the NPR-A, and south to areas near the Yukon River (Lenart 2005b). The Alaskan North Slope population increased in size until the mid-1990s, appeared to stabilize around 550 animals until 2000, and then declined to about 195 by 2005 (Lenart 2005b). The recent decline in total numbers can be attributed to a localized decline in the ANWR, as aerial counts in 1990 documented 332 and 122 muskoxen in the ANWR and between the Canning and Colville Rivers, respectively, and then 9 and 186 muskoxen in the same respective areas in 2005 (Lenart 2005b). While emigration from the ANWR may have caused some of the decline in that area, reduced net productivity and recruitment were also evident (Reynolds et al. 2002a; Lenart 2005b). Predation by bears or variability in weather that affects forage availability may have been responsible for reduced survival of young and adults (Reynolds et al. 2002a; Reynolds et al. 2002b). The Game Management Unit (GMU) 26B population is thought to be stable at 200 individuals (Lenart 2011b).

Muskoxen occur on the ACP year-round and use habitats along river corridors, floodplains, foothills, and bluffs in all seasons (Reynolds et al. 2002a). Muskoxen usually produce single calves and overall have low reproductive potential relative to most ungulate species (Lent 1988). Most females sampled from northeastern Alaska first bred successfully at 3 years of age, experienced reproductive pauses between calves of 2 or 3 years, and stopped calving by 15 years of age (Reynolds 2001); these numbers may indicate less production than average for the species (Klein 2000). Calves are usually born from April through June (Lent 1988).

Muskoxen eat sedges, forbs, and willow leaves in summer and primarily sedges in winter (Klein 2000). Spatial habitat models may be used to identify local areas likely to be selected seasonally by muskoxen such as wetter, low-lying areas in summer and drier, more rugged areas in winter (Lent 1988, Danks and Klein 2002). During summer, muskoxen form relatively small groups and travel more widely than during winter, when groups tend to be larger and more sedentary (Reynolds et al. 2002a; Lenart 2005b).

Lenart (2005b) noted that a female moved about 100 miles in a 2-month period during spring, traveling with a larger group for at least half that distance. Aerial surveys have documented relatively small groups near the coast between the Sagavanirktok River and the Badami Unit during spring and summer. Groups of muskoxen were located near the coast next to the Sagavanirktok, Kadleroshilik, Shaviovik, and Kavik rivers, and also on Tigvariak Island (Jensen et al. 2003).

Grizzly bears kill calf and adult muskoxen, and may become more efficient with experience (Reynolds 2002b). Muskoxen had been legally hunted east of the Canning River since 1982 and between the Canning and Colville Rivers since 1990 (Lenart 2005b). Subsistence hunting was preferentially allowed until 1998 when registration and drawing hunts were initiated (Lenart 2005b). The annual harvest has been <4% of the population size and has primarily targeted bulls (Lenart 2005b). No permits (Tier I and drawing) have been issued in GMU 26B since 2005, and no Tier II permits have been issued since 2006 (Lenart 2011b).

3.4.1.3. Grizzly Bears

Alaskan grizzly bears range north to the Beaufort Sea coast, but the coastal plain is considered marginal bear habitat due to severe climate, short growing season, and limited food resources (Shideler and Hechtel 2000). Grizzly bears have low reproductive potential compared to other North American terrestrial mammals (Pasitschniak-Arts and Messier 2000). Shideler and Hechtel (2000) reported lower cub mortality for bears feeding on anthropogenic food sources in North Slope oil fields relative to those feeding on natural food sources alone. The population trend of grizzly bears between the Colville and Canning rivers appears stable (Lenart 2011c). Brown bears are distributed throughout GMU 26B. Densities were generally highest in the foothills of the Brooks Range (10 to 30 bears/386 mi^2; [Carroll 1995]), moderate in the mountains and lowest on the coastal plain (0.5 to 2 bears/386 mi^2), but densities in the oil fields were relatively high with about 60 to 70 resident bears or 4 /386 mi^2 (Shideler and Hechtel 2000). Riparian habitats were exclusively used in GMU 26B (Lenart 2011c).

Permafrost is a limiting factor for denning in the Arctic. Grizzly bear den sites on the coastal plain are generally restricted to well-drained habitats such as pingos, stream banks, hillsides, and sand dunes where insulating snow cover tends to accumulate in the southwestern lee of prevailing winds. Dens are typically used only once (Shideler and Hechtel 2000). In the North Slope region, bears enter dens between late September and early November, and exit between March and May (Shideler and Hechtel 2000). Cubs are born sightless and helpless in the den during mid-winter (Pasitschniak-Arts and Messier 2000). Bears may select well-drained riparian habitats for vegetative forage in spring, wetter herbaceous meadows, riparian habitats, and ground squirrel mounds in summer, and inland areas with berries during the fall (Shideler and Hechtel 2000). Grizzly bears frequently prey on ground squirrels, and also on bird eggs and nestlings, rodents, fox pups, caribou calves, adult and calf muskoxen, and marine mammal carcasses. Anthropogenic food sources may also be used when available (BPXA 1998).

The average annual home range for 5 radio-collared adult females was about 1158.3 mi^2; they may travel up to 31.1 miles per day (Shideler and Hechtel 1995, 2000). Combined field and genetic studies show that bears move across the North Slope, with considerable gene flow among bears in the western Brooks Range, the Prudhoe Bay region, and the ANWR (Cronin et al. 2005).

Spring and summer aerial surveys of the coastal area between the Sagavanirktok River and the Badami Unit from 1998 to 2003 documented the presence of grizzly bears (Jensen and Noel, 2002; Jensen et al, 2003). Most of the bears were observed near riparian corridors such as the Shaviovik, Kavik, and Kadleroshilik rivers, and were at least 6.2 miles from the coast (Jensen et al, 2003).

Human harvest is the primary source of mortality of adult grizzly bears (Pasitschniak-Arts and Messier 2000). Wolves and wolverines can kill bear cubs but are not present in appreciable numbers on the ACP (Shideler and Hechtel 2000). Adult male bears will also opportunistically kill cubs (Ballard et al. 1993). Reynolds and Hechtel (1984) observed cub natural mortality due to infanticide at 47%. The ADF&G manages a sustainable annual harvest of about 5% of the North Slope bear population between the Colville and Canning rivers (Stephenson 2003). Most bears are taken during the fall by resident hunters. The annual harvest consists mostly of males and was 23, 17, and 28 brown bears in 2008, 2009, and 2010. The 3-year annual mean was 15 bears; 116 bear were taken during the 10-year period 2000 - 2009 (Lenart 2011c).

3.4.1.4. Foxes

Arctic foxes are typically found north of the foothills on Alaska's North Slope (Burgess 2000). Reproductive potential of the Arctic fox is highest among carnivores, but influenced by availability and variability of food resources, which include rodents, nesting birds and eggs, marine mammal carcasses, and seal pups (Smith 1976; Quinlan and Lehnhausen 1982; Tannerfeldt and Angerbjorn 1998; Anthony et al. 2000). Fox populations may cycle in response to prey populations, such as lemmings, but anthropogenic or marine resources may buffer against such oscillations (Burgess 2000; Roth 2003). Periodic rabies epizootics may also affect Arctic fox populations (Ballard et al. 2001; Mork and Prestrud 2004). Foxes often cache food, may readily switch between prey sources and are capable of removing more than 1,000 eggs per fox per year from nesting bird colonies (Stickney 1991; Samelius and Alisauskus 2000).

Arctic foxes may move onto the Beaufort Sea ice in winter to scavenge from polar bear kills, but stable anthropogenic food sources may reduce seasonal movements (Eberhardt et al. 1983a). Similarly, natal den densities were higher within the oil fields near Prudhoe Bay (1/5.9 mi^2) than on adjacent undeveloped tundra (1/10.8 mi^2 [Ballard et al. 2000]). Undeveloped areas east of Prudhoe Bay have even lower den densities (Burgess 2000). Arctic fox dens tend to be fixed features on the landscape and are often located in pingos and low ridges, and next to streams in well-drained sandy soils where snow accumulation is minimal (Chesemore 1967; Burgess 2000). Foxes may also den in culverts and road embankments, and underneath buildings (Eberhardt et al. 1983b, Ballard et al. 2000). Many dens are not used in a given year, and the proportion used appears to rely on availability of local food resources (Chesemore 1967, Eberhardt et al. 1983b).

Long-term ecological monitoring in BPXA's North Slope Oil Fields assessed the activity of 54 dens in the Prudhoe Bay field in 2009, including 50 natural and four artificial dens (Sanzone et al. 2010). Forty-eight dens were located within 0.62 miles of the road system, and the remaining six more were 0.62-1.24 miles from a road. Twenty dens were confirmed to be active in 2009 (16 natal dens, and four secondary dens). This level of occupancy was similar, although slightly higher, than in 2008 (19 dens). Observations from both years indicate that Arctic foxes had rebounded dramatically from the rabies epizootic that occurred during the winter of 2006–2007.

Red foxes continue to increase in numbers within the area of major oil-field development as indicated by den occupancy; red fox and Arctic fox dens were equally abundant in 2009 (Sanzone et al. 2010). Of the confirmed active dens (20) observed in 2009, 17 were in natural substrates, and three were "artificial" dens. Red foxes used two artificial den sites (a natal den and a secondary den) and Arctic foxes were observed at only one artificial secondary den. However, because potential artificial den sites exist throughout the oil-field infrastructure, it is likely that more were in use than were observed (Sanzone et al. 2010).

Predators of both fox species near the project area are mainly brown bears and golden eagles, which primarily take pups (Garrott and Eberhardt 1982; Burgess 2000). Red fox will also prey on the smaller Arctic fox (Sanzone et al. 2010). Harvest data for Arctic foxes are not available for northeastern Alaska, but indications from trapper reports are that foxes remain common, and trapping pressure has decreased since the late 1980s due to low fur prices (Stephenson 2001).

3.4.2. Marine Mammals

These sections are directly referenced from the BPXA Incidental Harassment Authorization Request for the Non-lethal Harassment of Marine Mammals During the Prudhoe Bay OBS Seismic Survey, Beaufort Sea, Alaska, 2014. The draft IHA contains additional detail that is summarized here. Section 3.2.4 provides an evaluation of potential impacts on marine mammal species likely to occur within the project area.

The following sections are limited to those marine mammals that are generally within the project area during the open water season. Marine mammals uncommon or extralimital to the project area are not discussed below, as they are unlikely to be affected by the proposed action. These include ribbon seal (*Histriophoca fasciata*), narwhal (*Monodon monoceros*), killer whale (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), and humpback whale (*Megaptera novaeangliae*). All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972 (16 United States Code [U.S.C.] Chapter 31), implemented by the National

Oceanic and Atmospheric Administration (NOAA), NMFS. The MMPA prohibits the take (defined by hunting, killing, capturing, and/or harassment) of marine mammals with the exception of subsistence by Alaska Natives or exceptions allowed under authorizations issued by the government. Under the MMPA, 50 CFR 18, Subpart J and 15 U.S.C. § 1371 Sec. 101(a)(5), incidental take of polar bears and pacific walrus can be authorized by the USFWS. Additionally, under Sections 101(a)(4)(A), 109(h), and 112(c), the take of polar bears by harassment for the protection of human life is allowable.

3.4.2.1. Threatened and Endangered Marine Mammals

The ESA of 1973 (16 U.S.C. §1531) provides a program for the conservation of threatened and endangered plants, as well as animals and the habitats in which they are found. The USFWS administers the ESA for terrestrial and avian wildlife as well as pacific walrus (*Odobenus rosmarus*) and polar bears (*Ursus maritimus*). The NMFS administers the ESA for threatened and endangered for all other marine mammals that could be found within the project area.

Four marine mammal species found within the project area are listed under the ESA; the bowhead whale (*Balaena mysticetus*) is listed as endangered, and the polar bear, ringed seal (*Pusa hispida*), and bearded seal (*Erignathus barbatus*) are listed as threatened. The pacific walrus can be found within the project area and is currently under consideration for listing (76 CFR 7634); as they are not yet listed, walrus are discussed in Section 3.4.2.5.2. Gray whales (*Eschrichtius robustus*) were listed as endangered under the ESA, but in 1994 they were delisted because the population had shown recovery. Gray whales are discussed in Section 3.4.2.5.3.

3.4.2.1.1. Bowhead Whale

Four stocks of bowhead whales are recognized worldwide by the International Whaling Commission for management purposes (Allen and Angliss 2013). The largest of these four stocks, the Western Arctic or Bering-Chukchi-Beaufort (BCB) stock, inhabits Alaskan waters. Commercial whaling decreased the bowhead population to approximately 3,000 whales (Woodby and Botkin 1993). Abundance estimates of whales from the BCB stock, before they were overharvested by commercial whaling, were between 10,400 to 23,000 whales. Since the ban on commercial whaling, the bowhead population has increased steadily. This is evidenced by data collected during 1977-2004 from ice-based counts, acoustic locations, and aerial transect data (George et al. 2004; Koski et al. 2010). A figure of the increasing population size, up to 2005, is included in the 2012 Stock Assessment Report (Figure 42, p. 204 in Allen and Angliss 2013). In 2011, the North Slope Borough (NSB) successfully completed a new ice-based count of bowhead whales, which estimated the population at ~16,892 animals, and an annual growth rate of 3.7% (George et al. 2013). Although the bowhead whale is recovering well following its decline, it is currently still listed as endangered under the ESA, depleted by the MMPA (Allen and Angliss 2013), and an Alaska Species of Concern with the

ADF&G. The Alaska Eskimo Whaling Commission has co-managed this stock with the United States government since the 1980s.

Whales of the BCB stock winter in the Bering Sea and migrate through the Bering Strait, Chukchi Sea, and Alaskan Beaufort Sea to their summer feeding grounds in the Mackenzie River Delta, Canadian Beaufort Sea. Most bowheads arrive in the coastal areas of the eastern Canadian Beaufort Sea and Amundsen Gulf in late May and June, but some remain in the offshore pack ice of the Beaufort Sea until about mid-July. Starting about mid-August through late October, bowheads migrate westwards through the Alaskan Beaufort Sea to their wintering grounds in the central and western Bering Sea (Moore and Reeves 1993; Quakenbush et al. 2010). Late summer and autumn aerial surveys have been conducted in the Alaskan Beaufort Sea since 1979 and have provided useful information on long-term bowhead whale migration and distribution patterns (Ljungblad et al. 1986, 1987; Moore et al. 1989; Monnett and Treacy 2005; Treacy et al. 2006; Clarke et al. 2012, 2013). The main migration corridor is located over the continental shelf, typically within 34 miles of shore during years with light to moderate ice conditions (Treacy et al. 2006). Data demonstrate that bowhead whales tend to migrate west in deeper water (farther offshore) during years with higher-than-average ice coverage than in years with less ice. Sighting rates are also lower in heavy ice years. During the fall migration, most bowheads migrate west in water ranging from 50 to 656 ft deep (Miller et al. 2002; Clarke et al. 2012) and few whales have been seen shoreward of the barrier islands in the Alaskan Beaufort Sea. In 2013, however, nearshore sightings appeared more common (NOAA daily flight summaries at http://www.asfc.noaa.gov/nmml/cetacean/bwasp/2013).

Although most bowhead feeding activity occurs in the Canadian Beaufort Sea, feeding activity has also regularly been documented at Point Barrow and, less frequently, in other areas of the Alaskan Beaufort Sea (Richardson and Thomson 2002; Koski et al. 2008, Bowhead Whale Feeding Ecology Study and Aerial Surveys of Arctic Marine Mammals [ASAMM] annual reports). Satellite tagging data showed that some whales were moving back and forth during the summer feeding season between the Alaskan and Canadian Beaufort Sea (Quakenbush et al. 2010). Satellite data from one tagged whale that remained in the central Beaufort Sea for several weeks in July appeared to be associated with at least 14 whales (Clarke et al. 2012).

Bowhead whales may be encountered during the Prudhoe Bay seismic survey during the summer season, but likely in low numbers. Historically, few bowhead whales have been recorded during the summer season close to shore (e.g., ASAMM 1979-2011 database), although this might have coincided with limited survey efforts during this period. During the 2013 ASAMM aerial survey, a larger number of bowhead whales were seen in nearshore waters than would be expected based on historical data (daily flight summaries, available online at the NOAA website). Vessel-based observers recorded one multiple species sighting of six animals, consisting of a few bowheads, on 16 August 2013 near Narwhal Island during the OBC Liberty seismic survey (Aerts et al. 2008). During 2008 and 2010 aerial surveys from early July through early October, conducted as part of industrial operations in Harrison and Prudhoe Bay, only a few bowheads were seen before mid-August. None of these whales were close to shore (Christie et al. 2010; Brandon et al. 2011). Bowhead whales were more commonly observed later in the season, but most animals were seen at distances of more than 15 miles from shore.

3.4.2.2. Polar Bears

Polar bears (*Ursus maritimus*) have been protected since the passage of the MMPA in 1972. In 2008, the polar bear was listed as threatened under the ESA due to their habitat being impacted by melting sea ice (73 CFR 28212). Polar bears depend on pack ice for hunting seals and for much of their denning habitat. Thinning and receding ice cover threatens to greatly reduce suitable habitat for polar bears. The USFWS has proposed critical habitat designation for three habitat units: sea ice over the continental shelf, barrier island habitat and terrestrial denning habitat (75 CFR 76086).

The main food source for the polar bear is the ringed seal, but they also feed on bearded seals (including seal carcasses), walrus, and whales. Small mammals, bird eggs, and vegetation are also consumed when typical food sources are not available (Small and Lentfer 2008). Information on polar bear hearing is limited. Between the 2006 and 2008 open-water seasons, 11 polar bears were observed in the Beaufort Sea and four bears in the Chukchi Sea. One of these animals was observed within the 170 dB re 1 μPa rms safety radius (initiating a precautionary power-down situation) and the rest were outside the 160 dB re 1 μPa rms safety radius (Savarese et al. 2010; Haley et al. 2010).

There are two population stocks of polar bears within the project area: the Alaska Chukchi/Bering Sea (CBS) and the Southern Beaufort Sea (SBS) populations. The range of both stocks overlaps in the project area (USFWS 2010b). There has been a suggested decline in the SBS population based on documented decreases in range, survival rate, and body size (Gleason and Rode 2009; Rode et al. 2010). The CBS population estimates are based on few studies with wide confidence intervals; therefore, they are not used in evaluating population size and trends (USFWS 2010b). A detailed description of the CBS and SBS polar bear stocks can be found in the, "Range-Wide Status Review of the Polar Bear (*Ursus maritimus*)" at
http://alaska.fws.gov/fisheries/mmm/stock/final_sbs_polar_bear_sar.pdf and
http://alaska.fws.gov/fisheries/mmm/stock/final_cbs_polar_bear_sar.pdf.

Polar bear sightings have been reported to the USFWS in the project area and surrounding areas by BPXA operations as required by LOA under the incidental take program. The number of reported sightings is influenced by the number of activities completed outside, number of employees that could potentially spot a polar bear and the visibility conditions. Approximately 1,414 polar bears were sighted between 2006 and 2010 by the oil and gas industry (USFWS 2012). Overall polar bear sightings (between 30 June and 31 August) have increased between 2007-2009 in BPXA operated areas compared to previous years (Sanzone et al. 2010).

Polar bears live and forage primarily from the sea ice, but terrestrial habitats may be become increasingly important as seasonal sea ice cover decreases (Sanzone et al. 2010), as habitat selection is primarily influenced by availability of sea ice and prey (Federal Register 2008). This species is most abundant near the shore in shallow-water areas, and areas where marine productivity is higher due to currents and ocean upwelling (USFWS 2013). From May to August, as sea ice degrades, there is increased polar bear presence on the mainland and barrier islands (Schliebe et al. 2006).

In late October and November, pregnant females find an area to den on land or sea ice; such as a snow bank, slope, or an area of rough ice that is a stable location to excavate a depression (Small and Lentfer 2008). Polar bears do not use the same dens or denning locations from year to year, therefore a female could potentially den within the project area in the future (Durner et al. 2003). Polar bear dens have been documented within the study area (Durner et al. 2010; Sanzone et al. 2010; Smith 2010); however, the majority of OBC project activities will be completed outside of the polar bear denning period. As described in Section 1.5.3.3, Onshore Zone, the Sagavanirktok River Delta was flown with FLIR in December, 2013 to identify polar bear dens prior to any potential winter surveys.

3.4.2.3. Ringed Seals

Ringed seals (*Phoca hispida*) have a circumpolar distribution and are year-round residents in the Beaufort, Bering, and Chukchi seas (King 1983). There is currently no complete population estimate available for the entire Alaskan stock (Allen and Angliss 2013). Historic ringed seal population estimates in the BCB area ranged from 1-1.5 million (Frost 1985) to 3.3-3.6 million (Frost et al. 1988). Frost and Lowry (1999) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter, indicating that half of the population moves into the Chukchi and Bering seas in winter. There is increasing concern about the future of the ringed seal due to receding ice conditions and potential habitat loss. The NMFS listed the Arctic stock of ringed seals as threatened under the ESA, effective 26 February 2013 (77 CFR 76706).

Like the other ice seals, ringed seals are closely associated with sea ice during breeding, pupping, and molting. During the open-water season, ringed seals are widely dispersed as single animals or in small groups, and they are known to move into coastal areas (Smith 1987; Harwood and Stirling 1992; Moulton and Lawson 2002; Green et al. 2007). Satellite-tagging data revealed that ringed seals cover large distances between foraging areas and haulout sites during the open-water season (Lowry et al. 1998, 2000; Kelly et al. 2010; Herreman et al. 2012). The time spent on haulout sites is much shorter than the time spent foraging in open water. For example, in July, ringed seals spent 70% of the time in open water, increasing to ≥90% in August (Kelly et al. 2010).

Ringed seals have routinely been observed during previous seismic surveys in this region and time period (Aerts et al. 2008; Funk et al. 2008; Savarese et al. 2010; Brandon et al. 2011; Reiser et al. 2011), during monitoring from Northstar Island (Aerts and

Richardson 2009, 2010) and during aerial surveys flown for bowhead whales (Clarke et al. 2011a). They are typically the most abundant seal species seen in the Beaufort Sea. Based on available data, ringed seals are likely to be the most abundant marine mammal species encountered in the area of the proposed activities. Despite being the most abundant seal species, the number of expected seal encounters during the proposed OBS survey is low. This is based on seal observation data from recent, similar shallow water seismic surveys in the central Beaufort Sea (Aerts et al. 2008; Hauser et al. 2008; HDR, Inc. 2012).

3.4.2.4. Bearded Seal

Bearded seals (*Erignathus barbatus*) have a circumpolar distribution. In Alaska, they occur over the continental shelf waters of the Bering, Chukchi, and Beaufort seas (Burns 1981). There is no reliable estimate of bearded seal abundance in Alaskan waters (Allen and Angliss 2013; Cameron et al. 2010). The abundance in the Bering Sea, based on aerial survey data collected in the central Bering Sea pack ice in 2007, is estimated at ~125,000 (Cameron et al. 2010). In the Chukchi Sea, the number of animals is estimated at ~27,000, based on data from 1999-2000 spring aerial surveys flown along the coast from Shishmaref to Barrow (Cameron et al. 2010). Aerial surveys of the eastern Beaufort Sea, conducted in June during 1974–1979, resulted in an average estimate of 2,100 individuals (Stirling et al. 1982), uncorrected for animals in the water. As the survey area covered roughly half of the ice-covered continental shelf of the western Beaufort Sea, the estimated number of bearded seals in the Beaufort Sea is thought to be 1.5 times 2,100 or ~3,150 (Cameron et al. 2010). Based on these numbers, the Alaskan stock of bearded seals is considered to be greater than ~155,000 (77 CFR 76740) and may be as large as 250,000–300,000 (Popov 1976; Burns 1981; MMS 1996). The NMFS listed the Alaska stock of bearded seals, part of the Beringia distinct population segment, as threatened under the ESA, effective 26 February 2013 (77 CFR 76740).

Bearded seals are closely associated with sea ice, specifically when they breed, give birth, raise young, molt, and rest. Bearded seals migrate seasonally with the advance and retreat of sea-ice (Kelly 1988). As the ice recedes in the spring, bearded seals migrate from their winter grounds in the Bering Sea north through the Bering Strait (mid-April to June) to areas along the margin of the multi-year ice in the Chukchi Sea or to nearshore areas of the central and western Beaufort Sea. Pupping takes place on top of the ice from late-March through May, primarily in the Bering and Chukchi seas. Some pupping occurs on moving pack ice in the Beaufort Sea. Bearded seals do not form herds, although loose aggregations of animals may occur. Spring surveys along the Alaskan coast indicate that bearded seals prefer areas of 70% to 90% sea ice coverage (Allen and Angliss 2013). They generally inhabit areas of shallow water (less than 65 ft) that are seasonally ice covered (Cameron et al. 2009). As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through the Bering Strait and into the Bering Sea where they spend the winter (Cameron et al. 2010). This southward migration is less noticeable and predictable than the northward movements in late spring and early summer (Burns 1981; Kelly 1988). Some bearded seals may overwinter in the Chukchi and Beaufort seas, but conditions are likely not as favorable.

Bearded seals have been commonly observed in the central Alaskan Beaufort Sea. Surveys associated with seismic programs in 2006, 2007, 2008, and 2010, which reported sightings of several tens of bearded seals during vessel-based and aerial surveys (Funk et al. 2008; Hauser et al. 2008; Savarese et al. 2010; Brandon et al. 2011; Reiser et al. 2011). Similar numbers were recorded during barge-based vessel surveys conducted from 2005 to 2007 (Green et al. 2005, 2006, 2007). Bearded seals were commonly sighted during aerials surveys conducted in the Beaufort Sea (Moulton et al. 2003; Clarke et al. 2011a; 2012, 2013). During BPXA's OBC seismic survey in Foggy Island Bay, close to the proposed project area, observers recorded a limited number of seal sightings (18) of which one was a confirmed bearded seal (Aerts et al. 2008). Based on available data bearded seals are expected to occur in the survey area, but the number of sightings is expected to be small.

3.4.2.5. Marine Mammals Not Listed Under the ESA

3.4.2.5.1. Spotted Seal

The spotted seal (*Phoca largha*) is found from the Beaufort Sea to the Sea of Japan. They are most numerous in the Bering and Chukchi seas (Quakenbush 1988), although small numbers do range into the Beaufort Sea during summer (Rugh et al. 1997; Lowry et al. 1998). There is no reliable estimate of the size of the Alaskan stock of spotted seals. The most current estimate of for the eastern and central Bering Sea is 141,479 animals (95% CI 92,769–321,882). This number is derived from aerial surveys conducted by the National Marine Mammal Laboratory in 2007 from the United States Coast Guard icebreakers that provided greater access to the central and eastern Bering Sea pack ice (Ver Hoef et al. in review as cited in Allen and Angliss 2013). The NMFS conducted a status review of the spotted seal to determine if listing under the ESA was warranted, because of concerns about changing ice conditions and associated potential habitat loss (Boveng et al. 2009). Based on this status review, the NMFS did not list spotted seals under the ESA because they are not currently in danger of extinction or likely to become endangered in the foreseeable future (NMFS 2009).

Like other ice seals, spotted seals overwinter in the Bering Sea. From late fall through spring, spotted seal habitat-use is closely associated with the distribution and characteristics of seasonal sea ice. The ice provides a dry platform away from land predators during whelping, nursing, breeding, and molting periods. Pupping occurs in the Bering Sea wintering areas in early spring (March and April), followed by mating and molting in May and June (Quakenbush 1988). The herds break up when the usable sea ice disappears in early summer and spotted seals move toward ice-free coastal waters from Bristol Bay through western Alaska to the Chukchi and Beaufort seas. Unlike other ice seals, they use coastal haulouts for at least part of the summer. Spotted seals are commonly seen in bays, lagoons, and estuaries, but also range offshore as far north as 69-72°N. When sea ice begins to form in the fall, spotted seals occupy the ice habitat, moving southwards to the Bering Sea overwintering areas (Lowry et al. 1998).

Spotted seals have been observed frequently in the central Alaskan Beaufort Sea in recent years, although in low numbers. Haulout sites in the Beaufort Sea include Oarlock Island, Pisasuk River, Colville River Delta, and Sagavanirktok River, of which the latter is near the Prudhoe Bay project area. Historically, the Colville River Delta and nearby Sagavanirktok River supported as many as 400-600 spotted seals, but in recent years, fewer than 20 seals have been seen at any one site (Johnson et al. 1999). From 2005 to 2007, Green et al. (2005, 2006, 2007) monitored marine mammals from barges travelling between Prudhoe Bay and Cape Simpson. Overall, they observed between 23 and 54 spotted seals annually. Savarese et al. (2010) reported between 59 and 125 spotted seals annually during surveys in the central Beaufort Sea between 2006−2008. In 2010, Reiser et al. (2011) reported most spotted seals in July and August, while other seal species were more commonly observed in September and October. During BPXA's OBC seismic survey in Foggy Island Bay, just southeast of the proposed project area, observers recorded a limited number of seal sightings (18), of which one confirmed a spotted seal (Aerts et al. 2008). During seismic data acquisition in Prudhoe Bay, it is expected that spotted seals will be encountered in the project area, though in low numbers.

3.4.2.5.2. Pacific Walrus

In 2011, the USFWS published a petition to the list the pacific walrus (*Odobenus rosmarus*) under the ESA, based on the threats of foreseeable summer and fall sea ice loss and subsistence harvest (NMFS 2011b; MacCracken 2012). There is not a complete set of information to determine the population size because of the expansive distribution throughout the southern Chukchi and northern Bering Sea during summer and winter. A 2006 walrus survey, conducted by Untied States and Russian researchers using thermal imaging in the pack-ice of the Bering Sea, detected walruses hauled out on sea-ice while satellite transmitters help account for walruses in the water (Speckman et al. 2010). Based on this survey, approximately 129,000 walruses with 95% confidence limits of 55,000 to 507,000 individuals were estimated (Garlich-Miller et al 2011). During summer months, most of the population migrates northward from the Bering Sea through the Bering Strait to summer feeding areas over the continental shelf in the Chukchi Sea during summer months (Garlich-Miller et al 2011). Pacific walrus are not frequently found in the Beaufort Sea, but they have been sighted east of Barrow (Clarke et al. 2011b) and within the project area. Movement and haulout locations are correlated with sea ice distribution (Garlich-Miller et al. 2011) and food availability along the continental self. Walrus will haulout on land when pack-ice has retreated beyond the continental shelf (Clarke et al. 2011c; NMFS 2011b).

Pacific walrus are unlikely to be encountered during seismic survey activities due to their primary summer range being in the Chukchi Sea and their close association with pack-ice.

3.4.2.5.3. Gray Whale

Gray whales (*Balaena mysticetus*) originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic population is believed to have become extinct by the early 1700s, likely from over harvesting. There are currently two populations of gray whales in the North Pacific Ocean: the eastern North Pacific population, which lives along the west coast of North-America, and the western North Pacific population, which is believed to occur mainly along the coast of eastern Asia (Rice et al. 1984; Swartz et al. 2006) and summers near Sakhalin Island, Russia. Recent satellite tagging and photo-identification data suggests that there is overlap between the eastern and western populations.

Though populations have fluctuated greatly, the eastern Pacific gray whale population has recovered significantly from commercial whaling, and was delisted from the ESA in 1994. In 1997, Rugh et al. (2005) estimated the population at 29,758 ±3,122, and in winter 2001-2002, the estimate was 18,178 ±1,780. The population estimate increased during winter 2006–2007 to 20,110 ±1,766 (Rugh et al. 2008). The NMFS does not consider the eastern Pacific stock of gray whales to be endangered or to be a strategic stock.

The eastern North Pacific population annually migrates from warm wintering ground lagoons in coastal Baja California and Mexico to summer foraging areas in the Bering and Chukchi seas off northern Alaska and Russia (Jones et al. 1984; Swartz et al. 2006, Lagerquist et al. 2011), primarily between Cape Lisburne and Point Barrow, most often in shallow coastal habitat (Moore et al. 2000). Not all eastern gray whales follow this migration pattern. A small subset of the eastern population feeds in coastal water off of British Columbia, Washington, and Oregon (Calambokidis et. al. 2002, 2010). In addition, gray whale calls have been recorded throughout the winter in the Beaufort Sea near Barrow, Alaska, suggesting that some gray whales remain in Arctic waters during this season (Stafford et al. 2007).

Few gray whales have historically been recorded in the Beaufort Sea east of Point Barrow. Hunters at Cross Island took a single gray whale in 1933 (Maher 1960). A total of five gray whales (three sightings) were sighted during 30 years of the Bowhead Whale Aerial Survey Project/ASAMM aerial surveys (database available on the NOAA website). Two of these whales were seen in the Prudhoe Bay area. A single gray whale was also seen on 1 August 2001 near the Northstar production island (Williams and Coltrane 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. 2009). In 2008, a multiple species sighting of six animals consisting of bowhead and gray whales were observed during the Liberty seismic survey in Foggy Island Bay close to Narwhal Island (Aerts et al. 2008). A few gray whales have also been observed in the Canadian Beaufort Sea (Rugh and Fraker 1981), indicating that small numbers have been passing through the Alaskan Beaufort in some years. Given the infrequent occurrence of gray whales in the Beaufort Sea in summer, the probability of encountering gray whales during the OBS seismic survey is low.

3.4.2.5.4. Beluga Whale

There are five stocks of beluga whales (*Delphinapterus leucas*) in Alaska: the Cook Inlet, Bristol Bay, eastern Bering Sea, eastern Chukchi Sea, and Beaufort Sea stocks (Allen and Angliss 2013). Animals of the Beaufort Sea and eastern Chukchi Sea stocks could potentially occur in the project area. The most recent population estimate for the Beaufort Sea stock is 39,258 individuals and the eastern Chukchi Sea stock is estimated at 3,710 animals (Allen and Angliss 2013). The population estimate of the Beaufort Sea stock is based on 1992 data and the size estimate of the eastern Chukchi Sea stock arises from survey efforts in 1989 to 1991. The population trends of both stocks are currently unknown; however, based on available data, there is no evidence that the eastern Chukchi Sea stock is declining (Allen and Angliss 2013).

In spring, the Beaufort and Chukchi sea stocks of beluga whales use open leads in the sea ice to migrate from their wintering grounds in the Bering Sea to the Arctic to their respective summer grounds in the Beaufort and Chukchi seas. Most animals of the Beaufort Sea stock migrate to the Mackenzie River estuary in the Canadian Beaufort Sea where they arrive in April or May, with some animals arriving as early as March or as late as July (Braham et al. 1977). They typically stay there during July and August to molt, feed, and calve. Later in the summer, they spread out, foraging in offshore waters of the eastern Beaufort Sea, Amundsen Gulf, and other northern waters (Davis and Evans 1982; Harwood et al. 1996; Richard et al. 2001). Belugas from the Chukchi Sea stock stay in coastal areas or shallow lagoons, such as the Kasegaluk Lagoon, early in the summer. Later in the summer (after mid-July) they move offshore to forage in the ice-packed deeper waters along and beyond the continental shelf (Finley 1982; Suydam et al. 2005). Five of 23 beluga whales fitted with satellite tags in Kasegaluk Lagoon (captured in late June and early July 1998-2002) were tracked north into the Arctic Ocean venturing into 90% pack ice at 79-80°N (Suydam et al. 2005), suggesting that a significant proportion of the population may be at these high latitudes during the mid- to late-summer period. In the fall, the Chukchi and Beaufort Sea stocks both return to their wintering grounds in the Bering Sea following a deepwater route along the continental shelf break or routes farther offshore.

Beluga whales are often seen migrating in large groups (Braham et al. 1977), probably consisting of smaller, permanent social units, such as nursing groups or family units (Brodie 1989). Beluga whales feed on a variety of fish and invertebrates, their diet varying by season and location (Burns and Seaman 1985; Hazard 1988). In the summer, beluga whales feed on a variety of schooling and anadromous fish, particularly Arctic cod. Most feeding is done over the continental shelf and in nearshore estuaries and river-mouths.

In the central and eastern Beaufort Sea, most beluga whales migrate in deep offshore waters along the ice edge more than 60 miles north of the Alaskan coast, both during the spring and fall migration (Clarke et a. 2012, 2013). Relatively few beluga sightings have been recorded in the nearshore area of Prudhoe Bay. Opportunistic sightings have been recorded from Northstar Island, the Seawater Treatment Plant facility and Endicott. During the 2008 OBC seismic survey in Foggy Island Bay, three sightings of eight individuals were observed at about 3 miles east of Endicott SDI (Aerts et al. 2008). In 2013, two adult belugas were reported at MDI (Endicott) on 10 August for about 2 days. Two weeks later, a large group of belugas (no estimate provided) was seen in the same area. Observers of the ASAMM aerial survey also recorded more nearshore beluga sightings than historically seen (2013 daily flight summaries – NOAA website). Based on available information, we can expect to encounter beluga whales in or close to the survey area. However, the chance of such encounters is low during the summer period.

3.5. Fish and Fish Habitat

The short Arctic summer is a period of concentrated biological activity. Primary production is stimulated by sea ice melting in the spring. As the ice edge retreats from the shore line, an estuarine-like corridor forms in which marine invertebrates thrive and serve as prey for coastal fish and birds. The shallow, coastal waters of Simpson Lagoon in the Beaufort Sea are a complex mixture of river runoff and seawater protected by barrier islands to the east of the Colville River Delta. The intersection of diverse habitats in this area, including freshwater, estuarine, marine, tundra, and barrier islands create conditions promoting an abundance of fish and wildlife.

Fish assemblages of the Beaufort Sea coast are categorized as freshwater, marine, or migratory (MMS 2006; MMS 2007a; NMFS 2011b). Detailed biological and ecological background descriptions of these species are provided in USDOI and MMS (2002) and USDOI and BLM (2005). Freshwater fish species live in streams, rivers, and lakes within the project area. Marine species are year-round residents of the nearshore and offshore zones of the Beaufort Sea. Migratory species spend part of their lives in freshwater streams, rivers, and lakes, and part of their lives in the Beaufort Sea. This life history mechanism is known as diadromy (Myers 1949) (various forms, including anadromy and amphidromy, described below), which indicates migration between fresh and salt water.

Freshwater species (i.e. Arctic grayling) remain within river, stream, and lake systems year round, although they may be found in coastal waters during summer in areas of low salinity and occur in low numbers (Fechhelm et al., 2005). Freshwater fish species abundance and distribution are limited by the availability of winter habitat. Surface waters of the North Slope less than 6 ft in depth freeze to the bottom due to extreme winter cold temperatures; overwintering habitat for freshwater fish is limited to surface waters greater than 6 ft in depth.

Marine fishes (i.e. Arctic flounder) spend their entire lives at sea, although some species may migrate into nearshore coastal waters during summer and occur sporadically and in very low numbers (Fechhelm et al. 2005). Arctic cod, Arctic flounder, and fourhorn sculpin are the exceptions and may be abundant in the project area.

The migratory fishes category contains most of the species that are targeted for harvest. These species are widely distributed and abundant in the most productive areas during the ice-free season (i.e. the nearshore, brackish, and estuarine environments). The majority of seismic testing will take place in these productive areas, and therefore migratory fishes are the focal point of the impact assessment that follows.

3.5.1. Migratory Fish

Migratory fishes can be further categorized as either anadromous or amphidromous species. Anadromous species spawn and rear in freshwater river systems, migrate to the marine environment where they spend most of their lives, and return again to their natal streams as adults to spawn (Myers 1949; Craig 1989). Amphidromous species migrate between freshwater and coastal marine environments (Myers 1949; Craig 1989) depending on environmental conditions, season, and life stage. Amphidromous species spawn and overwinter in lakes, rivers, and streams, but migrate into coastal waters for several months each summer to feed.

Descriptions of key fish species presented below are extensions of descriptions found in USDOI and MMS (2002). Additional information on the Arctic cisco, Dolly Varden, least cisco, broad whitefish, Arctic flounder and Arctic cod is provided in the Liberty Shallow Water Seismic Survey 2008 Biological Assessment Fish and Fish Habitat (Fechhelm and Aerts 2007). More recent research on Arctic cod is presented in Section 3.5.2.1.

Four migratory fish species (Arctic cisco, least cisco, broad whitefish and Dolly Varden) have been designated as key indicator species for detecting anthropogenic impacts associated with oil and gas development in the coastal Beaufort Sea (USACE 1980; 1984), and continue to be the primary focus of Beaufort Sea fish monitoring (Fechhelm et al. 2011). BPXA fisheries studies undertaken to assess potential effects of the Endicott Causeway are the longest term studies within the project area.

3.5.1.1. Arctic Cisco

In Alaska, adult Arctic cisco (*Coregonus autumnalis*) overwinter in the lower reaches of the Colville River where salinities are brackish (Moulton and Seavey 2005). During summer, they migrate along the coast to feed and are one of the most abundant species found in the coastal waters of Prudhoe Bay and vicinity (Fechhelm et al. 2005). The NPBU project area lies well within the coastal foraging range of the Alaskan Arctic cisco population, and Arctic cisco is the most abundant anadromous species found in the NPBU project area.

No spawning runs of Arctic cisco have been documented in Alaska despite anecdotal accounts to the contrary (USDOI and MMS 2002). Beaufort Sea Arctic cisco is understood to originate from spawning grounds in the Mackenzie River system of Canada (Gallaway et al. 1983; Moulton 2002; ABR, Inc. 2007). Newly-hatched fish are transported westward by wind-driven coastal currents and take up residence in the Sagavanirktok and Colville rivers (Fechhelm et al. 2005).

Arctic cisco enter the Colville River subsistence fishery as 5 year old fish (Moulton and Seavey 2005). Arctic cisco remain associated with the Colville River until the onset of sexual maturity, beginning at about age 7, at which time they are understood to migrate back to the Mackenzie River to spawn (Gallaway et al. 1983). The coastal dispersal corridor for young Arctic cisco initially moving from Canada to the Sagavanirktok and Colville rivers pass through the NPBU project area. Adults migrating back to the Mackenzie River to spawn likewise would pass through the area.

3.5.1.2. Least Cisco

Amphidromous least cisco (*Coregonus sardinella*) in the Alaskan Beaufort Sea occur in rivers west of and including the Colville River (Craig 1989), where they are known to spawn and overwinter (Craig 1984, 1989). There are no known spawning populations along the coastline between the Colville River and Mackenzie Delta (Craig 1984). Least cisco are important for the fall subsistence fishery in the Colville River (Moulton and Seavey 2005). During the open water season, least cisco are one of the most abundant species in the Prudhoe Bay area dispersing from the Colville River along the coast (Fechhelm et al. 2005). Adults can disperse as far east as Brownlow Point (Griffiths et al. 2002). The Simpson Lagoon project area lies within the summer feeding range of this species.

3.5.1.3. Broad Whitefish

The Colville and Sagavanirktok rivers harbor spawning populations of broad whitefish (*Coregonus nasus*) (Gallaway et al. 1997; Patton et al. 1997). Broad whitefish migrate upstream as early as June and spawn upriver in September and October (Morrow 1980 as cited in Fechhelm and Aerts 2007), after which they return downriver. However, several migration strategies appear to exist: some fish will remain in the same approximate locations throughout the year, while others travel in excess of 62.1 miles between spawning and overwintering areas (Fechhelm and Aerts 2007). On the Arctic coast they overwinter in deep river channels. Broad whitefish are primarily a bottom feeder of chironomids, snails, bivalve mollusks, mosquito larvae, and crustaceans (Morrow 1980).

The broad whitefish populations of the Colville and Sagavanirktok rivers are considered to be semi-isolated, due to limited gene flow between these two stocks (Patton et al. 1997). Presumably, high salinity water (>20%) separates the two stocks. It is difficult to determine how far westward or eastward the dispersal of adult broad whitefish is, because individuals from the Colville and Sagavanirktok stocks cannot be distinguished in the field.

Life history of the broad whitefish is as complex as the habitats available for their use (Morris et al. 2006). Several migration strategies appear to exist. Some fish remain stationary residing in the same approximate locations throughout the year. Others are wide-ranging and travel in excess of 62.1 miles between spawning and overwintering areas (Fechhelm and Aerts 2007). Large broad whitefish are regularly reported to occur in the delta of the Kuparuk River, located 16.1 miles east of Simpson Lagoon, but their origin has not been determined.

Mark-recapture studies indicate some movement around the West Dock Causeway, which makes it likely that some adults in Simpson Lagoon are of Sagavanirktok River origin (Moulton et al. 1986). In all likelihood, adult broad whitefish disperse westward into eastern Simpson Lagoon. Assuming that the westward dispersal is equivalent to the known eastern dispersal limit, their coastal range is on the order of 93.2 miles.

The most restricted coastal range of any group is for juvenile broad whitefish. Because of their intolerance of high salinities, the distribution of young fish is largely restricted to the brackish waters of river deltas (Fechhelm et al. 1992) and to so-called “tapped lakes.” Tapped lakes connect to river channels through direct breaches or a series of channels running from lake to lake and eventually into a river channel (North and Ryan 1989). During summer, most yearling broad whitefish are caught between Heald Point on the west and Point Brower on the east, a distance of some 9.3 miles. Assuming a maximum seaward distribution of 2.5 miles, the primary summer feeding habitat for juvenile fish is approximately 23.1mi^2. Because of the restricted range of juvenile fish, the Sagavanirktok River Delta can be considered the primary nursery area for the Sagavanirktok River stock. The Colville River stock of juvenile broad whitefish are not well-studied, but likely distribute into a wide array of floodplain lakes, flooded gravel mines, sloughs, side channels, and estuaries downstream from the spawning location (Shestakov 1992 as cited by Carter 2010; Hemming 1989, 1992).

3.5.1.4. Dolly Varden

The Sagavanirktok River is believed to support one of the larger Dolly Varden (*Salvelinus malma*) populations in Arctic Alaska (Yoshihara 1972). Amphidromous Dolly Varden also spawn in many of the “mountain streams” between the Sagavanirktok and Mackenzie rivers (Craig 1989). Amphidromous Dolly Varden migrate considerable distances along the coast during the summer, and the extensive alongshore and open-water migrations reported for this species suggest they may be more tolerant of marine conditions than other Arctic amphidromous species. Dolly Varden have been taken as far as 9.3 miles offshore in the Alaskan Beaufort Sea (Thorsteinson et al. 1991), and dietary evidence has led to speculation that Dolly Varden feed offshore among ice floes in mid- and late summer (Fechhelm et al. 1999). The Sagavanirktok River population is characterized by a large migration soon after breakup and a return migration in late August and September (Fechhelm et al. 2005). The Sagavanirktok River Delta is, therefore, the principal migratory pathway for this stock to and from foraging and overwintering grounds.

Except for the Sagavanirktok River, none of the streams and rivers along the 372.8 miles coast between the Mackenzie and Colville rivers support migratory fish populations in the winter other than Dolly Varden (Craig 1984).

3.5.2. *Marine Fish*

3.5.2.1. Arctic cod

Arctic cod (*Arctogadus glacialis*) are the most abundant forage fish in the Arctic and one of the most northerly distributed fishes (collected near the North Pole), and they play a central role in the transfer of energy from plankton to higher-level consumers like ringed seals and polar bears (Clement et al. 2013).

Arctic cod are a pelagic cod and are adapted to close association with ice (cryopelagic) (Mecklenburg et al. 2002). They are a major consumer of plankton in Arctic waters and they are a major prey species for many marine mammals, seabirds, and some fishes (Mecklenburg et al. 2002). They can be found from brackish lagoons in river mouths to oceanic waters and occasionally form large schools. Females spawn once per lifetime and produce as many 11,900 eggs for the single spawning event which occurs in nearshore waters (Mecklenburg et al. 2002). Arctic cod larvae are pelagic.

Arctic cod is a demersal marine fish species with a circumpolar distribution (Fechhelm et al. 2009), is one of the most abundant fish species collected in coastal waters during late summer (Logerwell et al. 2010, as cited in NMFS 2011b; Rand and Logerwell 2010), and also dominates the offshore, pelagic environment (Logerwell et al. 2011).

Arctic cod are integral in the trophic pathways of Arctic marine food webs (Bradstreet et al. 1986; Craig and Haldorson 1981 Outer Continental Shelf Environmental Assessment Program [OCSEAP]; Schmidt et al. 1983 OCSEAP; and Welch et al. 1992, as summarized by Mueter and Purtil 2011). Several marine mammals and birds depend on Arctic cod as a primary prey item in the US Arctic (Mueter and Purtil 2011). Spawning in the Beaufort Sea occurs during winter under the ice (Craig and Haldorson 1981) and Arctic cod is an ice-dependent species.

The North Pacific Fisheries Management Council (NPFMC) has described the essential fish habitat (EFH) of the late juvenile and adult Arctic cod as the general distribution area located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 656.2 ft [0 to 200 meters]) and upper slope (656.2 to 1640.4 ft [200 to 500 meters]) throughout Arctic waters, and often associated with ice floes, which may occur in deeper waters (NPFMC 2009).

3.5.2.2. Saffron cod

Saffron cod (*Eleginus gracilis*) is a planktivorous fish species of the Beaufort Sea and an important prey species for marine mammals (Frost and Lowry 1984) and seabirds (Springer and Roseneau 1978). Age at maturity is not documented for the Beaufort Sea, but is 2-3 years in Siberian waters (Morrow 1980, as cited by Pirtle and Muetter, Bureau of Ocean Energy Management, Regulation and Enforcement [BOEMRE] 2011). Saffron cod move nearshore in winter for spawning along the Beaufort Sea coast and move offshore to feeding areas in summer (Schmidt et al. 1983 OCSEAP as cited by Pirtle and Muetter BOEMRE 2011).

Pirtle and Mueter (BOEMRE 2011) summarized the diet of Saffron cod inferred from other regions because diet information for this species in the Beaufort Sea is lacking. In Kotzebue Sound, Saffron cod feed on fish, mysids, and decapods (Craig and Haldorson 1981 OCSEAP, as cited by Pirtle and Muetter BOEMRE 2011). In Siberian waters, prey items include fish, mysids, amphipods, and polychaetes (Morrow 1980, as cited by Pirtle and Muetter BOEMRE 2011). This species is not abundant in the Beaufort Sea (Craig and Haldorson 1981 OCSEAP; Schmidt et al. 1983 OCSEAP, as cited by Pirtle and Muetter BOEMRE 2011).

Saffron cod are found in Prudhoe Bay throughout the year (Smith 2010). In the summer, they are found both nearshore and offshore, and in rivers; however, in summer surveys they were found to be the least abundant species that move nearshore (Fechhelm et al. 2011).

3.5.2.3. Pacific salmon

Pacific salmon EFH includes the OCS of the Beaufort Sea, which extends from the coastline to 200 nautical miles offshore (NMFS 2011a). Logerwell (Logerwell et al. 2010, as cited in NMFS 2011b) did not capture any salmon in the western Beaufort Sea fish survey of summer 2008, and only three pink salmon (*O. gorbuscha*) were caught in 2011 (Fechhelm et al. 2011). The Sagavanirktok River Delta is not a known spawning ground for pink or chum salmon (*O. keta*) (Smith 2010). Based on the minimal detected presence of salmon in the general project area during the summer, they will not be assessed further in this report.

3.5.2.4. Arctic Flounder

The Arctic flounder (*Liopsetta glacialis*) is a circumpolar, demersal, marine fish species typically found in shallow coastal waters during summer (Walters 1955; Morrow 1980; Scott and Crossman 1973). Arctic flounder do not undertake extensive migrations, but live permanently near the coast. They spawn beneath the ice from January to March, remain in marine waters just adjacent to the bottomfast ice in winter, and then migrate toward the shore with the retreat of bottomfast ice during summer. Arctic flounder are abundant in brackish water (Craig 1984), but have also been reported to move considerable distances upriver (Morrow 1980).

3.5.2.5. Fourhorn Sculpin

Fourhorn sculpin (*Myoxocephalus quadricornis*) is another demersal marine fish species that is abundant in Beaufort Sea coastal waters. The home range of fourhorn sculpin includes deep waters not frequented by anadromous or amphidromous species (Griffiths et al. 1997) and occasional forays into freshwater where they have been reported as far as 89.5 miles upstream in the Meade River (Morrow 1980), which flows into the Arctic Ocean east of Point Barrow.

3.5.3. Essential Fish Habitat

The Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996, is the federal law that governs United States marine fisheries management. The act requires federal agencies to consult with the NOAA, NMFS on activities that may adversely affect EFH. EFH is defined in the Magnuson-Stevens Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.

In 2009, the Arctic Fisheries Management Plan (AFMP) was developed by the NPFMC for fish in the Chukchi and Beaufort seas (NPFMC 2009; 74 CFR 56734). Increasing water temperatures, changes in fish stock distributions, and changes in ice cover could favor development of commercial fisheries in AFMP waters. The current policy prohibits commercial fishing in the Chukchi and Beaufort seas until there is sufficient information available to enable sustainable management of commercial fisheries in the Arctic (NPFMC 2009; 74 CFR 56734).

EFH is designated in the Arctic Ocean for snow crab (*Chionoecetes opilio*), saffron cod (*Eleginus gracilis*), Arctic cod (*Arctogadus glacialis*) and pacific salmon (*Oncorhynchus*) (NPFMC 2009). Of these, Arctic cod is the only species in the Arctic Management Area for which designated EFH extends into the study area. In addition, nearshore and marine EFH has been designated for all five species of pacific salmon: pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), Chinook (*O. tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon.

Arctic populations of snow crabs may occur in the project area but information is lacking on this species of crustacean.

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4. CULTURAL RESOURCES

Cultural resources on the North Slope include sites and materials of prehistoric Native American, historic European, Euro-American, and historic Iñupiat origin. The archaeological record in the region extends from 7,000 years before present in the Prudhoe Bay area, to more than 10,000 years before present in the Brooks Range south of the ACP. Sources of information about cultural resources include: Alaska Heritage Resources Survey, maintained by the Alaska Department of Natural Resources (ADNR), Office of History and Archaeology; Traditional Land Use Inventory, maintained by the NSB (ADNR 2005; NSB 2003); and reports associated with oil and gas exploration and development.

4.1. Communities

The three main human settlements nearest to the project site are Nuiqsut, Deadhorse, and Kaktovik. The village of Nuiqsut is an Iñupiat community of more than 400 people located at the head of the Colville River Delta, about 35 miles inland from the Beaufort Sea coast and approximately 50 miles west of the project area. Nuiqsut residents maintain a very strong attachment to their subsistence hunting and fishing lifestyle, and they harvest a significant portion of their food from local sources, including fish, caribou, bowhead whale, seal, and waterfowl.

Kaktovik is in the ANWR on the north shore of Barter Island, on the Beaufort Sea coast. It is the easternmost community in the NSB. Like Nuiqsut, Kaktovik residents maintain a very strong attachment to their subsistence hunting and fishing lifestyle, and harvest a significant portion of their food from local sources including fish, caribou, bowhead whale, seal, and waterfowl.

Deadhorse is an unincorporated community within the NSB. Essentially a large work camp for the oil industry, Deadhorse consists mainly of facilities for the workers and companies that operate in Prudhoe Bay and Kuparuk oil fields. The Deadhorse Airport, which is owned and operated by the State of Alaska, provides support to Prudhoe Bay operations and oil exploration and production activities. Alaska Airlines and oil company charters provide daily service to Deadhorse from Anchorage and Fairbanks. About 648 tons of cargo is transported by air to the North Slope annually (USACE 1999).

4.2. Land Ownership

Land and water surfaces in the project area are owned and managed by the State of Alaska. The project area is within the NSB.

4.3. Demographics

The NSB is the largest borough in Alaska, comprising 15% of the state. The borough includes eight villages: Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright. The 2010 Census listed 9,430 people residing in the borough. This represents a 27.7% increase in borough population from 2000 to 2010, a period in which the population of the State of Alaska as a whole increased by 13.3%. There are 2,049 households residing in the entire borough. There is roughly one person per 9.5 mi^2. The ethnic makeup of the borough is 33.4% Caucasian, 1.0% African American, and 54.1% Native American, of which most are all or partly Iñupiat. The remainder of the NSB population is Asian (4.5%), Hawaiian or other Pacific Islander (1.1%), persons reporting two or more races (5.2%), and Hispanic (2.6%) (quickfacts.census.gov/qfd/states/02/02185.html).

The Village of Nuiqsut is home to 402 people according to the United States Census Bureau 2010 data (quickfacts.census.gov/qfd/states/02/02185.html). There are approximately 246 residents in Kaktovik (United States Census Bureau 2013).

4.4. Government Institutions

The NSB, which is the main local government institution on the North Slope, provides most community services (i.e., municipal services, police, education, etc.) to residents in each village.

The NSB receives 97% of its revenue from property taxes on oil and gas activities. Most NSB communities have local governments that provide services to their community. These include Alaska Native Claims Settlement Act village corporations, traditional village councils, Indian Reorganization Act councils, and city governments. Nuiqsut's village corporation is the Kuukpik Corporation. Kaktovik Inupiat Corporation is the village corporation in Kaktovik.

Non-governmental organizations with interests in the project area include the Alaska Eskimo Whaling Commission, Iñupiat Community of the North Slope, and Kuukpikmiut Subsistence Oversight Panel, Inc.

4.5. Economy

Development of the oil fields around Prudhoe Bay has influenced the economy of the North Slope. The oil and gas industry is an important sector in the Alaskan and North Slope economies, providing substantial revenues to the state and the NSB. Economic activities in the region are driven primarily by oil field activities and by government employment (MMS 2002). Other economic contributors include the construction sector, tourism, manufacturing, commercial fishing, and native arts.

Per capita household incomes have increased on the North Slope to an average of $75,057.00 per year, which is greater than the state average of $66,712.00 per year (data from 2010 census; quickfacts.census.gov/qfd/states/02/02185.html). These increases, however, have been offset by the high cost of living in the region. Subsistence resources continue to be of economic and cultural importance to residents of the NSB (Arctic Slope Regional Corporation 2004). However, the adoption of modern technology through a mixed economy has raised the cost of participating in subsistence activities. The overall qualities of life within NSB communities have improved, and the percentage of families with income below the poverty line (7.8%) is less than the percentage of families with income below the poverty line in the State of Alaska (9.1%) (data from 2010 census; quickfacts.census.gov/qfd/states/02/02185.html).

4.6. Subsistence

Subsistence uses are central to the customs and traditions of indigenous peoples in Alaska. Subsistence customs and traditions encompass processing, sharing networks, cooperative and individual hunting, fishing, gathering, and ceremonial activities. These activities are guided by traditional knowledge based on a long-standing relationship with the environment. Both federal and state regulations define subsistence uses to include the customary and traditional uses of wild renewable resources for food, shelter, fuel, clothing, and other uses (Alaska National Interest Lands Conservation Act, Title VIII, Section 803, and Alaska Statute 16.05.940[33]). The Alaska Federation of Natives not only views subsistence as the traditional hunting, fishing, and gathering of wild resources, but also recognizes the spiritual and cultural importance of subsistence in forming native peoples' worldview and maintaining ties to their ancient cultures (Alaska Federation of Natives 2005).

Subsistence hunting and fishing are traditional activities that include transmitting traditional knowledge between generations, maintaining the connection of people to their land and environment, and supporting healthy diet and nutrition in rural communities in Alaska. The ADF&G estimates that the annual wild food harvest in the Arctic is approximately 10.5 million pounds, or 516 pounds per person per year (Wolfe 2000). Subsistence harvest levels vary widely from one community to another, as well as from year to year. Sharing of subsistence food is common in rural Alaska and can exceed 80% of households giving or receiving resources (ADF&G 2011). The term harvest and its variants, harvesters and harvested, are used as the inclusive term to characterize the broad spectrum of subsistence activities, including hunting, fishing, trapping, and gathering.

Subsistence resource harvests differ among communities and may include bowhead whales, seals, polar bear, caribou, and fish. Whaling is important to the Iñupiat, but caribou and fish are the most essential overall subsistence resource in terms of number of animals harvested and consumed.

Subsistence is part of a rural economic system called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (Wolfe 2000). According to Wolfe and Walker (1987), fishing and hunting for subsistence resources provide a reliable economic base for rural regions and these important activities are conducted by domestic family groups who have invested in fish wheels, gillnets, motorized skiffs, and snow machines. Subsistence is not oriented toward sales, profits, or capital accumulation (commercial market production), but is focused on meeting the self-limiting needs of families and their extended kin and communities. Participants in this mixed economy in rural Alaska augment their subsistence production by cash employment. Cash (from commercial fishing, trapping, and/or wages from public sector employment, construction, firefighting, oil and gas industry, or other services) provides the means to purchase the equipment, supplies, and fuel used in subsistence activities. The combination of subsistence and commercial wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987). As one North Slope hunter observed: “The best mix is half and half. If it was all subsistence, then we would have no money for snow machines and ammunition. If it was all work, we would have no native foods. Both work well together” (Alaska Consultants, Inc. et al. 1984).

Participation in subsistence activities promotes transmission of traditional knowledge from generation to generation and serves to maintain peoples’ connection to the physical and biological environment. The subsistence way of life encompasses cultural values such as sharing, respect for elders, respect for environment, hard work, and humility. In addition to being culturally important, subsistence is a source of nutrition for residents in areas of Alaska where food prices are high. While some people earn income from employment, these and other residents rely on subsistence to sustain them throughout the year. Furthermore, subsistence activities support a healthy diet and contribute to residents’ overall well-being.

Subsistence is regulated in multiple ways, including federal and state regulations, local traditions, norms, and values that guide subsistence hunting and fishing practices. The federal and state governments regulate subsistence hunting and fishing in the state under a dual-management system. The federal government recognizes subsistence priorities for rural residents on federal public lands, while Alaska considers all residents to have an equal right to hunt and fish when resource abundance and harvestable surpluses are sufficient to meet the demand for all subsistence and other uses.

Historically, the North Slope has been inhabited by indigenous Iñupiat populations, which are comprised of two primary culture groups. The Tagiugmuit inhabited coastal areas of the ACP and the Nunamiut inhabited the Brooks Range and Arctic Foothills areas. Iñupiaq is the language spoken by both North Slope cultural groups, as well as in other areas of Alaska. Coastal Iñupiat (Tagiugmiut) relied primarily on harvests of marine mammals, terrestrial mammals, and fish, while their inland neighbors, the Nunamiut relied mostly on terrestrial mammals and fish, with caribou comprising the majority of their subsistence harvests.

Iñupiat are still the primary occupants of the North Slope today and continue the hunting and harvesting traditions of their ancestors. Local residents often harvest subsistence resources from specific camps that are situated in locations that provide multiple resource harvest opportunities throughout the year. Harvest activities tend to occur near communities, along rivers and coastlines, or at particularly productive sites where resources are known to occur seasonally. Determining what, where, and when a subsistence resource will be harvested is based on traditional knowledge about the distribution, migration, and seasonal variation of animal populations, as well as various other environmental factors (e.g., tides, currents, ice, and snow conditions).

While some harvest locations may be used infrequently, they can still be important to a subsistence user or a community if they are particularly productive areas, or if they have cultural, historical, or family significance to the user (USDOI and BLM 1978). Prior to the 1950s, when mandatory school attendance and economic factors, such as a decline in fur prices, compelled families to permanently settle in one of a few centralized communities, the Iñupiat were highly mobile and ranged over large geographic areas for trapping, fishing, gathering, sealing, and bird hunting activities. Contemporary subsistence use areas include many of these former areas. The advent of snow machines and all-terrain vehicles, including four-wheelers, have reduced the time required to travel to traditional hunting and harvesting areas, but have also increased the need for cash employment to pay for purchases, maintenance, and supplies for the new equipment (Ahtuangaruak 1997; Impact Assessment, Inc. 1990a and 1990b; Stephen R. Braund and Associates (SRB&A) and Institute of Social and Economic Research 1993; Worl and Smythe 1986). The nomadic land use patterns once typical of North Slope Iñupiat have evolved to the use of base camps consisting of tent platforms, cabins, and/or caches located near productive resource bases. Residents conduct subsistence hunting, harvesting, and processing activities from these locations (Impact Assessment, Inc. 1990b; SRB&A 2010).

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5. CONSEQUENCES AND MITIGATION

The following section provides an assessment of potential impacts that may result from the proposed project activities described in Section 1. Direct and indirect effects of project activities are evaluated for each resource, while cumulative impacts are evaluated only for resources that could result in impacts greater than negligible. As such, given there are no impacts anticipated to permafrost, soils, hydrology, or cultural resources, cumulative impacts are not further evaluated for these resources. The cumulative impact assessment specifically considers the potential contribution of the NPBU project in light of the proposed 2014 Liberty 2D Shallow Geohazard Survey tentatively scheduled for the same general timeframe as well as ongoing operations in the Prudhoe Bay area.

5.1. Physical Environment

5.1.1. Geology

Alaska's North Slope is underlain by deep, continuous permafrost that extends to depths of approximately 2,000 ft, the deepest occurring near Prudhoe Bay (National Research Council 2003). Permafrost is separated from the ground surface by an insulating active layer that thaws each summer to depths ranging from 8 inches to 6.5 ft.

Autonomous nodes will be located on the ground surface and the geophone(s) will be inserted approximately 3 ft below ground surface. Geophone installation will be either by hand using a planting pole or will be inserted into 1.5-inch diameter holes made with a hand-held drill. The nodes will only be placed in the active layer. On completion of recording operations in a particular area, land crews will retrieve the nodes. There are no anticipated impacts to the permafrost from installation and removal of the nodes.

5.1.1.1. Soils

Impacts to soils during project activities are expected to be non-existent. All geophone installation will either be by hand using a planting pole or will be inserted into 1.5 inch diameter holes made with a hand-held drill. On completion of recording operations in a particular area, land crews will retrieve the nodes. There are no anticipated impacts to soils from installation and removal of the nodes.

5.1.2. Air Quality

All equipment used for the project will be mobile, non-stationary equipment and will only be at the project locations for a short period of time. Each engine will meet the regulations for engine emissions (40 CFR Part 86 for on-road engines and 40 CFR Part 89 and 90 for non-road engines), and each piece of equipment will be operated according to manufacturer's recommendations to minimize emissions. In addition, ULSD fuel will be burned in diesel engines. Due to the short duration, equipment will be at the project sites and in compliance with regulations and operating procedures designed to reduce emissions, so the impact from the project on air quality in the area will be minimal.

Daily production and maintenance operations within the greater Prudhoe Bay area are under strict air emissions standards so as not to exceed compliance thresholds. The proposed Liberty 2D Shallow Geohazard Survey will use one vessel supported by a small number of support transportation (i.e., truck/van) that are not likely to result in notable impacts to air quality in the area given the survey would be a temporary activity. The potential contribution of NPBU project activities to cumulative impacts on air quality would likely be minimal given the mobile and temporary nature of the equipment when combined with potential effects from ongoing Prudhoe Bay operations and the proposed Liberty 2D Geohazard Survey.

5.1.3. Hydrology

The presence of perennial frozen soils and ice during breakup can cause a variety of hydrologic/surface flow conditions that are difficult to predict and may change over time and year to year. The project will not affect in-stream or overland flow, equilibrium, and hydraulic connections between and within wetlands; therefore, there will be no impacts to the existing hydrology.

5.1.3.1. Lower Sagavanirktok River and Sagavanirktok Delta

Areas in the Sagavanirktok River Delta will have receivers installed in holes up to 6 ft deep. In river areas, storm surge, snow melt, and high precipitation events resulting in fluctuating water levels may not allow the use of autonomous nodes. Some of the shallow delta areas and surf zone areas may be recorded on autonomous nodes using specially designed floats anchored to the bottom to record the data. If waterproof (floating) autonomous nodes are used in these fluctuation areas, they may need to be weighed down to prevent movement. A line marked by either a float or survey lathe will be attached to the receivers to facilitate removal. Receivers that are installed below the ground surface may require flushing using warmed water to further assist removal of the receiver. Support poles may be placed in water less than 18 inches deep and in tidal surge areas as needed to ensure that the nodes stay above surface waters to prevent them from becoming inundated as a result of fluctuating water levels.

If conditions allow, an advance crew may install geophones in the Sagavanirktok River Delta portion of the survey area in late winter. This crew would work for up to 30 days, beginning in April until tundra closure. Two tracked utility vehicles would drill in receivers and a support vehicle would provide logistics. Approximately 15 people may work two shifts during a 24-hour per day period. The DGPS location of the geophones will be recorded and survey lathe or markers would be used to assist in marking the location. The receivers would be connected to recording nodes during the main OBS survey time (July - August).

Impacts to the Sagavanirktok River Delta could include: disturbance of existing vegetation, which may induce hydraulic or thermal erosion; fuel spills, which may impact water quality; wildlife resources; fisheries; and disruption of polar bear denning.

The following are measures that BPXA will take to mitigate these potential effects:

- Facilities (e.g., docks and gravel pads), to the extent practicable, will not be sited within 1,500 ft of current surface drinking water sources or within 0.5 mile of the banks of a main river channel;
- In December 2013, an aerial survey using FLIR to detect maternal polar bear dens was conducted. During the survey, no polar bear dens were identified in the project area. If a den is discovered at a later date it will be immediately reported to USFWS. Occupied dens will be avoided by a one-mile radius in accordance with the LOA from the USFWS and BP's Polar Bear Interaction Plan.
- Node locations will be pre-surveyed to minimize surface disturbance;
- No access to the delta from vegetated banks;
- Areas of established vegetation will be avoided by project vehicles;
- To minimize surface disturbance, access will follow a one-way-in and one-way-out protocol;
- Helicopters will be used to avoid surface disturbance;
- River channels will be crossed perpendicular from bank to bank;
- Fueling will utilize existing roads and pads to the extent practicable;
- Double walled tanks or drums with overpacks will be used to transport fuel on the floodplain;
- Pre-designated fueling areas will be used to the extent practicable; and
- No fueling will be conducted within 100 ft of flowing waters of the Sagavanirktok River.

5.1.3.2. Channel Patterns

There are no anticipated impacts to channel patterns by the proposed project activities.

5.1.3.3. Groundwater

Project plans do not include utilizing any ground water; therefore effects on groundwater are not anticipated.

5.1.3.4. Lakes

The proposed project plans include placing marine node receivers in the larger lakes in the project area. The node receivers will be deployed by hand from Zodiac-type boats. The boats, nodes, and crews will be transported via helicopter to and from the lakes.

There are no plans to install subsurface anchors. Installation of nodes on the lake bottom could result in temporary suspension of sediments. Suspended sediments would be localized (within a few feet diameter of the activity) and would only be temporary. Therefore, impacts to the substrate are not anticipated during node installation in the lakes.

If liquid fueled motors are not used during this activity, there are no anticipated impacts to lakes. If gasoline engines are used, all fueling will be conducted away from the water's edge, following BPXA's fueling procedures. The engine to be used will be a four stroke, therefore reducing any introduction of hydrocarbons to the water. There are no anticipated effects from operating a motor during deployment or recovery of the nodes in the larger lakes.

5.1.3.5. Water Quality

The accidental release of fuels in the project area may result in impacts to water quality. Vessels will be fueled offshore by contractor-supplied or contracted vessels, or from shore-based locations at West Dock, East Dock, or other designated areas in the NPBU. Fuel transfers in the Sagavanirktok River Delta will require agency authorization. All fuel transfers will be conducted in accordance with applicable regulatory requirements. Due to the strict requirements described below for secondary containment during refueling, potential impacts of a fuel spill are minimal because the likelihood that fuel would be released outside secondary containment is extremely small.

Installation of nodes in the Sagavanirktok River Delta may result in disturbance of sediments. However, given the short-term nature of the installation of nodes, the activity would not result in notable changes to water quality in the area.

The following are measures that BPXA will take to mitigate potential water quality effects:

- Secondary containment will be provided for the storage of fuel or hazardous substances;
- No fuel storage will occur within 1,500 ft of a drinking water source or within 100 ft of a water body;
- Drip pans or other impervious liners will be used for activities in which fuel or hazardous substances could potentially be released;
- Appropriate spill response equipment will be on-hand during any fuel transfer operation; all fuel transfer operations will be observed by trained personnel;
- Vehicle refueling will take place on existing gravel pads as practicable;
- Double-walled tanks will be used to transport fuel on the floodplains;
- Pre-designated fueling areas in floodplains will be used to the extent practical;

- No fueling will be conducted within 100 ft of flowing waters of the Sagavanirktok River or Putuligayuk River; and
- Nodes will not be deployed in the main river channels.

5.2. Biological Environment

5.2.1. Vegetation and Wetlands

The proposed project was designed to minimize impacts to wetlands and vegetation. Access to vegetated areas will be from the existing road system, exposed beaches, or by helicopter. Nodes will be staged by helicopter or boats. The receivers will be installed by a team on foot, eliminating vehicle traffic on tundra. The team will use a hand-held drill to bore into the tundra, approximately 3 ft deep, and geophones will be placed in the ground, impacting a diameter of 1.5 inches of vegetation and wetland at each site. This equipment will be removed after the patch is surveyed. Once removed, the small amount of disturbed vegetation and soil will be placed back into the borehole. No fueling of vehicles or helicopters will occur on the tundra.

The following are measures that BPXA will take to mitigate potential effects to vegetation and wetlands:

- Keep foot traffic to a minimum for placing nodes; and
- Disturbed vegetation and soils will be used to backfill the holes after removing the nodes.

5.2.2. Boulder Patch

There are no impacts anticipated to the Boulder Patch because seismic equipment (nodes) will not be deployed in the identified Boulder Patch areas (Figure 1).

5.2.3. Birds

During the proposed seismic survey, associated processes, including airgun sounds, vessel activity and node deployment and retrieval, may impact birds. Because the open water season coincides with both the breeding and molting season, there is a chance for disturbance of birds during the nesting, brooding, and molting phases, in addition to feeding and migration.

Birds susceptible to disturbance during nesting may face temporary or permanent nest abandonment. Disturbance following the nesting phase may influence adults to move to less productive brooding areas. Also, birds in molting phase may be displaced from optimal resting and foraging locations. These disturbances could result in decreased nest success, extended molting periods and lower survival rates in young.

Disturbance to nests

Mobilization, deployment, and retrieval of seismic survey equipment onshore would involve helicopter mobilization and crews on foot placing equipment. The presence and noise from these seismic activities could cause both temporary and/or permanent nest abandonment. Temporary nest abandonment by adults may increase predation risk to nests. Nests occurring nearshore or in low-lying elevation areas such as spits and barrier islands have potential to be impacted by both vessel travel and crews on foot, the propagation of noise by airgun use, and by crews deploying receivers. However, nests located on islands with higher elevations tend to be impacted to a lesser degree (Rodrigues et al. 2007). Nesting birds may become accustomed to the noise and presence as the survey trends from a distance to closer proximity of the nesting location.

Vessel activity will occur offshore throughout the seismic project area, including shallow waters near shore. Airguns are operated in water depths of 3 ft and greater. To conduct surveys in these shallow water areas, the airgun array is placed in close proximity to the seafloor; at these shallow depths, air bubbles released will cause surface disruptions, but are not expected to disturb nesting activities (Rodrigues et al. 2007).

The majority of node deployment and retrieval activities onshore are scheduled to occur during the 2014-nesting season. An estimated 11 rotary events (helicopter operational activities) per mile are predicted for the project (660 rotary events total during the nesting season). Activities will include:

- equipment drop, deployment and retrieval; and
- crew drop off and pick up.

Islands with known nest colonization, Reindeer, Howe, Niakuk, and Gull have been omitted from the onshore survey to eliminate the possibility of any nest disruption. A survey by avian biologists will be conducted prior to onshore seismic survey activity to identify and mark nest locations on seismic lines and to establish buffer zones around each discovered nest location.

Disturbance of brood rearing, molting and feeding birds

During mobilization, deployment, and retrieval of receivers in areas where birds are actively molting or foraging, activities may cause displacement from preferential habitat to other areas. It is suggested by Rodrigues et al. (2007) that these short-term, temporary activities are unlikely to significantly impact molting birds and they will move back to preferred habitats after the crew has moved on.

There is an energetic cost for birds to repeatedly move away from survey activity disturbances or altered foraging opportunities (USDOI, Bureau of Ocean Energy Management [BOEM] 2013). In spite of this, the disturbance effects will likely be temporary and localized.

Noise caused by the use of the airguns during seismic surveys results in both horizontal and vertical sound propagation in the water. Diving birds are more likely to be affected by seismic noise than birds on or above the surface (LGL 2001). Studies of underwater seismic surveys on flightless long-tailed ducks (*Clangula hyemalis*) indicated that the surveys did not have noticeable effects on behavior in this bird species (Lacroix et al.

2003). There is potential for birds to be injured by an airgun pulse if the bird is in very close proximity, for example, less than 7 ft from an operating airgun. This would likely be a rare event because birds tend to avoid the general vicinity of the operating vessels and active airguns (USDOI, BOEM 2013).

Overall, seismic survey activities may cause localized, temporary displacement and disruption of nesting, feeding, or resting of some species (Rodrigues et al. 2007).

Effects on food availability

Waterfowl, loons, shorebirds, and seabirds potentially found in the survey area feed primarily on benthic invertebrates and other aquatic organisms, while loons feed on marine fish species. As described in the Section 5.2.6, project activities are expected to have negligible effects on benthic and fish populations, and thus, are not expected to significantly impact the availability of avian food sources.

Stress, injury, and mortality

Many seabird species fly at low altitudes over water (Johnson and Richardson 1982, as cited in Rodrigues et al. 2007), so the potential exists for these birds to collide with vessels, especially during inclement weather or darkness. Also, potential for unintentional attraction to lights used in low light or bad weather conditions can amplify the risk of collision. Although this impact would be unusual as there will be no periods of darkness in the survey area until approximately mid-August and seismic source activities are scheduled for completion by the historical 25 August CAA date.

Collisions with flightless molting flocks of seabirds are unlikely as birds will generally avoid slow moving, operating seismic vessels (USDOI - BOEM 2013), even with limited visibility due to poor weather conditions (Rodrigues et al. 2007). Bird collisions during flight in fog or bad weather conditions are possible; however, the small working vessel and slow travel speeds decrease the chance for collisions. The potential for bird mortality as a result from vessel collisions is not expected to occur and is unlikely to have significant effects on marine bird populations.

Overall, the effects of disturbance, injury/mortality and potential changes in habitat for marine and coastal birds would likely be temporary and localized, and are unlikely to have population-level effects for any of the localized species.

Mitigation

Based on the expected seismic sound exposure during the proposed survey activities, the extent of the impact at the population level is expected to be minimal. The following mitigation measures have been included in the design of the survey to reduce any potential impacts to the localized avian habitats:

- Islands with known nest colonization, Reindeer, Howe, Niakuk, and Gull have been eliminated from the survey;

- An extensive nest survey by avian biologists is planned to be conducted in all portions of the seismic survey area during the nesting period when active nests are anticipated. Each discovered nesting location will be identified and marked for the establishment of buffer zones. The avian biologist will transit to and from sites utilizing the road system or by boat prior to any rotary activity;
- A buffer of 100 ft will be established around all identified threatened, endangered, and candidate listed bird species nests for all land-based project associated activities, to include helicopter activities;
- Crew awareness training to avoid wildlife interactions and maintain distance from wildlife. Ground-based crews that encounter flocks of flightless/molting birds will avoid blocking access to an escape route and divert around flocks;
- Airgun ramp up, power down, and shut down procedures will be utilized; and
- Vessels and aircraft operators will maneuver to avoid high-density areas whenever possible.

5.2.3.1. Steller's and Spectacled Eider

Steller's and spectacled eiders are the only species of birds that may occur in the project area that are listed under the Endangered Species Act. Therefore, the following discussion singles out these species and discusses their potential impacts.

The proposed activities may result in disturbance of nesting females and young broods. The severity of disturbance and displacement effects depends upon duration, frequency, and timing of the disturbing activity. Disturbance that results in agitated behavior, flushing, or other movements in response to a stimulus can increase energy costs, especially for birds that are already energetically stressed from cold, lack of food, or physiologically demanding life cycle stages such as reproduction. Birds may be displaced from preferred habitats to areas where resources are less abundant or are of lower quality. Furthermore, eggs exposed by flushed hens or ducklings separated from their brood become more vulnerable to predation. Not all flushes would result in a nest being abandoned or depredated. The likelihood of nest abandonment or depredation resulting from aircraft landings and on-tundra activities probably varies among sites based on the number of aircraft landings during the nesting season and the intensity and duration of activities at each site. For example, a site visit that includes one helicopter landing of 15 minutes may result in a lower likelihood of nest abandonment than a site visit requiring several landings and 8-10 hours of on-tundra activity; however, the difference is difficult to quantify. Data from the Y-K Delta indicates that nest disturbance from human activity decreases spectacled eider nest survival rate by 4% (Bowman and Stehn 2003) and 14% (Grand and Flint 1997). For the proposed action, the majority of terrestrial disturbance events are expected to be attributed to aircraft landings and on-land activities.

Aircraft landings and on-tundra activities

It is difficult to assess the disturbance area within which listed eiders would be flushed by an aircraft landing; however, the USFWS has calculated disturbance using available data for their 2012 Biological Opinion for industry related activities on the ACP (USFWS 2012). The USFWS anticipates a gradient of effect centered on the landing site. A landing close to a nest would likely flush a female and prevent her from returning for as long as the aircraft, and the associated human activity, remains near the nest. The likelihood of a hen flushing and her reluctance to return to the nest likely decreases as distance from the landing site increases. For the purposes of calculating incidental take, the USFWS assumed that all hens within an estimated radius of a landing site would be flushed, and hence their nests would be at risk from abandonment or depredation (USFWS 2012).

Effects on food availability

Eiders potentially found in the survey area feed primarily on aquatic insects, crustaceans, aquatic plants and seeds, and benthic invertebrates. As described in Section 5.2.6, project activities are expected to have negligible effects on benthic and fish populations, and thus, are not expected to significantly impact the availability of avian food sources.

Stress, injury, and mortality

Eiders fly at low altitudes over water (Johnson and Richardson 1982, as cited in Rodrigues et al. 2007), so the potential exists for these birds to collide with vessels, especially in inclement weather or darkness. Also, potential for unintentional attraction to lights used in low light or bad weather conditions can amplify the risk of collision, although this impact would be unusual as there will be no periods of darkness in the survey area until approximately mid-August and seismic source activities are scheduled for completion by the historical 25 August CAA date.

Collisions with flightless, molting flocks of eiders are unlikely, as birds will generally avoid slow moving, operating seismic vessels (BOEM 2012; NMFS 2011b) even with limited visibility due to poor weather conditions (Rodrigues 2007). Bird collisions during flight in fog or bad weather conditions are possible; however, the small working vessel and slow travel speeds decrease the chance for collisions. The potential for bird mortality as a result of vessel collisions is not expected to occur and is unlikely to have significant effects on spectacled or Steller's eider populations.

Overall, the effects of disturbance, injury/mortality, and potential changes in habitat for eiders would likely be temporary and localized, and are unlikely to have population-level effects for any of the localized species.

Mitigation

Mitigation for eiders would not be different than for any of the other bird species with one notable exception. Should a threatened, endangered, or candidate listed eider species' nest be discovered the buffer zone will be extended to 100 ft to help minimize disturbance.

5.2.3.2. Cumulative effects on Birds

Daily BPXA production and maintenance operations within the greater Prudhoe Bay area follow existing wildlife procedures, the North Slope Environmental Handbook, and the project-specific mitigation plan for minimizing potential impacts on resources, including birds. Operations and maintenance for oilfield production has been ongoing in Prudhoe Bay for nearly 30 years and many wildlife species, including birds, are likely to be habituated (on some level) to these activities or they have the ability to move to areas that are not disturbed by human activity.

The proposed Liberty 2D Shallow Geohazard Survey would likely require the use of one vessel supported by a small number of support transportation (i.e., truck or helicopter). The geohazard survey would be a temporary activity and although it does have the potential to disturb molting birds offshore, these impacts would only occur during the relatively short survey (approximately 4-6 weeks) and thus would not likely cause population level effects. The potential contribution of NPBU project activities to cumulative impacts on birds relates to two key concerns: 1) potential for molting birds to be moved back and forth between the offshore Liberty and NPBU surveys, resulting in a higher level of energy expenditure and increased stress; and 2) nest destruction or abandonment from NPBU terrestrial activities combined with ongoing Prudhoe Bay production and maintenance operations. The proposed Liberty survey would likely implement similar mitigation measures for birds (as they apply to offshore activities) as proposed for NPBU and thereby minimize potential impacts to the extent practicable. Population level cumulative impacts resulting from the NPBU seismic survey, Liberty geohazard survey, and ongoing Prudhoe Bay operations and maintenance are expected to be minimal considering that each project will implement strict mitigation measures to avoid and minimize interactions with birds or their nests.

5.2.4. Terrestrial Mammals

Disturbance

Animal behavior has evolved to optimize survival, and a key component of survival is minimizing energy expenditure. Therefore, disturbance is likely to increase energy expenditure if an animal flees from an area of optimal habitat, resulting in potentially decreased fitness and overall survivorship of that individual and their young, if present. During the proposed seismic survey, associated processes including nearshore activity and node deployment and retrieval may impact terrestrial mammals. Activities associated with this project may cause interruptions in feeding and may cause individuals to move on from areas of insect relief.

Attraction

Many predatory mammals on the ACP exhibit opportunistic feeding behaviors, an intelligent strategy that entails a high degree of curiosity and exploratory behavior. Curiosity is advantageous in young individuals who lack refined hunting and food-seeking abilities. Bears are very curious and it is normal for them to investigate anything that is new and or unusual. The temporary placement of acoustic receivers for the project may attract curious individuals, in particular young brown or polar bears. Animal attraction may impact the project by causing interruptions in data collection due to play with or investigation of the units.

Mitigation

Based on the expected seismic sound exposure during the proposed survey activities, the extent of the impact is expected to be minimal andno population level impacts are expected.

The following mitigation measures have been included in the design of the survey to reduce any potential impacts terrestrial mammals.

- Crew awareness training to avoid wildlife interactions and maintain distance from wildlife. Ground based crews that encounter terrestrial mammals will avoid blocking access to an escape route; and
- Aircraft operators will maneuver to avoid high density areas whenever possible.

Cumulative Impacts on Terrestrial Mammals

Daily BPXA production and maintenance operations within the greater Prudhoe Bay area follow existing wildlife procedures, the North Slope Environmental Handbook, and the project-specific mitigation plans for minimizing potential impacts on resources including terrestrial mammals. Operations and maintenance for oilfield production has been ongoing in Prudhoe Bay for nearly 30 years and many terrestrial mammals are likely to be habituated (on some level) to these activities or they have the ability to move to areas that are not disturbed by human activity.

The proposed Liberty 2D Shallow Geohazard Survey would likely require the use of one vessel supported by a small number of support transportation (i.e., trucks/vans). Therefore, impacts to terrestrial mammals are not anticipated. Population level cumulative impacts resulting from the NPBU seismic survey, Liberty geohazard survey, and ongoing Prudhoe Bay operations and maintenance are expected to be minimal considering that each project will implement strict mitigation measures to avoid and minimize interactions with terrestrial mammals.

5.2.5. Marine Mammals

Potential impacts to marine mammals that may occur within the project area is evaluated in detail in the BPXA Draft IHA request for the Non-lethal Harassment of Cetaceans and Seals During the Prudhoe Bay OBC Seismic Survey, Beaufort Sea, Alaska, 2014 (BPXA 2014).

In alignment with Section 3.4.2 of this report, the following sections are limited to those marine mammals that are generally within the project area during the open water season, and therefore could be affected by proposed activities. This section briefly summarizes findings of that report and provides a list of mitigation measures that will be implemented to avoid and minimize potential impacts.

Several factors should be considered when determining the potential impact from sound exposure, such as what species will be exposed, for how long, to what frequencies, at what levels, and how do these parameters compare with an animal's hearing ability. Based on the species and circumstances, airgun sounds can have different effects on marine mammal species, such as temporary or permanent hearing impairment, non-auditory injury, masking of natural sounds important to marine mammals, or behavioral disturbance (Richardson et al. 1995). More detail about these effects is described in the NPBU 2013 IHA. For the purposes of this assessment, potential impacts on marine mammals considered in this assessment include:

- changes in habitat;
- disturbance;
- injury; or
- mortality.

Current policy regarding exposure of marine mammals to high-level sounds has been set forth by the NMFS as guidelines for Level A or B harassment of marine mammals (see Table 8). As defined by the MMPA, Level A harassment covers activities with the potential to cause physical injury, while Level B harassment involves the potential for behavioral disruption. The NMFS criteria use root mean squared (rms) values of noise levels, which represent averaged levels.

TABLE 8: NMFS CRITERIA FOR LEVEL A AND LEVEL B HARASSMENT

NMFS Level of Harassment	NMFS thresholds dB re 1 μPa (rms, un-weighted)
Level A	190 (pinnipeds) 180 (cetaceans)
Level B	160

Source: NMFS 2000

Potential impacts from underwater noise are also evaluated in light of data presented in Southall et al (2007), which considers both sound exposure over the duration of the survey (i.e., cumulative) sound exposure level (SEL) and marine mammal hearing sensitivity. Table 9 presents Southall et al. (2007) Level A thresholds for species evaluated in this assessment.

- baleen whales (e.g., bowheads) and toothed whales (e.g., belugas) are considered low-frequency cetaceans (although some toothed whales are split between mid- and high-frequency groups); and
- pinniped in water, which includes all species of seals and walrus.

TABLE 9: LEVEL A SOUNDS EXPOSURE LEVEL THRESHOLDS

Marine Mammal Group	Southall et al. (2007) Published SEL (dB re 1 µPa2-s)
Low-frequency cetacean	198
Mid-frequency cetacean	198
High-frequency cetacean	198
Pinniped (in water)	186

Southall et al. 2007

5.2.5.1. Anticipated Impact on Species/Stocks, Habitat, and Loss/Modification of Habitat

This section presents potential impacts of the proposed project activities on marine mammal species likely to occur within the area at the time of the survey. The evaluation of potential impacts due to vessel traffic that could result in mortality, changes in habitat, injury, or disturbance are presented first, followed by impacts that could occur due to underwater noise exposure.

5.2.5.1.1. Impacts Due to Vessel Traffic

Mortality

Vessel strike is one mechanism that can result in marine mammal mortality. Research indicates that vessel speed influences the potential for marine mammal mortality due to a strike. Of 292 large whale ship strikes reviewed in 2004, a total of 48 were known to result in injury and 8 resulted in mortality. No injuries to the whale were reported in only seven ship strike cases. The average vessel speed in 58 of the reported cases that resulted in ship strikes was 18.6 knots, with speed ranges falling into one of three categories: 13 to 15 knots, 16 to 18 knots, and 22 to 24 knots (Jensen et al. 2003). Average vessels speed during this seismic acquisition will range from one to five knots. Low vessel speed in combination with the timing of the survey, when fewer whales would likely to be in the project area, would reduce potential impacts resulting in mortality to whales.

Changes in Habitat

Physical changes to marine mammal habitat are not likely to occur as a result of this survey. Use of vessels, aircraft and airguns would not cause physical changes to marine habitat, given project activities are expected to be completed between 15 May and 15 September 2014. As described in the Plan of Operations, up to 10 vessels ranging from 32 ft to 116.5 ft in length may be used during the seismic survey.

Disturbance or Injury

Deployment of OBS nodes from seismic vessels could disturb or displace marine mammals that may be present in the project area. In general, marine mammals are able and expected to avoid these activities and equipment, particularly given the slow vessel speeds expected (1 – 5 knots). Considering this mobility, marine mammals are not expected to be disturbed or injured due to vessel or air traffic associated with the surveys. BPXA's Oil Discharge Prevention and Contingency Plan and Spill Prevention Control and Countermeasures Plan outlines procedures to help minimize oil spill risks during activities in the Prudhoe Bay area. Thus, while the potential for a fuel spill from vessels used in the survey does exist, the likelihood of a spill occurring is low. If a spill were to occur from a vessel, procedures are in place to respond quickly, thereby minimizing potential disturbance to marine mammals that could be in the area. Given the low likelihood of a spill, injury to marine mammals is also unlikely. Therefore, permanent, long-term damage to marine mammal populations resulting from a spill are not likely.

5.2.5.1.2. Impacts Due to Underwater Noise

Mortality

Marine mammals can be killed or severely injured when they happen to be in close proximity to underwater detonations of high explosives. Airgun pulses are much less energetic and have slower rise times. There is no available information showing that airgun sounds can cause serious injury, death, or strandings. The shallow water environment, small airgun arrays, and planned monitoring and mitigation measures of the proposed survey are not expected to result in mortality or live strandings of marine mammal species. For these reasons, marine mammal mortality due to underwater noise exposure is not further evaluated for species likely to occur within the project area.

Changes in Habitat

Physical changes to marine mammal habitat are not likely to occur as a result of noise from airguns due to the temporary nature of the survey. Noise propagation would not cause physical changes to marine habitat considering that airgun arrays would produce 223 – 247 dB re 1µPa @1 m depending on which array is used (880in^3 versus 640in^3). At this decibel range, physical impacts to the benthos or substrate are not likely.

Disturbance or Injury

Bowhead Whales

Bowhead whales migrating west across the Alaskan Beaufort Sea in fall are unusually responsive, with avoidance occurring out to distances of 12 to 18 mi (20 to 30 km) from a medium-sized airgun source (Miller et al. 1999, Richardson et al. 1999) where received levels were measured to be ~120-130 dB re 1 µPa rms. The call detection rate of bowhead whales migrating through areas with airgun activity was found to be dropping significantly at SELs of more than 120 dB re 1µPa•s-2 as summed over 15 minutes (Blackwell et al. 2013). More recent research on bowhead whales (Miller et al. 2005, Koski et al. 2008) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, bowheads typically begin to show avoidance reactions at a received level of about 160–170 dB re 1 µPa rms

(Richardson et al. 1986, Ljungblad et al. 1988, Miller et al. 1999). Koski et al. (2008) reported that feeding bowheads tolerated received levels of seismic sounds that approached ~160 dB re 1 μPa rms and that some tolerated even higher levels; one group of three whales tolerated received levels of ~180 dB re 1 μPa rms.

It is unlikely that bowhead whales will be encountered during the North Prudhoe Bay seismic survey, since it takes place in water depths of <45 ft south of the main fall migration corridor and because airgun operations will be halted before the majority of the westward migrating bowheads generally pass offshore of Prudhoe Bay. The Prudhoe Bay seismic project will be conducted during the summer, when most bowhead whales are commonly feeding in the Mackenzie River Delta. As part of the planned mitigation measures, BPXA will end data acquisition (i.e., the use of airguns) in late August at a date agreed upon in the CAA. The low vessel speeds that will be used during surveys minimize the potential for vessel strikes with whales.

In light of this information, impacts to bowhead whales from the proposed activities are therefore expected to be minimal, particularly given the relatively short duration of the survey.

Ringed, Bearded, and Spotted Seals

Seals are generally even less responsive to airgun sounds than whales and are not likely to show a strong avoidance reaction to the airgun sources that will be used during the proposed survey. Visual monitoring from seismic vessels has shown only slight avoidance or other changes in behavior in seals, if any responses occurred at all. Ringed seals do not frequently avoid the area within a few hundred meters of operating airgun arrays (Harris et al. 2001, Moulton and Lawson 2002, Miller et al. 2005). However, telemetry work suggests that avoidance and other behavioral reactions by harbor and grey seals to small airgun sources may at times be stronger than evident to date from visual studies of seal reactions to airguns (Thompson et al. 1998). Even if reactions of the seal species occurring in the proposed study area are as strong as those in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on seal individuals or populations.

Polar Bears

While underwater sound during the planned seismic survey has the potential to cause auditory injury to marine mammals, impacts to polar bears from underwater sound sources are not likely to occur. As described in Warner and Hipsey (2011), the distance to received sound levels during airgun operations are estimated to range from 16 to 310 meters for 190 dB re 1μPa rms, depending on the size of the array and its location with respect to the barrier islands. Potential incidental behavioral disturbance of polar bears encountered in the water is estimated based on the 160 dB re 1μPa rms, which propagates out to distances of 700 meters up to 5.5 kilometers, depending on array size and location. The mitigation measures, including the use of PSOs, exclusion zones, as well as proposed shutdown procedures, render the potential for injury to polar bears unlikely.

There is a possibility that polar bears will be encountered during the seismic operation, either in the water and/or on land. In 2013 BPXA documented a combined total of 145 bears in their operational area. These encounters may cause a behavioral reaction to the activity. Actions taken by the seismic crews, including reporting and operational modifications, after the sighting of a polar bear will be in accordance with their LOA and will follow the Polar Bear Interaction Plan. Even though a behavioral reaction may occur, it is not anticipated that the reaction will be long term or have a detrimental effect on the individual or population of the bears.

Pacific Walrus

Activities occurring in the areas along the coast in the Beaufort Sea are not expected to impact pacific walrus given their distribution is primarily in the Chukchi and deeper offshore waters of the Beaufort Sea. Considering the likelihood that a walrus would be encountered during this survey is very low, the potential for disturbance or injury from vessels or noise from airguns is minimal. Sound levels of 180 dB re 1µPa rms (Level A threshold for walrus) during airgun operations are estimated to range from 59 to 950 m, depending on the size of the array and its location with respect to barrier islands (Warner and Hipsey 2011). Potential for behavioral disturbance walruses encountered in water will be estimated based on the 160 dB re 1µPa rms, which propagates out to distances of 700 meters up to 5.5 kilometers, depending on array size and location. As described for polar bears, mitigation measures including the use of PSOs, exclusion zones, as well as proposed shutdown procedures, is likely to reduce the potential for injury to any pacific walrus. Proposed monitoring and mitigation are summarized in Section 5.2.5.2.

Gray Whales

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 µPa rms range seem to cause obvious avoidance behavior in some individuals. For the much smaller airgun arrays of this seismic survey measured distances to received levels of 160 dB re 1 µPa rms ranged from about 0.5 to 3 miles (about 0.8 to 5 kilometers) depending on various factors. Baleen whales within those distances of operating source vessels may show avoidance or other disturbance reactions, but few baleen whales are expected to occur in the Prudhoe Bay seismic survey area.

No densities have been estimated for gray whales and for whale species that are rare or extralimital to the Beaufort Sea (i.e., humpback whale, minke whale, killer whale, harbor porpoise, and narwhal), because sightings of these animals have been very infrequent. Gray whales may be encountered in small numbers throughout the summer and fall, especially in the nearshore areas.

Toothed Whales

Based on the relatively limited information available about the potential impacts from airgun sounds on toothed whales, it can be concluded that reactions of toothed whales to large airgun arrays are variable and generally seems to be confined to a smaller radius than has been observed for baleen whales. Miller et al. (2009) conducted at-sea experiments where reactions of sperm whales were monitored through the use of controlled sound exposure experiments from large airgun arrays consisting of 20-guns and 31-guns. Of 8 sperm whales observed, none changed their behavior when exposed to either a ramp-up at 4-8 mi (7-13 km) or full array exposures at 0.6-8 mi (1-13 km).

Most delphinids show some limited avoidance of seismic vessels operating large airgun systems, though seismic operators and marine mammal observers sometimes see dolphins and other small toothed whales relatively close to operating airguns. 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 (e.g., Goold 1996a, b, c; Calambokidis and Osmek 1998; Stone 2003). Beluga whales exhibit changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al. 2002, 2005), although the animals tolerated high received levels of sound (pk–pk level >200 dB re 1 μPa) before exhibiting aversive behaviors. Potential impacts to beluga whales due to sound exposure are unlikely because of the small range within which these levels would occur, combined with the low numbers of beluga whales expected to be encountered.

As described in more detail in Section 6.1 of the 2014 NPBU IHA, to estimate the density of beluga whales in the Prudhoe Bay area, the 2012 on-transect beluga sighting and effort data from the ASAMM surveys flown in July and August in the Beaufort Sea were used.

Cumulative Impacts on Marine Mammals

Daily BPXA production and maintenance operations within the Beaufort Sea in and near Prudhoe Bay follow existing IHAs and LOAs stipulating strict management measures to minimize potential impacts on marine mammals. In addition to the existing marine mammal mitigation procedures, the North Slope Environmental Handbook and project-specific mitigation plans (i.e., Simpson Lagoon 2012 IHA) provide guidelines and measures to minimize potential impacts on marine mammals.

The proposed Liberty 2D Shallow Geohazard Survey would likely require the use of one vessel supported by a small number of support transportation (i.e., truck or helicopter). The geohazard survey would be a temporary activity and although it does have the potential to disturb marine mammals, these impacts would only occur during the relatively short survey (approximately 4-6 weeks) and thus would not likely cause population level effects. The 2012 IHA for Simpson Lagoon states, "In general, the high resolution, site clearance and shallow hazards surveys are of lesser concern regarding impacts to cetaceans" (NMFS 2012). Richardson and Williams (2004 as cited in NMFS 2012) reported that in 2003, BPXA began to use hovercraft to access the Northstar facility, which generate considerably less underwater noise than similar-sized conventional vessels (previously detectable out to 30 km) and, therefore, may be an attractive alternative when there is concern over underwater noise. Mitigation measures proposed for the Liberty project are likely to be similar to those summarized in Section 5.2.5.2 for marine mammals and therefore, would be expected to minimize potential impacts from seismic acquisition on marine mammals to the extent practicable.

The potential combination of the proposed Liberty Geohazard and the NPBU OBS seismic surveys raises concerns about cumulative impacts due to: 1) behavioral disturbance of marine mammals because of the combined area of the surveys totaling approximately 140mi^2 (10.3 mi^2 for Liberty and 129mi^2 for NPBU offshore activities); and 2) potential vessel strike. Potential minor impacts of behavioral disturbance could cause marine mammals (i.e., bowhead whales) to alter course in order to avoid underwater noise. As described in Section 5.2.5.1.2 above, potential injury from underwater noise could occur but is unlikely given the water depth of the surveys, the short-term nature of both surveys, and that most marine mammals would either avoid the area or would transit through. Vessel strikes can be a concern for vessels operating at speeds greater than 10 knots. Most vessels transiting in and out of the proposed survey areas will be moving at speeds less than 5 knots. Occasional vessel traffic in and out of West Dock, East Dock, and Endicott follow strict protocols similar to those outlined in Section 5.2.5.2 below and would minimize potential vessel strikes. Population level cumulative impacts from behavioral disturbance or vessel strike resulting from the NPBU seismic survey, Liberty geohazard survey, and ongoing Prudhoe Bay operations and maintenance are expected to be minimal considering that each project will implement strict mitigation measures to avoid and minimize interactions with marine mammals as described below.

5.2.5.2. Mitigation

Mitigation measures for marine mammals are described in detail in the 2014 NPBU IHA and summarized briefly here. Exposure to airgun sounds in close proximity to the source may result in different effects to marine mammals, such as permanent or temporary threshold shifts (TTS or PTS) or behavioral changes. The mitigation measures described in this section, implemented to reduce any potential impact on marine mammals, are based on a combination of requirements set forth by the NMFS. The mitigation measures can be divided into two main groups:

- General mitigation measures that apply to all vessels involved in the survey; and
- Specific mitigation measures that apply to source vessels operating airguns.

General Mitigation Measures

These general mitigation measures apply to all vessels that are part of the Prudhoe Bay seismic survey, including crew transfer vessels:

- To minimize collision risk with marine mammals, vessels shall not be operated at speeds that would make collisions likely. When weather conditions require, such as when visibility drops, vessels shall adjust speed accordingly to avoid the likelihood of marine mammal collisions;

- Vessel operators shall check the waters immediately adjacent to a vessel to ensure that no marine mammals will be injured when the vessel's propellers are engaged;
- Vessel operators shall avoid concentrations or groups of whales and vessels shall not be operated in a way that separates members of a group. In proximity of feeding whales or aggregations, vessel speed shall be less than 10 knots;
- When within 900 ft (300 meters) of whales, vessel operators shall take every effort and precaution to avoid harassment of these animals by:
    - Reducing speed and steering around (groups of) whales if circumstances allow, but never cutting off a whale's travel path; and
    - Avoiding multiple changes in direction and speed;
- Sightings of dead marine mammals will be reported immediately to the BPXA Health, Safety, Security, and Environmental (HSSE) Representative. The BPXA HSSE Representative is responsible for ensuring reporting of the sightings according to the guidelines provided by the NMFS; and
- In the event that any aircraft (such as helicopters) are used offshore to support the planned survey, the mitigation measures below will apply:
    - Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 ft above sea level (ASL) when within 0.3 mile (0.5 kilometers) of groups of whales; and
    - Helicopters shall not hover or circle above or within 0.3 mile (0.5 kilometers) of groups of whales.

BPXA has developed a Polar Bear and Walrus Interaction Plan in order to comply with the terms of the USFWS regulations for obtaining LOA for the incidental take of polar bears and walrus and intentional take of polar bears for all BPXA operated fields in Alaska. This Polar Bear and Walrus Interaction Plan for BPXA Areas of Operation has been approved by the USFWS under the slope-wide Letter of Authorization (11-21), issued 3 August 2011 and valid until 3 August 2016. In areas where this project overlaps with routine operations in Greater Prudhoe Bay, crews will operate under LOA 11-21, and will establish ongoing interface with the BPXA Security teams. For this project, when working near facilities and on the road system (e.g., from West Dock to the Lisburne Production Center or along the Endicott causeway), bear guards and vessel captains will monitor for bear activity and work directly with security in developing an appropriate response plan and communicate crews location if bears are sighted or hazed.

In addition to the Polar Bear and Walrus Interaction Plan for BPXA Areas of Operation, specific measures have been identified for vessels and land-based crews in this project area (e.g., Sagavanirktok River Delta, East Dock, and along the coastline). A project-specific LOA will also be submitted to the USFWS prior to commencing the survey and will include additional details on polar bear and walrus mitigation measures. These measures are briefly summarized below:

- PSOs on-board source vessels and the captain on non-source vessels will be tasked with maintaining a watch for marine mammals and implementing seismic specific mitigation measures;
- Vessels will maintain the maximum possible distance from concentrations of polar bears or walruses. Vessels will not approach known polar bears or walrus on ice, on the islands, or in water closer than 0.5 miles (805 meters);
- Bears that are present on Endicott and West Dock Causeways will be avoided as per guidance provided by BPXA Operations Security (under direction from the BPXA LOA 11-21 for Operations);
- Vessel operators will take every precaution to avoid harassment of concentrations of feeding walruses if a vessel is operating near these animals;
- Vessels should reduce speed and maintain a minimum 805-meter (0.5-mile) operational exclusion zone around feeding walrus groups;
- Vessels may not be operated in such a way as to separate members of a group of walruses from other members of the group;
- When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to walruses or polar bears. Operators of support aircraft should conduct their activities at the maximum distance possible from known walruses or polar bears. Helicopters may not hover or circle above such areas or within 805 meters (0.5 mile) of such areas;
- Aircraft should not be operated at an altitude lower than 457 meters (1,500 ft) within 805 meters (0.5 mile) of known walruses or polar bears observed on land or ice, with the exception only for severe weather conditions;
- Plan all aircraft and vessel routes to minimize any potential conflict with active or anticipated walrus or polar bear hunting activity as determined through community consultations; and
- If winter seismic activities occur, the Sagavanirktok River Delta was flown with FLIR in December 2013 to identify potential polar bear dens. No dens were identified, but if dens are identified at a later date, they will

be reported immediately and avoided by a one-mile radius and in accordance BP's Polar Bear Interaction Plan and the LOA from the USFWS.

Specific Mitigation Measures

Specific mitigation measures will be adopted during airgun operations according to the NMFS guidelines, provided that doing so will not compromise operational safety requirements. The mitigation measures outlined below have been established by the NMFS to prevent marine mammals from exposures to received sound pressure levels of 190 dB dB re 1µPa (rms) for seals and 180 dB re 1µPa (rms) for whales. The three source vessels will operate under general mitigation measures described above as well as these additional set of specific mitigation measures:

- Ramp Up Procedure:
  - A ramp up, following a cold start, can be applied if the safety zone has been free of marine mammals for a consecutive 30-minute period. The entire safety zone must have been visible during these 30 minutes. If the entire safety zone is not visible, then ramp up from a cold start cannot begin;
  - Ramp up procedures from a cold start will be delayed if a marine mammal is sighted within the safety zone during the 30-minute period prior to the ramp up. The delay will last until the marine mammal(s) has been observed to leave the safety zone or until the animal(s) is not sighted for at least 15 minutes (seals, polar bears, and walrus) or 30 minutes (whales);
  - A ramp up, following a shutdown, can be applied if the marine mammal(s) for which the shutdown occurred has been observed to leave the safety zone or until the animal(s) has not been sighted for at least 15 minutes (seals, polar bears, or walrus) or 30 minutes (whales). This assumes there was a continuous observation effort prior to the shutdown and the entire safety zone is visible;
  - If, for any reason, electrical power to the airgun array has been discontinued for a period of 10 minutes or more, ramp up procedures need to be implemented. Only if the PSO watch has been suspended, a 30-minute clearance of the safety zone is required prior to commencing ramp up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp up; and
  - The seismic operator and PSOs will maintain records of the times when ramp ups start and when the airgun arrays reach full power.
- Power Down Procedures: A power down is the immediate reduction in the number of operating airguns such that the radii of the 190 dB and 180 dB (rms)

zones are decreased to the extent that an observed marine mammal is not in the applicable safety zone of the full array. During a power down, one airgun (or some other number of airguns less than the full airgun array) continues firing. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of airgun activity, and (b) retain the option of initiating a ramp up to full operations under poor visibility conditions.

- The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full array, but is outside the applicable safety zone of the single mitigation airgun;
- Likewise, if a mammal is already within the safety zone when first detected, the airguns will be powered down immediately;
- If a marine mammal is sighted within or about to enter the applicable safety zone of the single mitigation airgun, it too will be shutdown; and
- Following a power down, ramp up to the full airgun array will not resume until the marine mammal has cleared the safety zone. The animal will be considered to have cleared the safety zone if it has been visually observed leaving the safety zone of the full array, or has not been seen within the zone for 15 minutes (seals) or 30 minutes (whales).

- Shutdown Procedures: The operating airgun(s) will be shut down completely if a marine mammal approaches or enters the 190 or 180 dB (rms) safety radius of the smallest airgun. Airgun activity will not resume until the marine mammal has cleared the safety radius of the full array. The animal will be considered to have cleared the safety radius as described above under ramp up procedures.
- Poor Visibility Conditions:
  - There will be no periods of darkness in the survey area until mid-August. If during foggy conditions, heavy snow or rain, or darkness (which may be encountered starting in late August), the full 180 dB safety zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down; and
  - If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case, ramp-up procedures can be initiated, even though the safety zone may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.
- Protected Species Observers:
  - Two or three marine mammal PSOs will be present on each seismic source vessel. Of these PSOs, one will be on watch at all times to monitor

the 190 and 180 dB safety zones for the presence of marine mammals during airgun operations. PSOs will also monitor for polar bears within 0.5 miles around their vessels in water and on barrier islands;

    - Pre-season distances to received sound levels of 190 and 180 dB, produced by the proposed airgun arrays, have been determined based on existing sound source verification measurements. PSOs will use these distances to monitor the safety zones during the entire project. When marine mammals are observed within, or about to enter, these designated safety zones, PSOs have the authority to call for immediate power down (or shutdown) of airgun operations as required by the situation. A summary of the procedures associated with each mitigation measure is provided below. The criteria are consistent with guidance by the NMFS; and
    - For additional detail on PSO protocol and communications procedures, please see the 2014 NPBU IHA.
- Land-based Monitoring for Polar Bears
    - The seismic program will contract bear guards to provide support for project activities. Bear guards will be trained according to training requirements outlined in the BPXA LOA 13-INT-02.

5.2.6. *Fish, Fish Habitat, and Fisheries*

Fish can be expected to be exposed to underwater seismic testing sounds in proportion to their distribution and abundance in the work area at the time of testing. For example, broad whitefish are expected to occur in the seismic survey area as the Sagavanirktok River Delta is a known spawning and rearing location (Fechhelm and Aerts 2007).

Dolly Varden are likely to be found in and around the project area during the summer project season (Fechhelm and Aerts 2007). Least cisco are expected to occur in the project area during seismic survey activity (Fechhelm and Aerts 2007).

Other Marine Species like adult Arctic flounder and fourhorn sculpin are expected to be in the project area during seismic survey activities because of their habitat preference (Fechhelm and Aerts 2007).

Saffron cod may be present in the project area during seismic survey activities.

Adult Arctic cod may be present in the project area during seismic survey activities, but eggs and larvae are not expected to occur during seismic survey activities (Fechhelm and Aerts 2007).

5.2.6.1. Damage to Fish Eggs, Larvae and Fry

For the proposed survey, the potential impact on eggs and larvae from seismic energy pulses is not applicable as eggs and larvae are not likely to be present in the Prudhoe

Bay seismic survey area during the proposed summer activities. For example, broad whitefish and Dolly Varden spawn in freshwater streams, and Arctic cisco spawn in the Mackenzie River in Canada. Marine fish potentially present in the survey area (such as Arctic cod, Arctic flounder and fourhorn sculpin) spawn in winter, outside the scheduled summer survey timeframe (Fechhelm and Aerts 2007).

5.2.6.2. Physical Damage to Adult and Juvenile Fish

It is important to note that the current knowledge of hearing systems of different fish species and the effects of exposure to sound on such different auditory systems remains limited and many uncertainties relate to the interpretation of the existing data (Popper and Hastings 2009).

The available scientific and management literature suggests that mortality of adult and juvenile fish is unlikely as a result from seismic-survey activity (Department of Fisheries and Oceans 2004; MMS 2006; NMFS 2011a; Popper and Hastings 2009). The potential effects to fish from intense sound sources, such as seismic airguns, are primarily influenced by the level of sound exposure; higher sound levels are more damaging (NMFS 2011a).

Sound sources that have resulted in documented physiological damage of various life stages of fish have been at or above a received level of 180 decibels (dB) with regard to a reference level (re) of 1 micropascal (μPa) (MMS 2006; Popper and Hastings 2009). Physiological damage may lead to reduced fitness, increased vulnerability to predators, decreased ability to locate prey or mates, or sense their acoustic environment (MMS 2006; MMS 2007a).

The chance of physical damage from airgun sound exposure is related to characteristics of the sound waves, survey depths, environmental conditions, and the life stage and fish species exposed. In a study conducted by Popper and Hastings (2005 as cited in MMS 2007a), three fish species were stimulated with five shots of a small seismic air-gun array, with each shot having received mean peak sound level of 205-210 dB re 1 μPa. One species (*C. nasus*) showed no hearing loss, whereas *E. lucius* and *C. plumbeus* showed 10-25 dB of hearing loss that recovered within 24 hours after exposure. There is evidence that some fish can replace or repair sensory cells that have been damaged or fatigued due to sound exposures (Smith et al. 2006). Considering injury would most likely occur only to fish within a very close proximity to the sound source, any injury to adult and juvenile fish would be short-term, limited to a small number of animals (MMS 2007a), and would have negligible affect to overall populations.

The accidental release of vessel fuels into project areas may result in physical damage to adult and juvenile fish. Vessels will be fueled offshore by contractor-supplied or contracted vessels or from a shore-based location at West Dock, East Dock, or on-pad in the PBU. All fuel transfers will be conducted in accordance with applicable regulatory requirements.

During the proposed seismic survey, airgun arrays will be used with a total discharge volume of 640 cu in and an estimated peak level of 223 dB re 1 µPa at 3.3 ft. The minimum depth where seismic airguns can operate is ~3.3 ft. Under these shallow conditions, the underwater sound attenuation will be high and received sound levels of 180 dB re 1 µPa are expected to occur at relatively short distances from the source (Fechhelm and Aerts 2007).

Based on a small radius around the source for received sound levels of 180 dB or more, the area potentially ensonified to relevant levels will be a small portion of the habitat where most fish are present during the summer. Many fish are known to have directional hearing (Fay 2009); fish may avoid these sound sources by responding to ramp up mitigation measures, which will provide fish with an opportunity to move away from the source and reduce the risk of injury (MMS 2006).

Arctic cisco young-of-the-year are transported from spawning grounds by wind-driven currents (see Section 3.2.2). When winds are of sufficient direction, strength, and frequency, fish arrive in the Prudhoe Bay/Sagavanirktok River Delta area throughout the summer season (late June to mid-September) (Fechhelm et al. 2007). Although the fish do swim, due to the dominance of passive transport, the ability to avoid areas with sound levels >180 dB will be minimal; exposure will be determined primarily by predominant currents. However, since the young fish can be distributed from the shore to 7.5 mi offshore (Thorsteinson et al. 1991), and given the short range spatial extent of the >180 dB sound level, only a small percentage of the fish would pass through areas ensonified at levels with any potential to cause harm. Thus, it is unlikely that meaningful numbers of the young-of-the-year will be adversely affected by airgun sounds.

5.2.6.3. Behavioral Responses

Behavioral disturbance is the most probable impact to marine and migratory fishes due to seismic activity (MMS 2007a; NMFS 2011a). Marine fishes can hear airgun sounds at distances of 1.7 to 37.3 mi from their sources, depending on the sound characteristics, water depth, environmental conditions, life stage, and species involved (MMS 2006). Typical behavioral changes include balance problems, disoriented swimming behavior, increased swimming speed, tightening schools, displacement, interruption of biological behaviors (such as feeding, mating), shifts in vertical distribution, changes in orientation, and the occurrence of alarm or startle responses (MMS 2007a). The threshold for behavioral impacts generally occurs within the 160 to 200 dB re 1µPa range (Turnpenny et. al., 1994 as cited in MMS 2007a).

5.2.6.4. Stress from Prolonged Low-level Sound Exposure

It is unknown to what extent long term exposure to low-level anthropogenic sounds (<160 dB) might impact or cause stress to individuals or fish populations. However, it is doubtful that for the proposed seismic survey any single fish would be exposed to strong seismic and vessel sounds for a sufficiently long period that significant physiological stress would develop (Fechhelm and Aerts 2007). Based on the relatively small acoustic footprint of the proposed survey, the extent of exposure, natural fish behavior, constant movements of migrating and feeding fish, the lack of information on anthropogenic sound induced physiological stress, and the conversion to the population level, impacts to fish populations from the proposed survey are not expected.

Cumulative Impacts on Fish and Essential Fish Habitat

The proposed Liberty 2D Shallow Geohazard Survey would likely require the use of one vessel supported by a small number of support transportation (i.e., truck or helicopter). The geohazard survey would be a temporary activity and although it does have the potential to disturb marine mammals, these impacts would only occur during the relatively short survey (approximately 4 to 6 weeks) and thus would not be likely to cause population level effects on fish. While noise sources could be higher than 205 dB re 1 µPa, a level shown by Popper and Hastings (2005) not to result in injury to fish, species is likely to avoid areas where survey activities are occurring. Also, as described above, there is evidence that some fish can replace or repair sensory cells that have been damaged or fatigued due to sound exposures (Smith et al. 2006). Behavioral changes of fish are the most likely cumulative impact from the combination of Liberty, NPBU, and general Prudhoe Bay operations, though these would consist of avoiding the area and not result in a cumulative population level impact.

5.2.6.5. Mitigation

Based on the expected seismic sound exposure during the proposed survey activities, the extent of the impact is expected to be low and fall within natural variations; no population level impacts are expected.

The following mitigation measures have been included in the design of the survey to reduce potential impacts to the localized fish and fish habitats:

- BPXA fyke nets are monitored daily (weather allowing) during July and August and will be checked for variations between prior years and this survey;
- Ramp up procedures will be implemented according to the NMFS protocols’
- Refueling activities will follow applicable regulatory requirements;
- Project timing and location will minimize impacts to important fish spawning habitats; and
- Sound exposure will be localized for short durations; no long-term sound exposure will occur.

5.3. Cultural Resources

Impacts to known cultural resources are not expected from the proposed project. NSB cultural resource management policies and codes require that any discovered cultural or paleontological resource not be disturbed and the NSB Iñupiat History, Language, and Culture Commission be promptly notified.

5.3.1. Communities and Land Status

Communities and lifestyles in the area should not be affected by the project. Workers would have a negligible effect on the cultural aspects of the communities and Native Alaskan population. Workers involved in the project will be housed in existing facilities in Deadhorse or on project vessels. Overall impacts of the project to the surrounding communities would be insignificant.

5.3.2. Subsistence

The proposed seismic survey will take place between July and September, with seismic data acquisition occurring in July and August. The project area is located approximately 55 miles east from Nuiqsut, 3 miles south from Cross Island, and more than 100 miles west from Kaktovik and east from Barrow. The potential impact from the planned activities is expected to be mainly from sounds generated by the vessels and during active airgun deployment. However, due to the timing of the project and the distance from the surrounding communities, it is anticipated there will be no effects on spring harvesting and little or no effect on the occasional summer harvest of beluga whale, or subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted during July-September in the Beaufort Sea). The community of Nuiqsut historically begins fall whaling activities in late August to early September from Cross Island. As part of the planned mitigation measures, BPXA will limit airgun operations to dates agreed on by the Nuiqsut whaling captains as captured in the CAA. Though it is possible to see a bowhead whale inside the barrier islands, the fall bowhead whale migration corridor is generally outside of the barrier islands and north of the planned seismic activities. In addition during the fall migration, the majority of bowheads travel in water depths over 50 feet. The 50 foot depth contour is also north of the study area. Little or no impact on the fall bowhead hunt from the proposed activities is therefore expected to occur. BPXA has a Plan of Cooperation (PoC) for coordinating activities with subsistence users.

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6. MITIGATION TABLE

The following table is a summary of the recommended mitigation measure presented in Section 5.

TABLE 10: MITIGATION TABLE

Resource / Report Section	Mitigation Measure	On- or Offshore
5.1.3.1 – Sagavanirktok River Delta	• Facilities (e.g., docks and gravel pads), to the extent practicable will not be sited within 1,500 ft of current surface drinking water sources or within 0.5 mile of the banks of a main river channel; • The Sagavanirktok River Delta was flown with FLIR in December 2013 to identify potential polar bear dens. If any dens are identified at a later date, they will be avoided by a one-mile radius and in accordance with a LOA from the USFWS; • Node locations will be pre-surveyed to minimize surface disturbance; • No access to the delta from vegetated banks; • Areas of established vegetation will be avoided by project vehicles; • To minimize surface disturbance access will follow a one-way-in and one-way-out protocol and each vehicle will access node lines in a similar one-way-in and one-way-out protocol; • River channels will be crossed perpendicular from bank to bank; • Fueling will utilize existing roads and pads to the extent practicable; • Double walled tanks will be used to transport fuel on the floodplain; • Pre-designated fueling areas will be used to the extent practicable; and • No fueling will be conducted within 100 ft of flowing waters of the Sagavanirktok River.	Onshore

Resource / Report Section	Mitigation Measure	On- or Offshore
5.1.3.5 - Water Quality	• Secondary containment will be provided for the storage of fuel or hazardous substances; • No fuel storage will occur within 1,500 ft of a drinking water source or within 100 ft of a water body; • Drip pans or other impervious liners will be used for activities in which fuel or hazardous substances could potentially be released; • Appropriate spill response equipment will be on hand during any fuel transfer operation; all fuel transfer operations will be observed and performed by trained personnel; • Vehicle refueling will take place on existing gravel pads as practicable; • Double walled tanks will be used to transport fuel on the floodplains; • Pre-designated fueling areas in floodplains will be used to the extent practical; and • No fueling will be conducted within 100 feet of flowing waters of the Sagavanirktok River or Putuligayuk Rivers.	Onshore
5.2.1 - Vegetation and Wetlands	• Keep foot traffic to a minimum for placing nodes; and • Disturbed vegetation and soils will be used to backfill the holes after removing the nodes.	Onshore
5.2.2 - Boulder Patch	• Seismic equipment (nodes) will not be deployed in the identified boulder patch areas.	Offshore

Resource / Report Section	Mitigation Measure	On- or Offshore
5.2.3 - Birds (Including Threatened & Endangered Species)	• Islands with known nest colonization, Reindeer, Howe, Niakuk and Gull have been eliminated from the survey; • An extensive nest survey by avian biologists will be conducted in all portions of the seismic survey area during the nesting period when active nests are anticipated. Each discovered nesting location will be identified and marked for the establishment of buffer zones. The avian biologist will transit to and from sites utilizing the road system or by boat prior to any rotary activity; • A buffer of 100 ft will be established around all threatened, endangered, and candidate listed bird species nests for all land-based project associated activities, to include helicopter activities; • A buffer of 30 ft will be established around all identified waterfowl nests for all land-based project associated activities, to include helicopter activities; • Crew awareness training to avoid wildlife interactions and maintain distance from wildlife. Ground based crews that encounter flocks of flightless/molting birds will avoid blocking access to an escape route and divert around flocks; • Airgun ramp up, power down and shut down procedures provide a window of time for birds to move from active shooting activities; and • Vessels and aircraft operators will maneuver to avoid high density areas whenever possible;	On and Offshore
5.2.4 - Terrestrial Mammals	• Crew awareness training to avoid wildlife interactions and maintain distance from wildlife. Ground based crews that encounter terrestrial mammals will avoid blocking access to an escape route; • Aircraft operators will maneuver to avoid high density areas whenever possible; and • Aircraft operators will not harass terrestrial mammals from the air.	Onshore

Resource / Report Section	Mitigation Measure	On- or Offshore

5.2.5 - Marine Mammals (Including Threatened & Endangered Species)	Note that specific mitigation measures apply to vessels during airgun operations (ramp up, power down, shutdown) and when there is poor visibility. Additional monitoring will be done by Protected Species Observers and Land-based monitoring for polar bears. See the IHA application, LOA, and the Polar Bear and Pacific Walrus Interaction Plan for BP Area's of Operation (or comparable project specific document)for additional mitigation measures. See *Specific Mitigation Measures* in section 5.2.5. The following are general mitigation measure for marine mammals:
	• To minimize collision risk with marine mammals, vessels shall not be operated at speeds that would make collisions likely. When weather conditions require, such as when visibility drops, vessels shall adjust speed accordingly to avoid the likelihood of marine mammal collisions;
	• Vessel operators shall check the waters immediately adjacent to a vessel to ensure that no marine mammals will be injured when the vessel's propellers are engaged;
	• Vessel operators shall avoid concentrations or groups of whales and vessels shall not be operated in a way that separates members of a group. In proximity of feeding whales or aggregations, vessel speed shall be less than 10 knots;
	• When within 900 ft of whales vessel operators shall take every effort and precaution to avoid harassment of these animals by:
	  o Reducing speed and steering around (groups of) whales if circumstances allow, but never cutting off a whale's travel path; and
	  o Avoiding multiple changes in direction and speed.
	• Sightings of dead marine mammals will be reported immediately to the BPXA HSSE Representative. The BPXA HSSE Representative is responsible for ensuring reporting of the sightings according to the guidelines provided by NMFS and BPXA; and
	• In the event that any aircraft (such as helicopters) are used offshore to support the planned survey, the mitigation measures below will apply:
	  o Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 ft ASL when within 0.3 mile of groups of whales.; and
	  o
		Offshore

Resource / Report Section	Mitigation Measure	On- or Offshore
5.2.6 - Fish and Fish Habitat	• BPXA fyke nets are monitored daily (weather allowing) during July and August and will be checked for variations between prior years and this survey; • Ramp-up procedures will be implemented according to the NMFS protocols, thus allowing fish to escape the seismic areas; • Refueling activities will follow applicable regulatory requirements reducing the potential for any spill related impacts; • Project timing and location will minimize impacts to important fish spawning habitats; and • Sound exposure will be localized for short durations.	Onshore
5.3.2 - Subsistence	• BPXA will limit airgun operations to dates agreed upon by the Nuiqsut whaling captains as captured in the CAA; and • BPXA has a Plan of Cooperation (PoC) for coordinating activities with subsistence users.	

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