



Biological Assessment Oil and Gas Activities Associated with Lease Sale 193

Bowhead Whale, Humpback Whale, Fin Whale, Ringed Seal, and Proposed Ringed Seal Critical Habitat



Prepared by:
Office of the Environment
Alaska OCS Region
Bureau of Ocean Energy Management
U.S. Department of the Interior

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ACRONYMS AND ABBREVIATIONS

2D	Two-dimensional
3D	Three-dimensional
ACIA	Arctic Climate Impact Assessment
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
agl	Above ground level
AKR	Alaska Region
AMAP	Arctic Monitoring and Assessment Programme
ANCSA	Alaska Native Claims Settlement Act
ARBO	Arctic Region Biological Opinion
ARCWEST	Arctic Whale Ecology Study
ASAMM	Aerial Surveys for Arctic Marine Mammals
asl	Above sea level
BA	Biological Assessment
bbl	Barrels of oil
Bbbl	Billion barrels of oil
BE	Biological Evaluation
BIWS	Bureau of International Whaling Statistics
BLM	Bureau of Land Management
BMP	Best Management Practice
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BOP	Blow-out Preventer
BOWFEST	Bowhead Whale Feeding Ecology Study
BS	Boundary Segment
BSAI	Bering Sea/Aleutian Islands
BSEE	Bureau of Safety and Environmental Enforcement
BWASP	Bowhead Whale Aerial Survey Project
CFR	Code of Federal Regulations
CH	Critical Habitat
CHIRP	Compressed High Intensity Radar Pulse
CI	Confidence Interval
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	Centimeter(s)
COMIDA	Chukchi Sea Offshore Monitoring in Drilling Area
CPUE	Catch Per Unit Effort
CSESP	Chukchi Sea Environmental Studies Program
cm ³	Cubic inch(es)
CV	Coefficient of Variation
CWA	Clean Water Act
CYP1A	Cytochrome p-4501A
dB	Decibels
DDT	Dichlorodiphenyltrichloroethane
DFO	(Canadian) Department of Fisheries and Oceans
DNR	Alaska Department of Natural Resources
DNV	Det Norske Veritas
DPP	Development and Production Plan
DTAGS	Deep-Towed Acoustics/Geophysics System
DWH	Deepwater Horizon
EFH	Essential Fish Habitat
EEZ	Exclusive Economic Zone

EIS.....	Environmental Impact Statement
EP.....	Exploration Plan
EPA.....	Environmental Protection Agency
ERA.....	Environmental Resource Area
ERL.....	Effects Range Low
ERM.....	Effects Range Median
ERMA.....	Environmental Response Management Application
ESA.....	Endangered Species Act
EVOS.....	Exxon Valdez Oil Spill
EWC.....	Eskimo Walrus Commission
FEIS.....	Final Environmental Impact Statement
FR.....	Federal Register
ft.....	Feet
FWS.....	Fish and Wildlife Service
g.....	Gram(s)
G&G.....	Geophysical and Geotechnical
gal.....	Gallon(s)
GHG.....	Greenhouse Gas(es)
GLS.....	Grouped Land Segment
GPS.....	Global Positioning System
Hz.....	Hertz
IAOGP.....	International Association of Oil and Gas Producers
IHA.....	Incidental Harassment Authorization
IPCC.....	International Panel on Climate Change
IPF.....	Impact-producing factor
ITA.....	Incidental Take Authorization
ITL.....	Information to Lessees (Clauses)
IUCN.....	International Union for Conservation of Nature
IWC.....	International Whaling Commission
kg.....	Kilogram
kHz.....	Kilohertz
km.....	Kilometer(s)
kn.....	Knots
L.....	Liter(s)
LA.....	Launch Area
LACS.....	Low-level Acoustic Combustion Sources
LBCHA.....	Ledyard Bay Critical Habitat Area
LNG.....	Liquefied natural gas
LOA.....	Letter of Authorization
LOWC.....	Loss of Well Control
LS.....	Land Segment
µg.....	Microgram(s)
µPa.....	MicroPascal (s)
m.....	Meter(s)
Mbbl.....	Thousand barrels of oil
MBTA.....	Migratory Bird Treaty Act
Mcf.....	Thousand cubic feet
mi.....	Mile(s)
min.....	Minute(s)
MLC.....	Mudline Cellar
mm.....	Millimeter(s)
MMbbl.....	Million barrels of oil
MMC.....	Marine Mammal Commission
MMcf.....	Million cubic feet
MMO.....	Marine Mammal Observer
MMPA.....	Marine Mammal Protection Act

MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
ms	Millisecond(s)
MSY	Maximum Sustainable Yield
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
nmi	Nautical mile(s)
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPR-A	National Petroleum Reserve in Alaska
NRC	National Research Council
NSB	North Slope Borough
NSIDC	National Snow and Ice Data Center
NTL	Notice to Lessees
NWMB	Nunavut Wildlife Management Board
OBC	Ocean-based Cable
OC	Organochoride
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OSRA	Oil Spill Risk Analysis
OSRP	Oil Spill Response Plan
PAC	Poly-aromatic compound
PAH	Poly-aromatic hydrocarbon
PBTE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PL	Pipeline Segment
POP	Persistent Organic Pollutants
ppb	Parts per billion
psi	Pounds per square inch
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
ROD	Record of Decision
ROP	Required Operating Procedures
RS/FO	Regional Supervisor, Field Operations
RSL	Received Sound Level
SD	Standard Deviation
SE	Standard Error
sec	Second(s)
SEIS	Supplemental Environmental Impact Statement
SEL	Sound Exposure Level
SPLASH	Structures of Population, Levels of Abundance and Status of Humpback Whales
SPL	Sound Propagation Level(s)
SSV	Sound Source Verification
t	Ton(s)
TA&R	Technology Assessment & Research Program
TAPS	Trans-Alaska Pipeline System
Tcf	Trillion cubic feet
TTS	Temporary Threshold Shift
UERR	Undiscovered Economically Recoverable Resources
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior

USSR.....	Union of Soviet Socialist Republics
VGP.....	Vessel General Permit
VLOS	Very Large Oil Spill
VMS	Vessel Monitoring System
VSM	Vertical Support Member
VSP.....	Vertical Seismic Profiling
WCD.....	Worst Case Discharge
yd.....	yard(s)

1.0 INTRODUCTION

This document transmits the Bureau of Ocean Energy Management's (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) biological assessment (BA) in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq., ESA), on the effects of the Proposed Action on bowhead whales, humpback whales, fin whales, ringed seals, and proposed critical habitat (CH) for ringed seals. On July 25, 2014, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit challenging the listing of bearded seals under the ESA (*Alaska Oil and Gas Association v. Pritzker*, Case No. 4:13-cv-00018-RPB). The decision vacated the National Marine Fisheries Service (NMFS's) listing of the Beringia DPS of bearded seals as a threatened species. NMFS is presently appealing that decision (Notice of Appeal, Case No. 4:13-cv-00018-RRB). During the interim, this BA will continue to address effects to bearded seals (Beringia DPS) so that action agencies have the benefit of NMFS's analysis of the consequences of proposed actions on this DPS, should the status of the species be resolved. The North Pacific right whale (*Eubalaena japonica*) and Steller sea lion (*Eumetopias jubatus*) are not included as they were determined to be outside the Action Area as defined below in Section 2.1.

The Outer Continental Shelf Lands Act, as amended (OCSLA; 43 U.S.C. 1331 et seq.), requires that the Secretary of the Department of the Interior (USDOI) ensures that the U.S. government receives fair market value for acreage made available for leasing, and that OCS conventional (oil and gas) or renewable energy development activities conserve resources, operate safely, and take maximum steps to protect the environment. The Secretary has delegated responsibilities under OCSLA to BOEM and BSEE¹.

Under these delegations, the Secretary has divided duties generally between BOEM and BSEE as follows:

- BOEM: Leasing, exploration and development plan administration, environmental studies, resource evaluation, economic analysis, and the renewable energy program; and,
- BSEE: Enforcing safety and environmental regulations, field operations including permitting of drilling operations and research, inspections, offshore regulatory programs, oil-spill response, training and environmental compliance functions.

As detailed later in this BA, the Proposed Action entails oil and gas exploration, development, production, and decommissioning in connection with the 460 leased blocks from the Chukchi Sea Planning Area Oil and Gas Lease Sale 193 held by BOEM's predecessor, the Minerals Management Service, on February 6, 2008. Due to subsequent legal proceedings and new information, BOEM is supplementing its environmental analyses for the lease sale and USDOI will determine whether or not to reaffirm the currently suspended leases issued as a result of Lease Sale 193.

To supplement the environmental analyses, BOEM also updated its scenario for reasonably foreseeable activities and effects that may result from the Lease Sale. BOEM and BSEE have reinitiated consultation with NMFS as it relates to Sale 193 current leases; the consultation had previously culminated in a Biological Opinion (BO) issued in 2013 (NMFS, 2013a), covering lease sales and activities in the Chukchi and Beaufort seas.

This updated scenario provided considers potential exploration, development, and other activities in connection with the 460 current leases. The area covered by the 460 current leases is referred to as the "Leased Area." (See Figures 1–1 and 1–2). This reinitiated consultation applies only to oil and gas

¹ Collectively, BOEM and BSEE were historically part of a single agency, previously known as Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) and the Minerals Management Service (MMS). BOEMRE was reorganized, effective October 1, 2011, into the separate agencies of BOEM and BSEE.

activities resulting from the Leased Area. Lease sales and oil and gas activities in the Chukchi and Beaufort seas that occur outside of the Leased Area continue to be bound by findings of the 2013 Biological Opinion (NMFS, 2013a).

The USDO, through BOEM and BSEE, conducts staged decision making under the OCSLA in a tiered approach for review under NEPA and to proposes to use an incremental step consultation under the ESA as described in regulations at 50 CFR 402.14(k). The OCSLA review process gives the Secretary of the Interior a "continuing opportunity for making information adjustments" in developing OCS energy resources to ensure all activities are conducted in an environmentally sound manner. Section 7 consultation is not conducted at the first OCSLA stage—development of the Five Year OCS Oil and Gas Leasing Program. The 2013 BO likewise involved an incremental step consultation, and for the Chukchi lease sales included terms and conditions, reasonable and prudent measures and an incidental take statement through the first increment of activities (namely, the exploration phase prior to production and development.) Regulations at 50 CFR 402.14(k) state:

“When the Action is authorized by a statute that allows the agency to take incremental steps toward the completion of the action, the Service shall, if requested by the Federal agency, issue a biological opinion on the incremental step being considered, including its views on the entire action. Upon the issuance of such a biological opinion, the Federal agency may proceed with or authorize the incremental steps of the action if:

1. The biological opinion does not conclude that the incremental step would violate Section 7(a)(2);
2. The Federal agency continues consultation with respect to the entire action and obtains biological opinions, as required, for each incremental step;
3. The Federal agency fulfills its continuing obligation to obtain sufficient data upon which to base the final biological opinion on the entire action;
4. The incremental step does not violate Section 7(d) of the ESA concerning irreversible or irretrievable commitment of resources; and,
5. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2) of the ESA.”

As an incremental step consultation, this BA examines activities in the first step and Future Incremental Steps that may result from the Proposed Action, with the primary focus of the BA being assessment of potential impacts from the First Incremental Step. The First Incremental Step includes all activities associated with the exploration and delineation of the anchor field (large, initial field that is effectively a prerequisite to any future development) up to submission of a Development and Production Plan (DPP). Future Incremental Steps include all steps that would occur after anchor field is explored and delineated. These steps include development and production of the anchor field; exploration, development and production of a satellite field (smaller, secondary field), and decommissioning of both fields. This BA also considers potential impacts through the endpoint of the actions as described in the hypothetical development and production scenario.

We note the Proposed Action in this BA pertains to oil and gas activities associated with the Leased Area only. It does not pertain to other oil and gas activities that may occur off the Leased Area (e.g., off-lease marine seismic surveys). We also note that as specific projects (e.g., development projects) may be proposed in the future for authorizations by BOEM and/or BSEE, additional Section 7 consultations will be conducted as necessary to determine whether the proposed activities are likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.

Table 1–1 Determinations for Federally Listed Species and Critical Habitat Managed by the National Marine Fisheries Service. North Pacific right whale (*Eubalaena japonica*) and Steller sea lion (*Eumetopias jubatus*) are not included as they are outside of the Action Area as defined in Section 2.1.

Common Name	Scientific Name	Listing Status	Determination
Bowhead Whale	<i>Balaena mysticetus</i>	Endangered	May affect and likely to adversely affect
Fin Whale	<i>Balaenoptera physalus</i>	Endangered	May affect but not likely to adversely affect
Humpback Whale	<i>Megaptera novaeangliae</i>	Endangered	May affect but not likely to adversely affect
Bearded Seal	<i>Erignathus barbatus</i>	Vacated, in appeal ¹	May affect and likely to adversely affect
Ringed Seal	<i>Phoca hispida</i>	Threatened	May affect and likely to adversely affect
Critical Habitat			Determination
Ringed Seal Proposed Critical Habitat			May affect and likely to adversely affect

¹ On July 25, 2014, the U.S. District Court for the District of Alaska vacated NMFS's listing of the Beringia DPS of bearded seals as a threatened species. NMFS is presently appealing that decision (Notice of Appeal, Case No. 4:13-cv-00018-RRB).



Figure 1-1 Program Area. The Chukchi Sea OCS Oil and Gas Lease Sale 193 Program area excluded OCS blocks within a 25-mile (40 km) coastal buffer (deferred in the 2007/2012 Five-Year Program).



Figure 1-2 Sale 193 Lease Area. The Chukchi Sea Program Area is illustrated with a red border—it excludes OCS blocks within a 25-mile (40 km) coastal buffer (deferred in the 20072012 Five-Year Program). Also illustrated are the existing 460 leased blocks from Lease Sale 193..

2.0 PROPOSED ACTION DESCRIPTION

This section describes the Proposed Action, including the Action Area and a description of the Proposed Action and associated assumptions, and mitigation measures typical of Arctic oil and gas activities.

2.1. Action Area

The Action Area is the geographic region in which direct and indirect effects of the Proposed Action may occur. Exploration and development is assumed to occur as a result of activities on the 460 leased blocks (the Leased Area) in the Chukchi Sea Program Area, a subset of the Chukchi Sea Planning Area. The Chukchi Sea Planning Area consists of approximately 40.2 million acres of the Chukchi Sea from the US-Russia Maritime border west of Point Hope to the edge of the Beaufort Sea Planning Area at Barrow. The Action Area is broader than the Leased Area, as structures resulting from the Proposed Action could be constructed in marine waters outside the Leased Area (e.g., platform-to-shore pipelines) and on land for shore facilities, pump stations, and a pipeline connecting to the Trans-Alaska Pipeline System (TAPS), and the effects of the Proposed Action could affect areas outside the Chukchi Sea Planning Area. Because the specific location of future development is unknown, we have broadly defined the Action Area (Figure 1–2) to include:

- The Chukchi Sea Planning Area;
- Marine waters between the southern boundary of the Chukchi Sea Planning Area and the Alaska coastline; and
- Areas where impacts of the Proposed Action occur.

2.2. Proposed Action

The Proposed Action entails oil and gas exploration, development, production, and decommissioning in connection with the leases issued through Lease Sale 193. The activities comprising the Proposed Action are further described in the detailed hypothetical development scenario (henceforth Scenario) BOEM presented in USDOJ, BOEM, 2014. The hypothetical development scenario is not specific to any existing EP. The scenario was created using the best available information from previously submitted EPs and previous development elsewhere on the U.S. OCS to help identify reasonably foreseeable activities and locations.

Under the Proposed Action, a large prospect, referred to as the anchor field, and a smaller satellite field would be discovered, developed, and produced from the Leased Area. Their combined potential oil and condensate are 4.3 Bbbl, which is 37% of the estimated Undiscovered Economically Recoverable Resources (UERR) in the Chukchi Sea OCS at \$110/barrel of oil (USDOJ, BOEMRE, 2011c). Producing this volume of oil and its associated natural gas (estimated at 2.2 Tcf) would require eight platforms of a new Arctic-class design and drilling 589 total wells (exploration, delineation, production, and service.) The Proposed Action assumes that an oil pipeline (either TAPS in its present form or a future redesigned pipeline) will continue to carry oil from fields in northern Alaska, including the OCS and that infrastructure for a liquid natural gas (LNG) pipeline and gas processing would be available and accessible.

For the purposes of Section 7 consultation, BOEM's Proposed Action is divided into incremental steps. BOEM's and BSEE's request for incremental step consultation is appropriate because of the long-term, multistage nature of BOEM/BSEE decision making under the OCSLA. Incremental step consultation provides that BOEM/BSEE and the USFWS may conduct formal consultation in increments to maximize the opportunity for both agencies to more accurately evaluate potential

effects of the Proposed Action on listed species and critical habitat by considering specific details of activities closer to the time that they become viable (e.g., via submission of a DPP to BOEM).

The First Incremental Step for this consultation (the primary focus of this BA) includes all on-lease activities associated with the exploration and delineation of a hypothetical anchor field, up to and including a commercially viable oil and gas discovery. BOEM and BSEE considers all on-lease activities that would occur after the initial anchor field discovery to be components of Future Incremental Steps because they would occur after the submission of a DPP and would be the subject of consultation on the DPP.

2.2.1. First Incremental Step

The First Incremental Step includes all activities associated with exploration and delineation of the anchor field, including construction of supporting onshore facilities (also referred to as “shorebases”) (Table 2–1).

Deep penetration marine seismic surveys are conducted to define hydrocarbon deposits in the Leased Area. Companies would conduct three-dimensional (3D) or some two-dimensional (2D) geophysical seismic surveys to identify limits of the prospective hydrocarbon areas. Two-dimensional seismic surveying techniques are used to provide broad-scale information over a relatively large area, while 3D survey produce more detailed information on smaller, specific areas of interest (identified during 2D surveys). Because the focus is on-lease exploration and development in the Chukchi Sea Leased Area, BOEM and BSEE expect that most of the additional geophysical seismic surveys described under the Proposed Action would be 3D surveys focusing on specific leasing targets to identify possible drilling locations.

The Proposed Action assumes that the lessee company would proceed from seismic exploration of the prospect to exploratory and delineation drilling. At least one year prior to drilling exploratory wells, the company would conduct high-resolution geophysical surveys (also called “site clearance or shallow hazards surveys” or “geohazard surveys”) to further evaluate the near-surface geology, to locate shallow hazards, to identify depth to seafloor (bathymetry), potential shallow faults or gas zones, depth and distribution of ice gouges in the seabed, to obtain engineering data for drilling or placement of structures (platforms and pipelines), and detect archaeological resources and certain types of benthic communities. The company would also conduct geotechnical surveys to increase the understanding of such site characteristics as sediment structures, ice gouges, and a variety of shallow hazard information.

Based on the evaluation of the marine seismic and ancillary activity data (both geohazard and geotechnical surveys), BOEM and BSEE expect that the company would propose to drill several test wells in the area of interest. Two mobile offshore drilling units (MODUs) would be used to drill exploration wells (with a maximum of four wells drilled per open-water season). Assuming a discovery is made during exploration well drilling, MODUs would drill delineation wells to determine the areal extent of economic production. As a component of exploratory drilling, vertical seismic profiling (VSP) surveys would be conducted in the wellbores.

In conjunction with the beginning of the First Incremental Step, onshore facilities would be constructed near Barrow or Wainwright. These shorebases would provide air support, search and rescue capabilities, and personnel housing/equipment storage.

Table 2–1 Activities Anticipated During the First Incremental Step of the Proposed Action.

Activity Type	Maximal Number during First Incremental Step	Activity Period
Open-water season 2D/3D marine seismic survey	1	July–November
In-ice 2D marine seismic survey	1	October–December
Geohazard survey	5	July–November
Geotechnical survey	5	July–November
Exploratory and delineation drilling	28 wells	June–November
Vertical seismic profile survey	28	June–November
Shorebase construction	Up to 3 bases, 2 years of construction	January – December

2.2.1.1. Activities Associated with the First Incremental Step

This section describes the activities that are anticipated to occur during the First Incremental Step of the Proposed Action.

2.2.1.1.1. Deep Penetration Marine Seismic Surveys

During the exploration phase, companies would conduct deep penetration marine seismic surveys to search for and define the prospective areas on lease that could contain hydrocarbon deposits. 2D deep penetration seismic surveying techniques are used to provide broad-scale information over a relatively large area. These surveys are mostly used for pre-lease exploration or to provide area-wide geologic information. 3D deep penetration seismic surveys are conducted on a closely spaced grid pattern that provides a more detailed image of the prospect, which is used to select the proposed drilling locations.

Under the Proposed Action, two marine seismic surveys would be conducted during the First Incremental Step, with no more than one survey in any given year. One of these two surveys would be an in-ice survey; the other would be a typical 3D/2D marine seismic survey (Table 2–1).

The typical marine seismic survey would be conducted during the open-water season from July 1 into November. Even during the short open-water season, there are periodic incursions of sea ice, so there is no guarantee that any given location would be ice free throughout the survey. The in-ice survey would be conducted between October and late December. The exact timing of the in-ice survey would be dependent in part on ice conditions and the class of icebreaker available for escort.

2D/3D Marine Seismic Surveys

Airguns are the typical acoustic (sound) source for marine seismic surveys. An outgoing sound signal is created by releasing a high-pressure air pulse from the airguns into the water to produce an air-filled cavity (a bubble) that expands and contracts. The size of individual airguns could range from tens to several hundred cubic inches (in³). A group of airguns is usually deployed in an array to produce a more downward-focused sound signal. Airgun array volumes for marine seismic surveys are expected to range from 1,800–4,500 in³, but may range up to 6,000 in³. The airguns are fired at short, regular intervals, so the arrays emit pulsed rather than continuous sound. While most of the energy is focused downward and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson, 1988;

Hall et al., 1994). Marine 3D seismic surveys vary from typical 2D seismic surveys, because the survey lines are more closely spaced and are more concentrated in a particular area. The specifications of a 3D survey depend on client needs, the subsurface geology, water depth, and geological target. A 3D and 2D source array typically consists of two to three subarrays of six to nine airguns each. Source-array size can be varied during the seismic survey to optimize the resolution of the geophysical data collected at any particular site. The energy output of the array is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. communication, as cited in USDOl, MMS, 2007). Vessels usually tow up to three source arrays, depending on the survey-design specifications. Most operations use a single source vessel; however, in a few instances, more than one source vessel is used. The vessels conducting these seismic surveys generally are 70–90 m (230–295 ft) long.

The sound-source level (zero-to-peak) associated with typical 3D seismic surveys ranges between 233 and 240 dB re 1 μ Pa at 1 m (rms). Marine seismic surveys are acquired at typical vessel speeds of 4.5 knots (kn) (8.3 km/hr). A source array is activated approximately every 10–15 sec, depending on vessel speed. The timing between outgoing sound signals may vary for different surveys to achieve the desired “shot point” spacing to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m (82 or 123 ft).

The sound receivers for a 3D survey could include multiple (4–16) streamer-receiver cables towed behind the source array. Streamer cables contain numerous hydrophone elements at fixed distances within each cable. Each streamer could be 3–8 km (1.9–5 mi) long, with an overall array width of up to 1,500 m (4,921 ft) between outermost streamer cables. Biodegradable liquid paraffin is used to fill the streamer and provide buoyancy. Solid/gel streamer cables are also used.

The wide extent of this towed equipment affects both the turning speed and the area a vessel covers with a single pass over a geologic target. It is, therefore, common practice to acquire data using an offset racetrack pattern, whereby each acquisition line is several kilometers away from and traversed in the opposite direction of the track line just completed. Acquiring a single track line may take several hours, depending on the size of the survey area. The vessel then takes 2–3 hr to turn around at the end of the track line and starts acquiring data along the next track line. Adjacent transit lines for a modern 3D seismic survey generally are spaced several hundred meters apart and are parallel to each other across the survey area. Vessel transit speeds typically range from 8–12 kn (12.9–19.3 km/hr) depending on a number of factors including, but not limited to, the vessel itself, sea state, and ice conditions. Marine 3D surveys are acquired at vessel speeds of approximately 4.5 kn (8.3 km/hr). Seismic surveys are conducted day and night when ocean conditions are favorable, and one survey effort may continue for weeks or months, depending on the size of the survey. Data-acquisition is affected by number of streamer cables towed by the survey vessel and by weather/ice conditions. Typically, data are only collected between 25% and 30% of the time (or 6–8 hr a day) because of equipment or weather problems. In addition to downtime due to weather, sea conditions, turning between lines, and equipment maintenance, seismic surveys could be suspended for biological reasons (proximity to protected species). Individual seismic surveys could require 60–90 days to cover a 200 mi² (518 km²) area.

Marine 2D seismic surveys use similar geophysical-survey techniques as 3D seismic surveys, but both the mode of operation and general vessel type used are different. The 2D seismic surveys provide a less-detailed subsurface image because the survey lines are spaced farther apart, for coverage of wider areas to image geologic structure on more of a regional basis. Large prospects are easily identified on 2D seismic data, but detailed images of the prospective areas within a prospect can only be seen using 3D data. The 2D seismic-survey vessels generally are smaller than modern 3D-seismic survey vessels, although larger 3D survey vessels are able to conduct 2D surveys. The 2D seismic-sound source array typically consists of three or more arrays of six to eight airguns each, equivalent to the arrays used for 3D surveys. The sound-source level (zero-to-peak) associated with

2D marine seismic surveys are the same as 3D marine seismic surveys (233–240 dB re 1 μ Pa at 1 m (rms)). Typically, a single hydrophone streamer cable approximately 8–12 km (5–7.5 mi) long is towed behind the survey vessel. The 2D seismic surveys acquire data along single track lines that are spread more widely apart (usually several miles) than are track lines for 3D seismic surveys (usually several hundred meters).

Marine seismic vessels are designed to operate for weeks without refueling or resupply. A support vessel is typically used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data.

Marine seismic surveys require a largely ice-free environment to allow effective operation and maneuvering of the airgun arrays and long streamers. One exception to the need for a largely ice-free environment is the in-ice seismic survey. These seismic surveys use a specialized survey vessel with a special fitting that allows the streamer to be towed below the ice. These surveys require an icebreaker to clear a path through the ice for the survey vessel to follow. In-ice surveys could occur as late as late December, when the thickness of the ice becomes an issue. In the Arctic, the timing and areas of seismic surveys are often dictated by ice conditions.

In-Ice Towed-Streamer 2D Surveys

A change in technology has allowed geophysical (seismic reflection and refraction) surveys to be conducted in thicker sea ice concentrations. Sea ice concentration is defined in terms of percent coverage in tenths. An area with 1/10 coverage of ice means the area contains sporadic ice floes that provides for easy vessel navigation; whereas, 10/10 coverage of ice means there is no open water in the area. This new technology uses a 2D seismic source vessel and an icebreaker. The icebreaker generally operates ~0.5–1 km (~0.3–0.62 mi) ahead of the seismic acquisition vessel, which follows at speeds ranging from 4 to 5 kn (7.4 to 9.3 km/hr). Like open-water 2D surveys, in-ice surveys operate 24 hr a day or as conditions permit.

The seismic airgun arrays and streamers used in-ice are similar to those used in open water marine surveys. A single hydrophone streamer, which uses a solid fill material to produce constant and consistent streamer buoyancy, is towed behind the vessel. The streamer receives the reflected signals from the subsurface and transfers the data to an on-board processing system. The survey vessel has limited maneuverability while towing the streamer and thus requires a 10 km (6.2 mi) run-in for the start of a seismic line, and a 4–5 km (2.5–3.1 mi) run-out at the end of the line.

2.2.1.1.2. Geohazard Surveys

Prior to submitting an exploration or development plan, oil and gas industry operators are required to evaluate any potential geological hazards and document any potential cultural resources or benthic communities pursuant to 30 CFR 550. The BOEM, Alaska OCS Region, has provided guidelines (Notices to Lessees 05-A01, 05-A02, and 05-A03) that require high-resolution shallow hazards surveys to ensure safe conduct and operations in the OCS at drill sites and along pipeline corridors, unless the operator can demonstrate there is enough previously collected data of good quality to evaluate the site. These data are vital not only when planning for the design and construction of a facility, but also to ensure that all associated activities are completed safely.

Ancillary geohazard surveys:

- Locate shallow hazards (<2,000 m water depth);
- Obtain engineering data for placement of structures (e.g., proposed platform locations and pipeline routes); and
- Detect geohazards, archaeological resources, and certain types of benthic communities.

Under the Proposed Action, up to five ancillary geohazard surveys would be conducted during the First Incremental Step, with no more than one survey in any given year (Table 2–1). All Geohazard surveys would occur on-lease and would utilize airgun arrays or other sound generating equipment smaller in size and lower in sound level output than those described above for 2D and 3D seismic surveys. All geohazard surveys would be conducted during the open-water season (July–November).

Geohazard surveys use various geophysical methods (e.g., seafloor imaging, water-depth measurements, and high-resolution seismic reflection profiling) designed to identify and map hazards such as shallow faults and ice gouges, and may also collect oceanographic data. Most basic components of a geophysical system include a sound source to emit acoustic impulses or pressure waves, a hydrophone or receiver that receives and interprets the acoustic signal, and a recorder/processor that documents the data.

The suite of equipment used during a typical shallow hazards survey consists of:

- Seismic systems (e.g., airguns, sub-bottom profilers, sparkers, etc.) which produce sound waves that penetrate the seafloor
- Single beam and multibeam echosounders which provide water depths and seafloor morphology (including ice gouges); and
- Side scan sonar that provides acoustic images of the seafloor.

The waves will reflect at the boundary between two layers with different acoustic impedances, producing a cross sectional image. These data are interpreted to infer geologic history of the area. Seismic energy can be produced by different types of sources, discussed briefly below: a sub-bottom profiler that provides 20–200 m sub-seafloor penetration at a 6–20 cm resolution; a bubble pulser or boomer with 40–600 m sub-seafloor penetration; and a multichannel seismic system with 1,000–2000 m sub-seafloor penetration. Magnetometers that detect ferrous items have not been required in the Alaska OCS to date.

A typical operation consists of a vessel towing an acoustic source (airgun) about 25 m (82 ft) behind the ship and a 600 m (1,969 ft) streamer cable with a tail buoy. The source array usually is a single array composed of one or more airguns. A 2D ancillary geohazard survey usually has a single airgun, while a 3D ancillary geohazard survey usually tows an array of airguns that are typically smaller in volume than the arrays used in marine seismic exploration activities. The ships travel at 3–3.5 kn (5.6–6.5 km/hr), and the source is activated every 7–8 sec (or about every 12.5 m (41 ft)). All vessel operations are designed to be ultra-quiet, as the higher frequencies used in ancillary geohazard work are easily masked by the vessel noise.

Typical seismic surveys cover one proposed drilling location at a time. Federal regulations require information be gathered on a 300 by 900 m (984 x 2953 ft) grid, which amounts to about 129 line-kilometers (80 mi) of data per lease block (NTL No. 05-A01). If there is a high probability of archeological resources, the north-south lines are 50 m (164 ft) apart and the 900 m (2953 ft) remains the same. Including line turns, the time to survey a lease block is approximately 36 hrs. Airgun volumes for ancillary geohazard surveys typically are 40–450 in³ (1.5–2.5 L), and the output of a 90-in³ (1.5 L) airgun ranges from 229–233 dB high-resolution re 1μPa at 1 m (rms). Airgun pressures typically are 2,000 pounds per square inch (psi), although they can be used at 3,000 psi for higher signal strength to collect data from deep in the subsurface.

- **Seismic Systems.** Seismic systems produce sound waves that penetrate the seafloor. The waves will reflect at the boundary between two layers with different acoustic impedances, producing a cross sectional image. These data are interpreted to infer geologic history of the area. Seismic energy can be produced by several different types of sources; they will be discussed briefly below.

Single channel high-resolution seismic reflection profilers. High-resolution seismic reflection profilers, including sub-bottom profilers, boomers, and bubble pulsers, consist of an electromechanical transducer that sends a sound pulse down to the seafloor. Sparkers discharge an electrical pulse in seawater to generate an acoustic pulse. The energy reflects back from the shallow geological layers to a receiver on the sub-bottom profiler or a small single channel streamer. Sub-bottom profilers are usually hull mounted or pole-mounted; the other systems are towed behind the survey vessel. These systems range in frequency from 0.2 to 200 kHz (Laban et al., 2009; Greene and Moore, 1995).

Multichannel high-resolution seismic reflection systems. The multichannel seismic system consists of an acoustic source which may be a single small gun (air, water, Generator-Injector, etc.) 10 to 65 in³ or an array of small guns, usually two or four 10 in³ guns. The source array is towed about three meters behind the vessel with a firing interval of approximately 12.5 m (7–8 sec). A single 300–600 m, 12–48 channel streamer with a 12.5 m hydrophone spacing and tail buoy is the passive receiver for the reflected seismic waves. A 40 in³ airgun array is commonly used in the Arctic as the source for these multichannel seismic surveys. This array will typically have frequency between 0 and 200 Hz and a source level between 196 and 217 dB re 1 µPa at 1 m (rms) (NMFS, 2008a, 2009a, 2010a; Greene and Moore, 1995).

Survey ships are designed to reduce vessel noise because the higher frequencies used in higher resolution work are easily masked by the vessel noise if special attention is not paid to keeping the ships quiet. Surveys are site specific and can cover less than one lease block, but the survey extent is determined by the number of potential drill sites in an area. The typical survey vessel travels at 3–4.5 kn (5.6–8.3 km/hr). A single vertical well site survey will collect about 70 line-miles of data per site and take approximately 24 hrs. BOEM regulations require data to be gathered on a 150- by 300-m grid within 600 m of the drill site, a 300 by 600 m grid out to 1,200 m from the drill site, and a 1,200 by 1,200 m grid out to 2,400 m from the well site. If there is a high probability of encountering archeological resources, the 150- by 300-m grid must extend to 1,200 m from the drill site.

- **Echosounder.** Echosounders measure the time it takes for sound to travel from a transducer, to the seafloor, and back to a receiver. The travel time is converted to a depth value by multiplying it by the sound velocity of the water column. Single beam echosounders measure the distance of a vertical beam below the transducer. The frequency of individual single beam echosounders can range from 3.5 to 1000 kHz with source levels between 192 to 205 dB re 1 µPa at 1 m (rms) (Koomans, 2009).

Multibeam echosounders emit a swath of sound to both sides of the transducer with frequencies between 180 and 500 kHz and source levels between 216 and 242 dB re 1 µPa at 1 m (rms) (Hammerstad, 2005; HydroSurveys, 2010).

- **Side scan sonar.** Side scan sonar is a sideward-looking, narrow-beam instrument that emits a sound pulse and “listens” for its return. The side scan sonar can be a two or multichannel system with single frequency monotonic or multiple frequency Compressed High Intensity Radar Pulse (CHIRP) sonar acoustic signals. The frequency of individual side scan sonars can range from 100 to 1600 kHz, with source levels between 194 and 249 dB re 1 µPa at 1 m (rms). Pulse lengths will vary with according to the specific system, monotonic systems range between 0.125 and 200 milliseconds (ms) and CHIRP systems range between 400 and 20,000 ms. (HydroSurveys, 2008a, b; Dorst, 2010)

2.2.1.1.3. Geotechnical Surveys

In addition to geohazard surveys, there are other ancillary activities that can provide more detailed information about a prospective site. These geotechnical surveys are important to understand such site characteristics as sediment structures, strudel scouring, ice gouges, and a variety of shallow hazard information.

Geological/geochemical surveys involve collecting bottom samples to obtain physical and chemical data on surface sediments. Sediment samples typically are collected using a gravity/piston corer, grab sampler, or dredge sampler. Shallow coring, using conventional rotary drilling from a boat or drilling barge, is another method used to collect physical and chemical data on near-surface sediments.

Under the Proposed Action, five ancillary geotechnical surveys would be conducted during the First Incremental Step, with no more than one survey in any given year (Table 2–1). All geotechnical surveys would be conducted during between July and November.

2.2.1.1.4. Exploratory and Delineation Drilling

Under the Proposed Action, exploration drilling operations during the First Incremental Step will employ two MODUs with icebreakers and other support vessels (detailed in Section 2.2.1.1.6). Examples of MODUs include drillships, jackup rigs, and semisubmersibles.

Drillships

A drillship is a maritime vessel that has been equipped with a drilling apparatus. Most are built to the design specification of the company, but some are modified tanker hulls that have been equipped with a dynamic positioning system.

One example of a drillship that has been used in drilling on the Alaska OCS is the *M/V Discoverer* (also known as the *Noble Discoverer*). Shell Oil has proposed, in prior applications, to use the *Discoverer* for drilling in both the Chukchi and Beaufort seas and used the vessel in their 2012 exploratory drilling in the Leased Area (Shell Offshore, Inc., 2010; Bisson et al., 2013). The *Discoverer* is a drillship, built in 1976, that has been retrofitted for operating in Arctic waters. It is a 156 m (512 ft) conventionally-moored drillship with drilling equipment on a turret. It mobilizes under its own power, so it can be moved off the drill site with help of its anchor handler. Depending on the circumstances of the situation, the procedure and time needed to move off a drill site can change. In extreme emergencies, this process can be completed in less than one hour. In the event that operations must be temporarily curtailed due to the advance detection of a hazard, the process could take from 4 to 12 hrs. Typical transit speed of the *M/V Discoverer* is 8 kn (14.8 km/hr). Measurements of sounds produced by the *Discoverer* in the Chukchi Sea were performed in 2012. Broadband source levels of the *Discoverer* were 182 dB re 1 μ Pa (rms) (Bisson et al., 2013).

Support vessels are used to assist the drillship with icebreaking and ice management, anchor handling, oil spill response, refueling, resupply, and servicing. There is also the potential for re-supply to occur via a support helicopter from the shore to the drill site. The total number of support vessels and aircraft depends on the local conditions and the design of the exploration program. Section 2.2.1.1.6 provides further detail on the number and type of vessels and aircraft anticipated to support exploratory drilling operations.

Jackup Rigs

A jackup rig is an offshore structure composed of a hull, support legs, and a lifting system that allows it to be towed to a site, lower its legs into the seabed, and elevate its hull to provide a stable work deck. Because jackup rigs are supported by the seabed, they are preloaded when they first arrive at a site to simulate the maximum expected support leg load to ensure that, after they are jacked to full

airgap (the maximum height above the water) and experience operating loads, the supporting soil will provide a reliable foundation. The actual dimensions of a jackup rig would depend on the environment in which the unit would be operating and the maximum operating water depth. A typical jack up rig with a maximum operating depth of 50 m (164 ft) is approximately 50 m (164 ft) in length, 44 m (144 ft) beam, and 7 m (23 ft) deep.

Noise levels from jackup rigs have not been measured in the Arctic or any other environment (Wyatt, 2008), but are expected to be similar to or less than noise levels produced by the drillship discussed above, as jackup rigs use the same general drilling machinery that is the source of underwater noise for drillships. Sound levels transmitted into the water from bottom-founded structures are typically less than sound levels from a drillship because the vibrating machinery is not in direct contact with the water because the platform is above water. Because the jackup rig has fewer structures in direct contact with the water, noise levels are expected to be less.

As with drillships, support vessels are used to assist with ice breaking and ice management, oil spill response, refueling, resupply, and servicing. There is also the potential for re-supply to occur via a support helicopter from the shore to the drill site. The total number of support vessels depends on local conditions and the design of the exploration plan. Section 2.2.1.1.6 provides further detail on the number and types of vessels anticipated to support exploratory drilling operations.

Semisubmersibles

A semisubmersible is a MODU designed with a platform-type deck that contains drilling equipment and other machinery supported by pontoon-type columns that are submerged into the water. Semisubmersibles may either have their own propulsion or be towed into place. Once in place, they are partially submerged in the water using a pontoon system. This makes them less subject to rolling and pitching than other types of MODU. Semisubmersibles maintain their position either by mooring or dynamic positioning, whereby the vessel uses its propulsion system to maintain position.

Semisubmersibles are generally smaller vessels than drillships. Their noise levels would be comparable, but somewhat less because they have smaller engines than drillships. The only subsea footprint would be caused by mooring if the vessel were not dynamically positioned. Support vessels needed for semisubmersibles would be the same as those needed for drillships.

To date semisubmersibles have not been used in the U.S. Arctic. However, at least one company has proposed to use a semisubmersible drilling unit in future exploratory drilling in the Leased Area.

Exploratory Drilling Operations

Drilling operations are expected to range between 30 and 90 days at different well sites, depending on the depth of the well, delays during drilling, and time needed for well logging and testing operations. Considering the relatively short open-water season in the Chukchi Sea OCS (June–November), BOEM estimates that two wells per drilling rig could be drilled, tested, and abandoned during a single open-water season, assuming both MODUs were operating simultaneously. If a discovery were made during exploration well drilling, MODUs would drill delineation wells to determine the real extent of economic production. Operators need to verify that sufficient volumes are present to justify the expense of installing a platform and pipelines.

During the First Incremental Step, a maximum of 28 exploratory and delineation wells would be drilled, including dry wells. No more than four wells would be drilled annually (Table 2–1). All wells, including successful exploration and delineation wells would likely be plugged and abandoned rather than converted to production wells because it would require several years before platforms and pipelines could be installed and oil produced.

Exploratory drilling will disturb an area of the seafloor. The area of disturbance would vary based on the type of drill rig used, ocean currents, and other environmental factors, but in general includes disturbance from the mud cellar, the anchoring system for the MODU (e.g., legs of the jack up rig or footprint of the drillship anchors), displacement of sediments, and discharges from the drill hole. For example, a previous drilling operation on the Burger prospect (in the Leased Area) is estimated to have disturbed 1,018 ft² of seafloor per well and each well cellar excavated 619 yd³ of sediment (USDOI, BOEM, 2014). Cuttings from the well cellar excavation were deposited on the seafloor below the temperature and salinity stratification layer. It is estimated that the maximum thickness of the sediment deposition onto the seafloor would be 10.4 ft (3.2 m) and the deposition would continue out to a horizontal distance of 449 ft (137 m) from the excavation site, where it would be 0.4 in (1 cm) thick. The anchoring system of a drill ship with 12 anchors (usually drill ships use 8–12 anchors) would disturb an estimated 78,000 ft² (7,500 m²) of the sea floor.

Vertical Seismic Profiling

Vertical seismic profiling (VSP) is conducted as part of a drilling program in the wellbore. These programs use hydrophones suspended in the well at intervals, which receive signals from external sound sources; usually an airgun(s) is suspended from the drill rig or a nearby supply vessel. Data are used to aid in determining the structure of a particular petroleum-bearing zone. Purely defined, VSP refers to measurements made in a vertical wellbore using geophones inside the wellbore and a source at the surface near the well. In the more general context, VSPs vary in the well configuration, the number and location of sources and geophones, and how they are deployed. Most VSPs use a surface seismic source, which is commonly a vibrator on land and an airgun in offshore or marine environments. VSPs include the zero offset VSP, offset VSP, walk away VSP, walk-above VSP, salt-proximity VSP, shear-wave VSP, and drill-noise or seismic-while-drilling VSP. A VSP is a much more detailed survey than a check-shot survey because the geophones are more closely spaced, typically about 25 m (82 ft), whereas a check-shot survey might include measurements at intervals hundreds of meters apart. In addition, a VSP uses the reflected energy contained in the recorded trace at each receiver position, as well as the first direct path from source to receiver. The check-shot survey uses only the direct path travel time. In addition to tying well data to seismic data, the vertical seismic profile also allows for converting seismic data to zero phase data and distinguishing primary reflections from multiples. Airgun volumes for VSPs typically are 450–750 in³ (7.4–12.3 L). For example, a 500 in³ airgun array was used offshore Greenland for a VSP survey. The acoustic properties were modeled for an environmental impact assessment (Kyhn et al., 2011) to predict the possible exposure levels to marine mammals. The output of 500-in³ airgun array was 222 dB re 1 µPa at 1 m (rms).

It is unlikely that VSPs would be conducted at every exploratory and delineation well; however, for the purposes of this BA, BOEM conservatively assumes that VSP would be conducted in association with each wellbore, resulting in a maximum of 28 VSP occurring during the First Incremental Step (Table 2–1).

Authorized Discharges

The Proposed Action assumes that the synthetic drilling mud would be reconditioned and reused with an efficiency of 80%. All of the rock cuttings would be discharged at the exploration site. Discharges from exploration operations in the Chukchi Sea are permitted under a National Pollutant Discharge Elimination System (NPDES) General Permit that is issued by EPA and has a term of five years. Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage. Detailed information on the various types and properties of discharges from routine oil and gas activities is contained in the 2007 FEIS (USDOI, MMS, 2007). The estimated drill cuttings from one exploration well would be 5,800 bbl, while the estimated 3,200 bbl of drilling fluids would be associated with one exploration well.

The current NPDES General Permit for exploration discharges in the Chukchi Sea is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (Environmental Protection Agency (EPA), 2012). For background, the terms of this permit are indicative of the expected terms of future General Permits. The types of discharges in the current 2012–2017 General Permit are presented in Table 4–6 of the second SEIS (USDOJ, BOEM, 2014).

Unauthorized Discharges

Small Spills. A few small refined oil spills (<1,000 bbl) are considered reasonably foreseeable during the First Incremental Step. Spills during the First Incremental Step are expected to be small and consist of refined oils because crude and condensate oils would not be produced during exploration. Refined oil is used in exploratory drilling activity for equipment and refueling. Small refined oil spills during seismic and geophysical and geotechnical surveys and exploratory drilling activities would occur during July through early November.

The estimated total and annual numbers and volumes of small refined oil spills during First Incremental Step activities is presented in Table 2–2. BOEM and BSEE estimate that approximately 20 spills ranging in size from <1 bbl up to 55 bbl per spill could occur during the First Incremental Step (spill ranges sourced from USDOJ, BOEM, 2014). BOEM and BSEE anticipate that most spills from the Proposed Action’s seismic and G&G survey activities would be <1 bbl, one would be up to 13 bbl (spill ranges sourced from USDOJ, BOEM, 2014). BOEM and BSEE anticipate that most spills originating from the Proposed Action’s exploration and delineation drilling activities would be up to 5 bbl; some would be up to 55 bbl. For the purpose of analysis, BOEM and BSEE assume that the 13 bbl spill and one 55 bbl spill would occur during the First Incremental Step.

Table 2–2. Annual and Total Potential Small Spills from First Incremental Step Activities

Activity Phase	Estimated Total Number of Small Spills	Estimated Total Volume of Small Spills (bbl)
Small Refined Oil Spills		
Exploration Geological and Geophysical Activities	0 – 6	0 – < 18
Exploration and Delineation Drilling	0 – 14	0 – < 115

Large Spills. BOEM and BSEE estimate that no large spills >1,000–150,000 bbl would occur during the First Incremental Step of the Proposed Action. This estimate is based on a robust set of historical data about oil spills. Of over 15,000 exploration wells drilled on the OCS from 1971–2010, no crude oil spills ≥1,000 bbl have occurred during exploration, other than the Deepwater Horizon (DWH) incident. The DWH falls within the category of VLOS, which is defined as spills greater than 150,000 bbl, and is considered a low-probability, high-impact event. In other words, a spill of this volume is highly unlikely to occur during any activity phase, but if one did occur, the impacts would be substantial (USDOJ, BOEM, 2014). VLOS are analyzed separately from large oil spills, as they are not reasonably certain to occur.

In addition to the above assumption, no large spills are assumed to occur because only a very small fraction of spills are estimated during the relatively short First Incremental Step, as compared to the total spill frequency for Future Incremental Steps (which include development and production activities). Nevertheless, the exploration drilling program in the Proposed Action would include oil spill response and cleanup vessels and equipment, which may be staged near the drilling area or in more protected nearshore areas, such as Goodhope Bay in Kotzebue Sound.

Very Large Oil Spill. It is highly unlikely but cannot be wholly discounted that a VLOS could occur from a well control incident followed by a long duration flow during exploratory drilling in the First Incremental Step, and drilling for production in a Future Incremental Step. A VLOS is extremely unlikely to occur because the frequency of such a spill from a loss of well control incident is extremely low. Thus, while the potential effects of a VLOS would be substantial if one were to occur, and such effects were analyzed in the Second SEIS for the purpose of evaluating a low-probability, high impact event, the effects of a VLOS cannot be said to be reasonably certain to occur. Therefore, they are not considered a direct or indirect effect of Proposed Action under the ESA and are beyond the scope of the analysis here.

Details of the assumptions of the VLOS scenario and analytical methods used are presented in depth in Section 4.4.2 and Appendix A of the draft second SEIS (USDOI, BOEM, 2014). The OSRA does not account for response, cleanup, or containment and therefore may overestimate the chance of a large spill contacting a given geographical area.

2.2.1.1.5. Onshore Facilities Construction

Under the Proposed Action, up to three exploration-support facilities would be constructed onshore during the First Incremental Step to provide housing and equipment storage, air support, and search and rescue. These coastal facilities would be situated near Wainwright or Barrow, with efforts made to use existing infrastructure and to co-locate the bases, although uncertainty remains regarding the specific location of these exploration-support facilities.

Before any onshore construction activities occurred, the lessee would be obligated to coordinate with the land owner(s) in order to obtain necessary authorizations and permits for all onshore activities, including construction and gravel mining. This coordination could require additional ESA consultation(s) and additional mitigation measures to reduce construction and operation activity impacts to natural resources. Typical mitigation measures for onshore activities are presented in Section 2.3.

2.2.1.1.6. Transportation

Operations at remote locations in the Leased Area would require transportation of supplies and personnel by different means, depending on seasonal constraints and phase of the operations. Under the Proposed Action, marine vessels would be the primary form of transportation during the First Incremental Step. Aircraft would be used to conduct any search and rescue efforts and would support exploratory drilling activities as well as onshore construction. Onshore vehicle presence would be restricted to activities associated with shore base construction.

During exploration seismic surveys, the vessels would be largely self-contained. Therefore, helicopters would not be used for routine support of operations. Under the Proposed Action, during the open-water season smaller support vessels would make occasional trips (one to three round-trips per survey, depending upon the duration of the survey), probably operating out of Barrow and/or Wainwright. Additionally, if directed by NMFS or U.S. Fish and Wildlife Service (USFWS) during consultation, a mitigation vessel might accompany the seismic survey vessel. No support vessels would be associated with the in-ice seismic survey; however, an icebreaker would be present during the survey for ice management (Table 2–3).

During exploration drilling, operations would be supported by both helicopters and supply vessels (Table 2–3). An anchor handler would move MODUs to various drill sites. Helicopters would fly from Barrow and/or Wainwright at a frequency of one to six flights per day. Support-vessel traffic would be one to three round-trips per week, also out of Barrow and/or Wainwright. After completion of the exploration-support shore-bases, air and vessel traffic might alternatively originate from the onshore air support facility.

During the First Incremental Step, a tug and a refueling barge may be moored in Kotzebue Sound for oil spill recovery. It is anticipated that these vessels would be moored in the Goodhope Bay area of Kotzebue Sound. These vessels would be used for nearshore oil spill recovery. An additional tanker would serve as spill storage.

Ice-breaking and ice-management would likely occur during some of the activities described in the previous subsections. BOEM and BSEE define ice breaking and ice management as separate activities. Ice-breaking is defined as opening a pathway or lead through pack ice, ice floes, or landfast ice for the purpose of moving vessels through sea ice. Ice-breaking occurs in waters with ice. BOEM defines ice management as using an ice-hardened vessel or icebreaker to move floes away from a stationary vessel, such as a drill rig, by pushing, towing, or passing back and forth upstream of the stationary vessel or drill rig. Ice management activities take place in an environment that is primarily open water.

During shorebase construction, heavy equipment and materials would be moved to the coastal site using barges, aircraft, and perhaps winter ice roads. Under the Proposed Action, one to two barge trips (possibly from either West Dock or Nome) would occur in each of two consecutive open-water seasons. There could be as many as five transport aircraft (C-130 Hercules or larger) trips per day during peak periods of base construction (Table 2–3).

Utilization of winter ice roads would depend on the location of the shore-bases in proximity to Wainwright or Barrow, the presence of any existing ice roads, and the EP submitted to BOEM and BSEE by the lessee. Submission of an EP would require project-specific NEPA analysis and additional ESA consultation that would assess impacts of any proposed ice-roads or additional infrastructure associated with the shore-bases on threatened or endangered species and critical habitat. The overall frequency of transportation in and out of the shorebase would decrease substantially after construction is completed. In construction of the shorebase, it is anticipated that mobile ground equipment such as dozers, graders, crew vehicles would be used (Table 2–3).

Table 2–3. Transportation Potentially Associated with First Incremental Step Activities¹.

Activity Type	Activity Period	Transportation Type		
		Marine Vessel	Aircraft	Terrestrial Vehicle
Open-water season 2D/3D marine seismic survey	July–November	1 source/receiver vessel, 1 support vessel (<i>1–3 trips to shore per survey</i>), +/- 1 mitigation vessel	None	None
In-ice 2D marine seismic survey	October–December	1 seismic survey vessel, 1 icebreaker	None	None
Geohazard survey	July–November	1 vessel ²	None	None
Geotechnical survey	July–November	1 vessel ²	None	None
Exploratory drilling	June–November	Drilling Support: 2 MODUs, 2 ice breakers, 3 anchor handlers, 2 supply tug-and-barges, 3 offshore supply vessels, 2 support tugs, 2 science vessels, 2 shallow water vessels, +/- 1 MLC ROV system vessel	1+ helicopter (<i>1–6 flights per day</i>)	None

Activity Type	Activity Period	Transportation Type		
		Marine Vessel	Aircraft	Terrestrial Vehicle
		Oil Spill Response: 1 oil spill response vessel, 1 oil spill response tug and barge, 2 oil spill tankers, 1 oil spill containment system tug and barge, 1 oil spill response tug and barge for nearshore response		
Shorebase construction	Year-round	1–2 barge trips during first two open-water seasons of shorebase construction	1+ C-130 Hercules or similar, 1+ Boeing 737 or similar (Up to 5 flights per day)	Crew vehicles, Dozers, Graders, Dump trucks, Other mobile construction equipment as determined by the lessee's DPP

¹ The quantitative information contained in this table is BOEM and BSEE's best estimates for transportation activities Previous and present-day EPs as well as government NEPA documents specific to the Alaska OCS were consulted in the development of these estimates.

² In lieu of additional support vessels, companies that conduct geohazard and geotechnical surveys in the Arctic typically coordinate to ensure that two survey vessels are present in the vicinity of one another to provide support in case of emergency.

2.2.2. Future Incremental Steps

As described previously, Future Incremental Steps include all activities that would occur after anchor field exploration and delineation, and the approval of a DPP. These activities include the development and production of the anchor field, the exploration, development, and production of the satellite field, and decommissioning of both fields. Table 2–4 details the activities anticipated during Future Incremental Steps. Under the Proposed Action, oil would be produced first, as it can be shipped to market via TAPS, while the gas would initially be re-injected to aid oil recovery. Gas production would likely to occur much later in time after a gas transportation system (anticipated to be via pipelines) has been constructed. The Proposed Action assumes that that infrastructure to transport gas across state will be available in the later years of the prospects' production.

Under the Proposed Action, development of the anchor field would begin in approximately the 5th year and BOEM and BSEE assume that majority of development activities associated with the anchor field and the satellite field would occur over the next approximately 20 years (installation of supplemental offshore gas pipeline could continue into the later years of the Proposed Action). BOEM and BSEE anticipate that production activities would begin in approximately the 10th year and continue for roughly 50 years. Decommissioning would commence after oil, gas reserves at a given platform are depleted, and income from production no longer pays operating expenses. To comply with BSEE regulations (30 CFR 250.1710—wellheads/casings and 30 CFR 250.1725—platforms and other facilities), lessees are required to remove all seafloor obstructions from their leases within one year of lease termination or relinquishment. Under the Proposed Action, decommissioning is anticipated to begin after approximately 30 years of production.

It is important to note that the schedule of activities presented in the Proposed Action is a compressed and ambitious one resulting in a robust level of activities upon which to base the impacts analyses in

this consultation. The Proposed Action assumes there would be no construction delays for platforms, regulatory delays, or other delays of any kind. The Proposed Action also assumes immediate commitment from the operator(s) after a successful exploration program, with no funding delays, and that all operators coordinate and cooperate successfully. These assumptions help ensure the potential impacts of the Proposed Action will not be underestimated, while the actual timeline for development of a prospect in the Leased Area would be determined by the lessee and could be affected by any of the variables mentioned above.

Table 2–4. Activities Anticipated During Future Incremental Steps of the Proposed Action¹.

Activity	Activity Period	Estimated Operations	Associated Transportation
Exploration (Satellite Field)			
Marine seismic surveys (including potential in-ice surveys)	July–November (October–December for in-ice)	6 surveys over ~20 years; no more than one survey per year	1 source/receiver vessel, 1 support vessel (1–3 trips to shore per survey), +/- 1 mitigation vessel +/- 1 icebreaker (in-ice surveys only)
Geohazard survey	July–November	8 surveys over ~20 years; no more than two surveys per year, generally a maximum of 1 survey per year	1 vessel ¹
Geotechnical survey	July–November	8 surveys over ~20 years; no more than two surveys per year	1 vessel per survey ¹
Exploratory and delineation drilling	June–November	12 wells drilled in satellite field; maximum of 4 wells drilled per open-water season; maximum of 4 MODUs per open water season (includes MODUs for production drilling)	Drilling Support: 2–4 MODUs, 2–4 ice breakers, 3–6 anchor handlers, 2–4 supply tug-and-barges, 3–6 offshore supply vessels, 2–4 support tugs, 2–4 science vessels, 2–4 shallow water vessels, +/- 1 MLC ROV system vessel Oil Spill Response: 1 oil spill response vessel, 1 oil spill response tug and barge, 2 oil spill tankers, 1 oil spill containment system tug and barge, 1 oil spill response tug and barge for nearshore response
Development			
Offshore			
Subsea oil pipeline installation	July–November	160 mi of buried oil pipe from hub platform to shore; installed at the onset of development over the course of several open-water seasons	1 lay vessel, 1 trenching vessel, +/- 1 mitigation vessel
Subsea gas pipeline installation	July–November	160 mi of buried gas pipe from hub platform to shore; installed in towards the end of development over the course of several open-water seasons	1 lay vessel, 1 trenching vessel, +/- 1 mitigation vessel

Activity	Activity Period	Estimated Operations	Associated Transportation
Platform Installation	July–November	8 platforms installed over ~20 years (5 in anchor field, 3 in satellite field)	multiple tugs, barges
Flowline Installation	July–November	30 mi of flowline connecting subsea templates to host platforms (2 mi per template)	1 reel vessel, 1 trenching vessel, +/- 1 mitigation vessel
Template Installation	July–November	15 subsea templates	1+ installation vessel, 1 ROV, +/- 1 mitigation vessel
On-platform drilling	Year-Round	16 wells per platform per year (including both production and service wells)	None
Subsea well drilling	July–November	90 production wells (6 per template); maximum of 4 MODUs during open-water season (includes MODUs for exploratory drilling); BOEM assumes that a single MODU could drill up to 3 subsea wells in a single season	Drilling Support: 2–4 MODUs (includes MODUs associated with exploratory drilling that could occur simultaneous to subsea well drilling), 2–4 ice breakers, 3–6 anchor handlers, 2–4 supply tug-and-barges, 3–6 offshore supply vessels, 2–4 support tugs, 2–4 science vessels, 2–4 shallow water vessels, +/- 1 MLC ROV system vessel Oil Spill Response: 1 oil spill response vessel, 1 oil spill response tug and barge, 2 oil spill tankers, 1 oil spill containment system tug and barge, 1 oil spill response tug and barge for nearshore response
Personnel and supply transport	Year-Round	Includes crew changes, supply delivery, and waste transport	1–3 vessel trips per platform per week, 1–3 helicopter trips per platform per day, 1–2 barge trips per open-water season (for waste disposal)
Spill response	July–November	Vessels will likely be stationed at Wainwright or Barrow	1 barge (for spill response), 1 tug (for spill response), 1 tank vessel (for spill storage)
Onshore			
Production base construction	Year-Round	Construction to occur over 2 years. Would include landfall valve pad, protective ice berm, valve enclosure control building, pipeline riser well, onshore pipeline trench and backfill, a pump station, pipeline pigging facilities, and a land-farm for barged drilling waste treatment	Dump trucks, graders, crew transport vehicles Flights Barges

Activity	Activity Period	Estimated Operations	Associated Transportation
Boat terminal construction	Year-Round	Construction to occur over 2 years. Boat terminal would include a barge dock with lay-down area and material storage, fuel tank farm, and vehicle parking	Dredge, dozers, dump trucks, graders, crew transport vehicles Flights Barges
Oil pipeline installation	Year-round	300–320 mi of oil pipeline tying into TAPS; installed at the onset of development over the course of several winters. Includes VSMs and pump station installation.	Crew transport vehicles, helicopters, graders, backhoes, dump trucks, other large construction vehicles as needed
Gas pipeline installation	Year-round	300–320 mi of gas pipeline tying into future existing gas transport system; installed towards the end of development over several winters	Crew transport vehicles, helicopters, graders, backhoes, dump trucks, other large construction vehicles as needed
Personnel and supply transport	Year-Round	Includes crew changes and supply delivery	1–2 barge trips each summer for 2 summers during production base construction, Up to 5 C-130 or larger aircraft flights per day, road traffic
Production			
Offshore maintenance and support	Year-Round	Pigging, pipeline repairs, equipment and facilities maintenance and upgrades, well servicing, crew changes	1 support vessel trip per platform every 1–2 weeks, 1–3 flights per platform per day
Onshore maintenance and support	Year-Round	Pigging, pipeline repairs, equipment and facilities maintenance and upgrades, crew changes	2 flights per day, road traffic
Decommission			
Offshore decommission	Year-Round	Drilling and plugging wells, plugging pipelines and flowlines, removal of templates, manifolds, platforms	2–3 MODUs
Onshore decommission	Year-Round	Transfer of existing facilities and pipelines to other entities (e.g., industry, village associations)	Crew transport vehicles

¹ The quantitative information contained in this table is BOEM and BSEE's best estimates for transportation activities. Previous and present-day EPs as well as government NEPA documents specific to the Alaska OCS were consulted in the development of these estimates.

2.2.2.1. Infrastructure Development

Offshore and onshore development would commence simultaneously. Development would begin with the installation of oil pipelines (on- and off-shore) over the course of several years and the installation of processing and waste management facilities and a supply boat terminal at the exploration base, which would become the production base and first pump station. The lessee would coordinate with landowner(s) and relevant government agencies to obtain all necessary permits and authorizations for onshore activities, which may include separate ESA consultation processes.

Onshore, a main production shorebase would be developed. This may occur at a new location, or, alternatively, the existing exploration camp would likely be expanded and converted to a production shorebase. The shorebase would support offshore operations, including oil and gas processing, and would serve as the first pump station. The location of this shorebase is unknown, but BOEM and BSEE consider the likely location near Wainwright or Barrow or on the coast between Icy Cape and Point Belcher. The production base would be expected to be composed of the landfall valve pad with, protective ice berm, valve enclosure control building, pipeline riser well, onshore pipeline trench and backfill, a pump station, pipeline pigging facilities, a land-farm for barged drilling waste treatment. See Section 2.2.1.1.5 for discussion of the processes and permits necessary before final site selection is achieved, in order to ensure avoidance and minimization of impacts to listed species and designated critical habitat.

In association with the production shore-base, a supply boat terminal would be constructed. The boat terminal would include the barge dock with lay-down area and material storage, fuel tank farm, and vehicle parking.

From the production base, vertical support members (VSMs) would suspend communication cables and oil pipelines approximately 300–320 mi east to connect to existing North Slope oilfield infrastructure. Onshore oil pipeline placement would occur during winter. BOEM and BSEE assume that a large scale onshore gas transport system (similar to TAPS) will be developed in the future. On that assumption, the Proposed Action anticipates that a chilled high-pressure gas pipeline would be buried in the same corridor, approximately 20 years after the oil pipeline is installed.

Offshore pipeline installation would occur during the open-water season. All pipelines would be trenched in the seafloor as a protective measure against damage by floating ice masses. BOEM and BSEE anticipate that the depth and width of subsea pipeline trenches would be similar to those dug for Northstar (7–11 ft deep and 8–52 ft wide), with pipelines at greater depths requiring deeper and wider trenches. Approximately 6–9 ft of backfill would cover trenched pipelines.

An estimated 160 mi of trunk oil pipelines would connect the anchor field hub platform (1st installed platform) to the onshore processing facility (discussed below). An additional estimated 20 mi of oil pipeline would connect the satellite field hub platform to the anchor field hub. Subsea gas pipelines would be installed approximately 20 years after the oil pipelines and along the same routes.

After pipeline installation, offshore production platforms would be installed over the course of several open-water seasons. BOEM and BSEE anticipate that large, bottom-founded platforms, which would be pinned to the seafloor and stabilized by its wide base, anchoring system, and ballast, be used. Platforms would likely be constructed in large sections, which would be transported to the site by boat during the open-water season, before they are mated together. Five platforms would be located in the anchor field. Additional exploratory surveys and drilling (as described in Section 2.2.1.1) conducted during development of the anchor field would reveal a smaller discovery in the satellite field approximately 20 mi from the anchor field hub platform. An additional three platforms would be installed at the satellite field.

Each platform would have two drilling rigs capable of drilling year-round. Each platform would also house processing equipment, fuel and production storage capacity, and quarters for personnel. It is assumed that oil would be piped to the shore as soon as it is processed. There would be some storage capacity on the platforms to accommodate periods of processing equipment downtimes. The first platform would serve as the hub. Additional anchor field platforms would be located approximately 5 mi from the hub platform, with buried subsea flowlines (placed during pipeline installation) connecting each platform to the hub. One of the three satellite field platforms would act as a secondary hub, delivering oil and gas to the anchor field hub via 20 mi of subsea flowline. The two remaining satellite field platforms would connect to the secondary hub via 5 mi of subsea flowline.

A total of 15 subsea templates would be installed during open-water seasons. Template would be located within 2 mi of the host platform and connected via subsea flowline.

2.2.2.2. Production Drilling

Production well and service well drilling would be conducted both from production platforms and from drillships. An estimated annual maximum of eight wells could be drilled by each production platform rig (e.g., 16 wells total per platform per year). A total of 459 production and service wells would be drilled from production platforms over the life of the Proposed Action. Subsea wells would be drilled by drillships. With efficiencies gained by repeated operations, BOEM and BSEE assume that a single drillship could drill up to three subsea wells in a single season. The Proposed Action estimates that 6 to 9 subsea wells would be drilled per open-water season, requiring two to three drillships each summer over approximately 12 years. A total of 90 subsea production wells would be drilled over the life of the Proposed Action. Treated well cuttings and mud wastes for platform and subsea wells could be reinjected into disposal wells or barged to an onshore treatment and disposal facility located at the shorebase. The IPFs associated with production well drilling (i.e., noise generation, rock cuttings, drilling mud) would be similar in type as those described for exploratory drilling but, as previously stated, production well drilling produces less drilling mud and fewer cuttings than does exploration and delineation well drilling.

2.2.2.3. Production

Production operations would largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair. Maintenance and repair work would be required on the platforms, and processing equipment would be upgraded to remove bottlenecks in production systems. Well repair work would be required to keep both production and service wells operational. Well workovers would likely be made at 5–10 year intervals to restore production flow rates. Pipelines will be inspected and cleaned regularly using internal devices (“pigs”). Crews would be rotated at regular intervals.

2.2.2.4. Discharges

2.2.2.4.1. Authorized Discharges

Discharges from development and production operations in the Chukchi Sea are permitted under a National Pollutant Discharge Elimination System (NPDES) General Permit that is issued by EPA and have a term of five years. Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage.

The production fluids. The production fluids (oil, gas, and water) would be gathered on the platforms where gas and produced water would be separated and gas and water reinjected into the reservoir using service wells. During the later gas sales phase, water would continue to be reinjected. Disposal wells would handle wastewater from the crew quarters on the platforms.

2.2.2.4.2. Unauthorized Discharges

BOEM and BSEE’s estimate of the likelihood of one or more large spills occurring assumes that there is a 100% chance that development(s) will occur and 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced. For the purposes of analysis under the Proposed Action, BOEM and BSEE estimate that approximately 777 small spills (<1,000 bbl) could occur over the life of the Proposed Action (20 during the First Incremental Step and 757 during Future Incremental Steps).

Small Spills. Small spills (<1,000 bbl) of both refined oils and crude and condensate oils could occur both onshore and offshore during Future Incremental Steps. The estimated total and annual numbers and volumes of small refined oil spills resulting from Future Incremental Step activities are presented in Table 2–5. BOEM and BSEE estimate that approximately 535 spills of refined oil and 222 spills of crude or condensate oil or liquid nature gas could occur during Future Incremental Steps. BOEM and BSEE anticipate that these spills would be <1–5 bbl each but assumes that one of the on-shore spills would be a roughly 700–bbl spill occurring along the 300–320 mi onshore pipeline.

Table 2–5. Annual and Total Potential Small Spills from Future Incremental Step Activities.

Activity Phase	Estimated Total Number of Small Spills	Estimated Total Volume of Small Spills (bbl)
	Small Refined Oil Spills	
Exploration Geological and Geophysical Activities	0 – 9	0 – < 9
Exploration and Delineation Drilling	0 – 6	0 – < 30
Development and Production	0 – 520	0 – 1,600
	Small Crude or Liquid Natural Gas Condensate Oil Spills	
	0 – 222	0 – 2,000

Large Spills. A large spill could potentially come from four sources associated with OCS exploration or development operations: (1) pipelines (2) facilities (3) tankers or (4) support vessels. During the development of the second SEIS (USDOI, BOEM, 2014), BOEM and BSEE reviewed those four sources and determined well-control incidents (LOWCs) have the potential for the largest spill volumes, assuming all primary and secondary safeguards fail and the well does not bridge (collapse in on itself). At this time, pipelines are the preferred mode of petroleum transport (over tankers) in the Chukchi OCS and, therefore, BOEM and BSEE did not consider the loss of a fully loaded tanker reasonably foreseeable. The loss of the entire volume in an offshore pipeline would be less than a long duration well control incident with high flow rates. Sizes of spills from support vessels were considered based on foundering and the loss of entire fuel tanks, and determined to be lower in volume than a well control incident where all primary and secondary safeguards failed.

To estimate the effects of a large oil spill resulting from the Proposed Action, BOEM and BSEE estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM and BSEE also estimated the mean number of large spills and the chance of one or more large spills occurring over the life of the Proposed Action.

The large spill-size assumptions BOEM and BSEE used are based on the reported spills in the Gulf of Mexico and Pacific OCS because no large spills have occurred on the Alaska OCS from oil and gas activities. BOEM used the median OCS spill size as the likely large spill size (Anderson, Mayes, and LaBelle, 2012) because it is the most probable size for that spill size category. The Gulf of Mexico and Pacific OCS data show that a large spill most likely would be from a pipeline or a platform. The median size of a crude oil spill $\geq 1,000$ bbl from a pipeline on the OCS over the last 15 years is 1,720 bbl, and the average is 2,771 bbl (Anderson, Mayes, and LaBelle, 2012). The median spill size for a platform on the OCS over the entire record from 1964–2010, is 5,066 bbl, and the average is 395,500 bbl (Anderson, Mayes, and LaBelle, 2012). Outliers, such as the DWH spill volume, skew the average and the average is not a useful statistical measure. For purposes of analysis for the second SEIS, BOEM/BSEE used the median spill size, rounded to the nearest hundred shown below, as the likely large spill sizes.

BOEM and BSEE estimate that there is a 75% change of one or more large spills (>1,000 bbl) occurring from platforms or pipelines during Future Incremental Steps. For the OSRA in the second SEIS, BOEM and BSEE assume that two large spills would occur during the lifetime of the Proposed Action: one of these large spills would be from a production platform and the other from large offshore pipeline. No large spills are assumed to occur onshore.

Large condensate and diesel fuel spills would evaporate and disperse generally within 1–13 days. A large crude oil spill, however, is estimated to persist much longer: after 30 days 28–40% would evaporate, 3–16% would disperse, and 44–62% would remain. A large crude oil spill from a platform (5,100 bbl) into open-water would cover an estimated discontinuous area of 54 km² after 3 days and 1,063 km² after 30 days. A large crude oil spill from a platform on to the ice surface during November through May would cover an estimated discontinuous area of 18 km² after 3 days and 351 km² after 30 days. A large crude oil spill from an offshore pipeline (1,700 bbl) during open-water would cover an estimated discontinuous area of 31 km² after 3 days and 615 km² after 30 days. A large offshore pipeline crude oil spill onto the ice surface during November through May, would cover an estimated discontinuous area of 10 km² after 3 days, and 200 km² after 30 days. Oiled ice that drifts and subsequently melts during open water would introduce oil into surface waters in new areas. A discussion of large spill cleanup activities is presented in Section 2.2.1.1.4 of this BA and further details presented in Section 4.2 of the second SEIS (USDOI, BOEM, 2014).

BOEM and BSEE analyzed the potential impacts of a VLOS (a spill of >150,000 bbl) scenario in the second SEIS for the purposes of evaluating a low-probability, high-impact event in the Leased Area. VLOS are analyzed separately from large oil spills due to their lower level of probability. Because a VLOS is a highly unlikely event and is not reasonably certain to occur it is not considered for the purposes of this BA to be an IPF of the Proposed Action. The VLOS scenario and analysis are detailed in Section 4.2 and Appendix A of the draft second SEIS (USDOI, BOEM, 2014).

Large Spill Cleanup Activities. Cleanup activities would likely occur after a large spill. Activities could include vessel traffic, aircraft traffic, in-situ burning, animal rescue, dispersant use, booming, beach cleaning, drilling of a relief well, and bioremediation (USDOI, BOEM, 2014). Detailed descriptions of these activities are presented in Section 4.2 of the draft second SEIS (USDOI, BOEM, 2014). Based on clean-up activities with the Exxon Valdez Oil Spill where only about 14% was recovered or disposed (Wolf et al., 1994), spill response may be largely unsuccessful in remote open water conditions, and spill response drills have had various levels of success in the cleanup of oil in broken-ice conditions (Dickens, 2011). It is difficult to say how effective cleanup efforts would be at reducing the volume of oil in the environment if a large oil spill occurred.

Pollution prevention and oil spill response regulations and methods implemented by BOEM, BSEE, and offshore operators since the Deepwater Horizon event (USDOI, BOEMRE, 2011a; Visser, 2011) have improved oil exploration and development/production operations, with the goal of reducing the likelihood of a large spill. However, if an oil spill does occur, cleanup efforts would likely take place. The duration of cleanup activities for a large spill would depend on the timing and amount of oil spilled, but would likely last months or years. These activities could involve multiple marine vessels and aircraft operating in the spill area for a long time (USDOI, BOEM, 2014).

2.2.2.5. Transportation

During Future Incremental Step construction activities, BOEM and BSEE estimate up to three helicopter flights per day and three support vessel trips per week would be made to the central platform site, either from the shore base or from Barrow. Heavy equipment and other materials for construction would likely be transported to the shore base site via barges (estimated at two barge trips per year) and aircraft (five C-130 flights per week).

In the production phase, the number of helicopter trips to the production platforms would likely remain the same, while vessel traffic would drop to one trip every one to two weeks. Two barge trips per year for six years may also be required to remove cuttings and spent mud from the subsea templates and central platform. Two to three daily aircraft flights are expected at the shorebase and ice roads may be constructed as needed. Table 2–4 presents transportation types and trip frequencies estimated to occur during Future Incremental Steps by activity type.

2.2.2.6. Decommissioning

Decommissioning would commence after both oil and gas resources are depleted, and income from production no longer pays operating expenses. MODUs (two to three per open-water season over an estimated 12 years) would be used to plug wells with cement permanently. Wellhead equipment would be removed and processing modules would be moved off the platforms. Subsea pipelines and flowlines would be decommissioned by cleaning the line, plugging both ends, and leaving it in place buried in the seabed. The overland oil and gas pipelines would remain in operation and are likely to be used by other fields in the NPR-A. Lastly, the platform would be disassembled and removed from the area and the seafloor site would be cleared of all obstructions. Post-decommissioning surveys would be required to confirm that no debris remains following decommissioning and that pipelines were abandoned properly.

2.3. Mitigation Measures

The following sections describe a variety of mitigation measures typically required for the types of activities comprising the Proposed Action. As described below, at the lease sale stage these mitigations typically take the form of lease stipulations; post-lease activities may have mitigation imposed through conditions of approval of plans, permit conditions, or other mechanisms. We note, however, that while the Proposed Action represents a reasonably foreseeable suite of exploration, development, production, and decommissioning activities that could potentially occur, considerable uncertainty exists as to what activities will actually be proposed in the future. As specific projects are proposed in this multi-stage oil and gas program, more precise information about the nature and extent of the activities – including the scale and location of the activities and a description of the particular technologies to be employed – will be considered and evaluated in additional ESA consultations and other analyses (such as NEPA) as appropriate. Through this multi-stage process, a dynamic analysis of the potential effects of oil and gas activities is ensured, and additional mitigation measures and protections may be developed and at any stage based on the specific details of the particular projects.

There are a variety of typical design features and operational procedures used to mitigate the potential impacts of petroleum activities. Leaseholders and other permittees routinely request, and are expected to obtain, authorizations that include Incidental Harassment Authorizations (IHAs) and Letters of Authorization (LOAs). These authorizations are for activities that could result in the “take” or “harvest” of marine mammals under the MMPA. These authorizations contain mitigation measures to ensure the authorized activities would result in the take of no more than small numbers of marine mammals and have no more than a negligible impact on marine mammal stocks. This standard represents a threshold for impacts than the jeopardy standard under the ESA. Mitigation measures typically required for activities in the Chukchi Sea are described below and analyzed in Section 5. As such measures are continually being revised or updated, and can be site-specific, the list below is not intended as a commitment for any particular activity. The final design features and operational procedures used for mitigation are identified in each LOA or IHA prior to commencement of activities in the Alaska OCS.

In the following sections, BOEM and BSEE discuss the kinds of mitigation measures that are typically applied to the types of activities comprising the First Incremental Step and then those specific to Future Incremental Step activities. The final section addresses two new technologies with potential for ameliorating the effects of airguns, as well as several new technologies with potential for replacing airguns as a means of reducing potential adverse effects on marine mammals. BOEM did not identify any additional mitigation measures specific to the natural gas development and production scenario evaluated in the Lease Sale 193 Exploration and Development Scenario in the 2014 second SEIS (USDOJ, BOEM, 2014).

2.3.1. Lease Sale 193 Stipulations

Mitigation measures are associated with each lease sale in the form of lease stipulations. Stipulations are requirements added to the lease that become contractual obligations that the lessee must follow. The seven stipulations that apply to the leases issued pursuant to Chukchi Sea OCS Oil and Gas Lease Sale 193 are set forth in Appendix D of the Second SEIS and are included in Appendix A. The list of lease stipulations below remains comprehensive:

1. Protection of Biological Resources
2. Orientation Program
3. Transportation of Hydrocarbons
4. Industry Site-Specific Monitoring for Marine Mammal Subsistence Resources
5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvest Activities
6. Pre-Booming Requirements for Fuel Transfers
7. Measures to Minimize Effects on Spectacled And Steller's Eiders from Exploration Drilling

Of particular relevance to this BA are lease stipulations 1, 4, and 5. Stipulation 1 gives BOEM and BSEE additional authority when a previously unidentified biological population or habitat is discovered in the lease area, including the authority to require that the lessee conduct biological surveys to determine the presence, extent, and composition of the biological population(s) or habitat(s), and relocate and/or modify the types and timing of operations to minimize impacts to the biological population(s) and/or habitat(s). Stipulation 4 requires that lessees who are proposing to conduct exploration operations on lease blocks that were identified during Lease Sale 193 as important areas for subsistence (see Appendix A) conduct a Regional Supervisor, Field Operations (RS/FO)-approved site-specific monitoring program unless the RS/FO, in consultation with appropriate agencies (i.e., NMFS, USFWS) and co-management organizations (e.g., Alaska Eskimo Whaling Commission (AEWC), Ice Sea Commission), determines that a monitoring program is not necessary. Stipulation 5 requires that all exploration, development, and production operations (and support activities associated with such operations) within lease blocks that were identified during Lease Sale 193 as important areas for subsistence (see Appendix A) and in all Federal waters landward of the Lease Sale 193 area be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities.

In addition to stipulations, lease sales may also have ITLs (Information to Lessees) and NTLs (Notices to Lessees) associated with them. Certain ITLs and NTLs provide additional information to the lessees on best practices or ways to further mitigate the potential for impacts.

2.3.2. Mitigation Measures Associated with First and Future Incremental Step Activities

Mitigation measures are specific to the different types of activities in each phase of oil and gas development. Below, with respect to exploration, mitigation measures and typical monitoring

protocols for seismic operations are addressed first, and then mitigation measures associated with exploratory and delineation drilling are presented. Mitigation measures for vessel, aircraft, and terrestrial vehicle operations and onshore development activities, are also presented.

If First Incremental Step activities delineate oil and gas reserves of sufficient size, and companies choose to move into production, additional consultation would take place when BOEM receives a DPP. The DPP describes development and production activities proposed by an operator for a lease or group of leases. The description includes the timing of these activities, information concerning drilling vessels, the location of each proposed well or production platform or other structure, and an analysis of both offshore and onshore impacts that may occur as a result of the plan's implementation. The DPP would identify the precise location of the production well and associated facilities such as pipelines to shore and onshore processing facilities, providing BOEM, BSEE, and NMFS with project-specific details of Future Incremental Step activities that enable the agencies to evaluate impacts on listed species at a more detailed level and identify potential mitigation of such impacts.

2.3.2.1. Seismic Operations

Seismic operations include deep penetration (primarily marine streamer 2D and 3D surveys; see Section 2.2.1.1.1) and ancillary activities (high-resolution surveys; see Sections 2.2.1.1.2 and 2.2.1.1.3). Monitoring is conducted by on-board Protected Species Observers (PSOs) in order to activate appropriate mitigation measures to protect marine mammals during completion of specific activities. Therefore, monitoring protocols are discussed first, followed by mitigation measures in four categories of seismic survey.

2.3.2.2. Seismic Survey Mitigation

The monitoring protocols below are important for ensuring that the following mitigation measures are implemented as appropriate. Mitigation measures vary with the specific category of seismic survey being utilized. Four categories are discussed below.

2.3.2.2.1. Vessel-based Seismic Surveys

BOEM and BSEE's G&G permit stipulations for vessel-based surveys include:

- **Timing and location:** Timing and locating survey activities to avoid interference with the marine mammal hunts.
- **Minimized energy:** Selecting and configuring the energy source array in such a way that it minimizes the amount of energy introduced into the marine environment by using the lowest sound levels feasible to accomplish data collection needs.
- **Established safety zones:** Early season field assessment to establish and refine (as necessary) the appropriate 180-dB and 190-dB safety zones, and other radii relevant to behavioral disturbance.

The potential disturbance of marine mammals during seismic survey operations is minimized further through the typical implementation of several ship-based mitigation measures, which include establishing and monitoring safety and disturbance zones, speed and course alterations, ramp-up (or soft start), power-down, and shutdown procedures, and provisions for poor visibility conditions.

- **Safety and disturbance zones:** Operators are required to use NMFS-approved observers onboard the survey vessel to monitor the 190-, 180-, and 160-dB (rms) safety radii for pinnipeds and cetaceans and to implement other appropriate mitigation measures. Safety radii for marine mammals around airgun arrays are customarily defined as the distances within which received pulse levels are greater than or equal to 180 dB re 1 μ Pa (rms) for cetaceans

and greater than or equal to 190 dB re 1 μ Pa (rms) for pinnipeds. A 160 dB re 1 μ Pa (rms) monitoring zone has also been established and will be monitored for the presence of an aggregation of 12 or more bowhead whales or gray whales. The NMFS should define what constitutes an aggregation in the IHA.

- **Ramp-up:** A ramp-up (or “soft start”) of a sound source array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns until the desired operating level of the full array is attained. The purpose of a ramp-up is to alert marine mammals in the vicinity to the presence of the sound source and to provide them time to leave the area and thus avoid any potential injury or impairment of their hearing abilities. During a survey program, the operator is required to ramp up sound sources slowly (if the sound source being utilized generates sound energy within the frequency spectrum of cetacean or pinnipeds hearing). Full ramp-ups (i.e., from a cold start after a shutdown, when no airguns have been firing) will begin by firing one small airgun. Ramp-ups are required at any time electrical power to the airgun array has been discontinued for a period of 10 min or more and the observer watch has been suspended. The entire safety zone must be visible and monitored by observers during the 30 min lead-in to a full ramp-up, and clear of marine mammals for 15 min prior to beginning the ramp-up from a cold start, to ensure that no marine mammals enter the safety zone.
- **Power-downs and Shutdowns:** A power-down is the immediate reduction in the number of operating energy sources from all firing to some smaller number. A shutdown is the immediate cessation of firing of all energy sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching near or close to, the applicable safety zone of the full arrays but is outside the applicable safety zone of the single source. If a marine mammal(s) is sighted within the applicable safety zone of the single energy source, the entire array will be shut down (i.e., no sources firing).
- **Following a power-down or shutdown,** operation of the airgun array will not resume until the marine mammal has cleared the applicable safety zone. If a marine mammal(s) is sighted within the safety zone during the 30 min watch prior to ramp-up, ramp-up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15 min for pinnipeds or 30 min for baleen whales. For an aggregation of 12 or more mysticete whales, the acoustic equipment will not be turned back on or return to full power until the aggregation has left the 160-dB isopleths or the animals forming the aggregation are reduced to fewer than 12 bowhead or gray whales. The vessel operator and observers will maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

During periods of transit between survey transects and turning, at least one airgun (or sound source) will remain operational. The ramp-up procedure still must be followed when increasing the source levels from one gun to the full array. Keeping an air gun firing avoids the prohibition of a cold start during darkness or other periods of poor visibility. Survey operations can resume upon entry to a new transect without a full ramp-up and the associated 30 min lead-in observations as long as the exclusion zones are free of marine mammals.

- **Operations at Night and in Poor Visibility:** Most operators conduct seismic operations 24 hr/day. When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infrared or night-vision binoculars will be available for use. It is recognized, however, that their effectiveness is limited. For that reason, observers will not routinely be on watch at night, except in periods before and during ramp-ups. As stated earlier, if the entire safety zone is not visible for at least 30 min prior to ramp-up from a cold start, then ramp-up may not proceed. It should be noted that if one small airgun has remained

firing, the rest of the array could be ramped up during darkness or in periods of low visibility. Survey operations may continue under conditions of darkness or reduced visibility. Note: An exception to this is when conducting in-ice surveys.

For in-ice surveys only, vessel-based observers would typically be required to monitor for marine mammals near the seismic source vessel during all periods of airgun survey operations and prior to any ramp up of the airgun array. Observers would not be required to monitor for marine mammals during turns and during transit between seismic survey lines when a mitigation airgun is operating.

- ***Speed and Course Alterations:*** If a marine mammal (in water) is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course will be changed in a manner that does not compromise safety requirements. The animal's activities and movements relative to the source vessel will be closely monitored to ensure that the individual does not approach within the safety radius. If the mammal is sighted approaching near or close to the applicable safety radius, further mitigative actions must be taken, i.e., additional course alterations, power-down, or shutdown of the airgun.

In the event that an injured or dead marine mammal is sighted within an area where the operator deployed and utilized airguns within the past 24 hr, the airguns must be shut down immediately and the Marine Mammal Stranding Network/NMFS notified. If an assessment (certified by the lead PSO onboard) indicates, the marine mammal was not a casualty of project-related vessel/seismic operations, the ramp-up may be initiated and the survey continued.

2.3.2.2.2. In-Ice Seismic Surveys

A recent proposal for an in-ice seismic survey incorporated design features and operational procedures for minimizing the potential for impacts to marine mammals (NMFS, 2013a). The survey was designed to proceed as follows:

- The survey was scheduled to occur in late September–December to avoid higher local marine mammal abundance.
- The in-ice seismic survey would have been completed prior to the time when ringed seals would establish and enter birth lairs.
- The seismic survey would have begun in the deep water area of the northeastern U.S. Beaufort Sea where marine mammals would be least abundant.
- The survey would then have progressed toward shore, concentrating on the eastern half of the U.S. Beaufort Sea. Most bowhead whales would have migrated through this area before the vessels began work in the eastern portion of the migration corridor in late October.
- The survey vessels would then have proceeded to the deep water area of the northwestern Beaufort Sea and progressed toward shore in the western half of the Beaufort Sea.
- PSOs were required to be on duty whenever airguns were firing during daylight and during the 30-min periods prior to ramp up. PSOs were on standby for monitoring during periods of darkness. The PSOs could be called to duty when marine mammals were sighted and/or during ramp up of the powered-down array when the mitigation gun was firing during low visibility.
- The survey would have proceeded along a course designed in part to avoid interference with marine mammal migrations.

Authorization of an in-ice seismic survey is anticipated to require the same basic mitigation measures as required for open-water vessel-based seismic surveys, with additional measures to account for longer periods of darkness:

- **Safety zones:** As with other seismic surveys, a 180-dB (for cetaceans)/190-dB (for pinnipeds) isopleth zone around the seismic-survey-sound source must remain free of marine mammals before the survey can begin and must remain free of marine mammals during the survey.
- **Observers:** Trained observers would watch for and identify marine mammals; recording their numbers, distances, and reactions to the survey operations. The observers have the authority to initiate a power-down or shutdown.
- **Equipment:** The observers would have 7×50 reticle binoculars, +20× binoculars, a GPS unit, laptop computers, and night vision binoculars available. The observers may use night vision binoculars or floodlights to aid monitoring during periods of darkness. A forward looking infrared thermal imaging (FLIR) camera system mounted on a high point in front of the icebreaker would also be available to assist with detecting the presence of seals on ice and in water ahead of the airgun array.
- **Ramp up:** If the airgun array is shut down for any reason, it will not be ramped up again until no marine mammals are detected within the 180/190-dB exclusion zone for 30 min.
- **Exclusion zone:** While ice would be more prevalent during the post-September period, observations of a seal on ice would not trigger a shutdown unless the seal entered the water within the exclusion zone.

BOEM requires detailed weekly operations reports, which includes observer reports during operations, and a comprehensive completion report due 30 days after operations cease. Any harm or mortality to a marine mammal must be reported to BOEM, BSEE, and NMFS immediately. Review of the observer reports, vessel track, and activity reports can be used as a management tool to monitor disturbance events during the survey and to modify survey plans, if necessary.

2.3.2.2.3. Protected Species Monitoring

Monitoring for marine mammals during seismic surveys will be conducted throughout the period of survey operations by trained PSOs. The observers are stationed aboard the survey source vessel. Duties of the observers include watching for and identifying cetaceans and pinnipeds; recording their numbers, distances, and reactions to the survey operations; initiating mitigation measures; and reporting the results.

The observers must be on watch during all daylight periods when the energy sources are in operation and when energy source operations are to start up at night. A shift does not exceed four consecutive hours, and no observer works more than three shifts in a 24-hr period (i.e., 12 hr total per day) in order to avoid fatigue. Observers are biologists/local experts who have previous marine mammal observation experience and field crew leaders are highly experienced with previous vessel-based monitoring projects. Qualifications for these individuals are typically provided to NMFS for review and acceptance. All observers complete a training session on marine mammal monitoring shortly before the start of their season.

Monitoring Methods

The following are the standard monitoring methods utilized to ensure that appropriate mitigation measures are initiated at the appropriate times.

- **Vantage point:** The observer(s) will watch for marine mammals from the best available vantage point on the operating source vessel, which is usually the bridge or flying bridge. Personnel on the bridge will assist the PSOs in watching for marine mammals.
- **Observer equipment:** The observer(s) will scan systematically with the naked eye and 7 x 50 reticle binoculars, supplemented with 20 x 50 image stabilized binoculars, and night-vision equipment when needed.
- **Safety zones:** The observer(s) will give particular attention to the areas within the “safety zone” around the source vessel. These zones are the maximum distances within which received levels may exceed 180 dB re 1 μ Pa (rms) for cetaceans or 190 dB re 1 μ Pa (rms) for pinnipeds. The observers will also monitor the 160 dB re 1 μ Pa (rms) radius for Level B harassment takes, and the 160-dB isopleth will be monitored for the presence of aggregations of 12 or more bowhead or gray whales. When a marine mammal is seen within the applicable safety radius, the geophysical crew will be notified immediately so that the required mitigation measures can be implemented. It is expected that the airgun arrays will be shut down or powered down within several seconds—often before the next shot would be fired, and almost always before more than one additional shot is fired. The observer will then maintain a watch to determine when the mammal(s) is outside the safety zone such that airgun operations can resume.
- **Sighting information:** When a marine mammal sighting is made, the following information about the sighting is recorded: (1) species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from the source vessel, apparent reaction to the source vessel (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace; (2) time, location, heading, speed, activity of the vessel, and operational state (e.g., operating airguns, ramp-up, etc.), sea state, ice cover, visibility, and sun glare; and (3) the positions of other vessel(s) in the vicinity of the source vessel. This information will be recorded by the observers at times of marine mammal sightings.
- **General information:** The ship’s position, heading, and speed; the operational state (e.g., number and size of operating energy sources); and the water temperature (if available), water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 min during a watch, and whenever there is a substantial change in one or more of those variables.
- **Estimated distances:** Distances to nearby marine mammals (e.g., those within or near the 190-dB (or other) safety zone applicable to pinnipeds) will be estimated with binoculars (7 x 50) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers will use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.
- **Observation equipment:** Prior to mid-August, there will be no hours of total darkness in the Chukchi Sea Program Area. Onboard observers will scan systematically with the naked eye, and the operators will also provide or arrange for the following specialized field equipment for use by the observers: reticle binoculars, 20 x 50 image stabilized binoculars, Big Eye binoculars, laser rangefinders, inclinometer, and laptop computers. Night vision equipment will be available for use when needed.

Acoustic Sound Source Verification Measurements

The operator or leaseholder is typically required by NMFS to conduct acoustic measurements of their equipment (including source arrays) at the source. These sound source verification (SSV) tests will be

utilized to determine safety radii for the airgun array. A report on the preliminary results of the acoustic verification measurements, including as a minimum the measured 190-, 180-, and 160-dB re 1 μ Pa (rms) radii of the airgun sources, will be submitted within 5 days after collection and analysis of those measurements. This report will specify the distances of the safety zones that were adopted for the survey. The measurements are made at the start of the field season so that the measured radii can be used for the remainder of the survey period.

Field Data-recording and Verification

The following data recording and verification procedures allow initial data summaries to be prepared during and shortly after the field season. These procedures will facilitate transfer of the data to statistical, graphical, or other programs for further processing. Quality control of the data will be facilitated by the start-of-season training session, subsequent supervision by the onboard field crew leader, and ongoing data checks during the field season.

- **Recording:** The observers will record their observations onto datasheets or directly into handheld computers.
- **Database:** During periods between watches and periods when operations are suspended, data will be entered into a laptop computer running a custom computer database.
- **Verification:** The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered and by subsequent manual checking of the database printouts.

Use of Passive Acoustic Arrays

Although not specifically required, industry has jointly funded an extensive acoustic monitoring program. This program incorporates the use of dozens of recorders distributed broadly across survey area and the nearshore environment. The broad area arrays are designed to capture both general background soundscape data and marine mammal call data. From these recordings, it is anticipated that industry/government may be able to gain insights into large-scale distribution of marine mammals, identification of marine mammal species present, movement and migration patterns, and general abundance data. The intense area arrays are designed to support localization of marine mammal calls on and around the survey areas.

Reporting

The results of vessel-based monitoring, including estimates of “take” by harassment, are presented in “90 day” and final technical reports. The technical reports include:

- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through study period versus operational state, sea state, and other factors affecting visibility and detectability of marine mammals).
- Summaries of the occurrence of power-downs, shutdowns, ramp-ups, and ramp-up delays.
- Analyses of the effects of various factors, influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare).
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.
- Sighting rates of marine mammals versus operational state (and other variables that could affect detectability).
- Initial sighting distances versus operational state.

- Closest point of approach versus operational state.
- Observed behaviors and types of movements versus operational state.
- Numbers of sightings/individuals seen versus operational state.
- Distribution around the acoustic source vessel versus operational state.
- Estimates of take by harassment.

The take estimates are calculated using two different methods to provide both minimal and maximal estimates. The minimum estimate is based on the numbers of marine mammals directly seen within the relevant radii (160, 180, and 190 dB (rms)) by observers on the source vessel during survey activities. The maximal estimate is calculated using densities of marine mammals determined for non-acoustic areas and times. These density estimates are calculated from data collected during (a) vessel based surveys in non-operational areas, or (b) observations from the source vessel or supply boats during non-operational periods. The estimated densities in areas without data acquisition activity are applied to the amount of area exposed to the relevant levels of sound to calculate the maximal number of animals potentially exposed or deflected. These reports are due 90 days after termination of the survey season.

2.3.2.3. Exploration and Delineation Drilling

Under the Proposed Action, exploration and delineation drilling operations are expected to use MODUs with icebreaker support vessels. Drilling operations are expected to range between 30 and 90 days per well site, depending on the depth of the well, delays during drilling, and time needed for well logging and testing operations. Considering the relatively short open-water season in the Chukchi Sea OCS (June–November), BOEM and BSEE estimate that two wells per drilling rig could be drilled, tested, and abandoned during a single open-water season. Drilling operations would be supported by resupply vessels and, most likely, ice management vessels.

Drilling activities generate continuous non-pulse sounds during operations. The continuous nature of these sounds allows cetaceans and pinnipeds approaching the activity to be exposed to increasing levels of noise and to have an opportunity to avoid the location well before there is any chance of injury.

Mitigation measures are unique depending on the specific circumstances of the drilling operations, as described below.

Shell Gulf of Mexico, Inc. measured the sounds produced by the *Discoverer* while drilling on the Burger Prospect (within the Leased Area) in 2012. A broadband (10 Hz – 32 kHz) source level of 182 dB was calculated for the *Discoverer* based on the measurements recorded when drilling the 26-inch hole interval (Bisson et al., 2013). These estimates are considered representative of a typical industry-standard, ice-reinforced drillship that would be used for exploration drilling in the Arctic OCS.

Shell's measurements showed source levels from drilling would fall below 160 dB (rms) within 10-m from the drillship. The 2012 measurement of the distance to the 120-dB (rms) threshold for normal drilling activity by the *Discoverer* was 0.93 mi (1.5 km) while the distance of the ≥ 120 dB (rms) radius during mudline cellar (MLC) construction was 5.1 mi (8.2 km) (Bisson et al., 2013). These near-continuous, non-pulse source sound levels were expected to cause some temporary avoidance of the immediate area by marine mammals but no physical damage to marine mammal hearing.

Drilling activities could cease in certain areas in deference to subsistence whaling when operations are close enough to impact the hunt(s). While MODUs could be moved to another area during this period of inactivity, moving a drilling rig in the middle of the season increases the chance of a spill and poses associated safety and logistical concerns. The non-operation of MODU would avoid

drilling-related effects to listed species at the drill site, however as this measure is highly location- and season-specific, this type of mitigation measure cannot be considered to apply to all MODU operations. The mitigation of subsistence marine mammal harvests is a requirement of the MMPA, and is not a direct consideration of the ESA.

Previously submitted exploration plans have included the use of observers onboard the drillship and various support vessels to monitor marine mammals and marine mammal responses to industry activities. While not specifically required for inclusion in exploration plans, these monitoring efforts will help industry/government agencies evaluate the effectiveness of mitigation measures and evaluate adverse effects of the activity on marine mammals. The observers would initiate mitigation measures should in-field measurements of the operations indicate conditions represented a threat to the health and well-being of marine mammals.

Mitigation measures for authorized discharges are described according to relevant requirements of the EPA NPDES permit (see Section 2.2.1.1.4)

2.3.2.4. Vessel Operations

There are wide varieties of vessels of different types and sizes that operate in support of exploration activities. These vessels typically conform to the following operational procedures with respect to whales, as stipulated in IHAs:

- **Maximum distance.** Operators of vessels should conduct their activities at all times at the maximum distance possible from pods of whales.
- **Changes in direction.** Vessel operators should avoid multiple changes in direction when within 300 yd of whales; however, those vessels capable of steering around such groups should do so.
- **Changes in speed.** Vessels should avoid multiple speed changes; however, vessels should slow down within 300 yd of whales, especially during poor visibility, to reduce the potential for collisions.
- **Groups of whales.** Vessels may not be operated in such a way as to separate members of a group of whales.

Some oil and gas exploration activity includes the use of an icebreaker. Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Greene and Moore, 1995). As the icebreakers would not generate noise above 160 dB re 1 μ Pa (rms), and because the icebreaker activity would most likely be needed to protect the safety of fleet/drilling platform, there are no associated mitigation measures or provisions for shutdowns, power-downs, or ramp-ups. The icebreakers could be required to have on-board PSOs whose duties will include watching for and identifying marine mammals, recording their numbers, recording distances, and recording their reactions to the drilling operations.

2.3.2.5. Aircraft Operations

Aircraft are typically required to operate within specific height and distance parameters with respect to marine mammals. These include the following:

- **All aircraft:** Aircraft are typically required to operate above 1,500 ft above sea level (asl) when within 500 lateral yd of pods of whales, except for an emergency or navigational safety.
- **Helicopters:** Helicopters may not hover or circle above marine mammals.

- **Inclement weather:** When weather conditions do not allow a 1,500 ft asl flying altitude, such as during storms or when cloud cover is low, aircraft may be operated below 1,000 ft asl, but the operator should avoid known whale concentration areas and take precautions to avoid flying directly over or within 500 yd of whales.
- **Support aircraft:** Support aircraft must avoid extended flights over the coastline to minimize effects on marine mammals in nearshore waters or the coastline.
- **Support aircraft:** Support aircraft must avoid extended flights over the coastline to minimize effects on marine mammals in nearshore waters or the coastline.

Aerial marine mammal surveys have not been required in the Chukchi Sea because of a lack of adequate landing facilities and the prevalence of fog and other inclement weather in that area, potentially resulting in an inability to return to the airport of origin, and thereby resulting in safety concerns.

2.3.2.6. Onshore Operations

Onshore activities associated with the Proposed Action would be subject to permits, authorizations, stipulations, required operating procedures (ROPs), and best management practices (BMPs) as recommended or required by the appropriate land-based resource and management agencies. The U.S. Bureau of Land Management's 2013 Record of Decision (ROD) for the National Petroleum Reserve – Alaska Integrated Activities Plan (USDOI, BLM, 2013) presents stipulations and BMPs that are typical of the types of mitigation BOEM anticipates for onshore oil and gas activities described in the Proposed Action if located on Federal lands. These mitigation measures provide operators with guidance in minimizing impacts to wildlife, vegetation, and subsistence resources, including requirements for water and mineral withdrawals, waste disposal, construction footprints, and contaminant and spill handling. Of particular applicability to ESA-listed species are the following BMPs:

- C–1:** Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.
- Requirement/Standard:
- a. Cross-country use of heavy equipment and seismic activities is prohibited within ½ mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game.
 - b. Cross-country use of heavy equipment and seismic activity is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with USFWS and/or NOAA-Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.
- E–4:** Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.
- Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved Quality Assurance/Quality Control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections.

E-5: Objective: Minimize impacts of the development footprint.

Requirement/Standard: Facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include:

- a. Use of maximum extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads;
- b. Sharing facilities with existing development;
- c. Collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads;
- d. Integration of airstrips with roads;
- e. Use of gravel-reduction technologies, e.g., insulated or pile-supported pads,
- f. Coordination of facilities with infrastructure in support of offshore development.

Note: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.

E-8: Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.

Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate Federal, State, and North Slope Borough regulatory and resource agencies and consider:

- a. Locations outside the active flood plain.
- b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use.
- c. Potential use of the site for enhancing fish and wildlife habitat.
- d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.

E-10: Objective: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.

Requirement/Standard: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration.

E-11: Objective: Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.

Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.

F-1 (i): Objective: Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.

Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):

Subsection (i): Aircraft used as part of a BLM-authorized activity along the coast and shorefast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.

K-3: Objective: Protect fish and wildlife habitat (including, but not limited to, that for waterfowl and shorebirds, caribou insect-relief, and marine mammals), preserve air and water quality, and minimize impacts to subsistence activities and historic travel routes on the major coastal waterbodies.

Requirement/Standard (Development): With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within $\frac{3}{4}$ mile seaward of the shoreline (as measured from mean high tide) of the major coastal waterbodies or the natural coastal islands (to the extent that the seaward subsurface is within NPR-A). These areas include: Kogru River, Dease Inlet, Admiralty Bay, Elson Lagoon, Peard Bay, Wainwright Inlet/Kuk River, and Kasegaluk Lagoon, and their associated Islands. Elsewhere, permanent facilities within the major coastal waterbodies will only be permitted on or under the water if they can meet all the following criteria:

- a. Design and construction of facilities shall minimize impacts to subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.
- b. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.
- c. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through the major coastal waterbodies as identified by the North Slope Borough.
- d. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and “top-setting” of hydrocarbon-bearing zones.
- e. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound “direct spill” related impacts on area resources and subsistence uses.
- f. Before conducting open water activities, the permittee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

K-6: Objective: Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.

Requirement/Standard:

- a. Exploratory well drill pads, production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the Reserve and the mainland, or in inland areas within one mile of the coast. (Note: This would include the entirety of the Kasegaluk Lagoon and Peard Bay Special Areas.) Other facilities necessary for oil and gas production within NPR-A that necessarily must be within this area (e.g., barge landing, seawater treatment plant, or spill response staging and storage areas), would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. Lessees/permittees shall consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the North Slope Borough, and local whaling captains associations to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
- b. Marine vessels used as part of a BLM-authorized activity shall maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) using a terrestrial haulout unless doing so would endanger human life or violate safe boating practices. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast except when necessary for the safe operation of the vessel.
- c. Marine vessels used as part of a BLM-authorized activity shall maintain a ½-mile buffer from shore when transiting past an aggregation of walrus using a terrestrial haulout.

In addition to the mitigation BLM sets forth in the NPR-A ROD (USDOI, BLM, 2013), the following measures may be enacted to reduce potential impacts to NMFS-managed ESA species:

In the event that construction activities are required after 1 March in a previously undisturbed area of floating landfast ice (i.e., in waters deeper than 3 m (9.8 ft)), a survey with dogs will be completed to delineate an area where construction activities may proceed without disturbing seal structures or, alternatively, another suitable approach will be taken in consultation with NMFS. In case of dog surveys, trained dogs will search all floating sea ice for ringed seal structures. Those surveys will be done prior to the new proposed activity on the floating sea ice, to provide information needed to prevent injury or mortality of young seals.

Some construction or maintenance is often associated with new or existing facilities. These activities would continue to be managed to minimize adverse effects on marine mammals. For example, impact hammering activities may occur at any time of year to repair sheetpile or dock damage due to ice impingement. Most activities would be scheduled during the winter season, when many marine

mammals are not present. For example, impact hammering most likely occurs during the ice-covered season or break-up period, and would not be scheduled during fall bowhead migrations.

2.3.3. Mitigation Measures Considered for Alternative Exploration Technologies and Decreasing Airgun Noise

The impulsive airgun has been under scrutiny and criticism as a sound source for seismic exploration due to the belief that the propagated sound waves may harm marine life during operations. The BOEM frequently receives comments from stakeholders who suggest that airguns should be replaced by more “environmentally-friendly” alternative technologies and other techniques to mitigate current technologies used in oil and gas exploration. The 2011 BE for Oil and Gas Leasing and Exploration Activities in the Beaufort Sea and Chukchi Sea Planning Areas (USDOI, BOEMRE, 2011b) provides detailed clarification on the status of these proposed technologies, including hydraulic and electric marine vibrators, Low-level Acoustic Combustion Sources (patented, LACS), Deep-towed Acoustics/Geophysics Systems (DTAGS), low frequency passive seismic methods (e.g., natural seismicity, ocean waves, microseism surface waves), and fiber optic receivers, and why they are not currently practicable. Technologies supplemental to seismic operations such as gravity/gradiometry and controlled source electromagnetics are commercially available and discussed in BOEM’s 2011 BE (USDOI, BOEMRE, 2011b).

2.3.3.1. Mitigation by Decreasing Airgun Impacts

In addition to alternative methods for seismic data collection, industry and the public sector have actively investigated the use of the technology-based mitigation measure to lessen the impacts of airguns in water.

2.3.3.2. Air Gun Silencer

One new technology-based measure to lessen the impacts of the airguns currently in use is an airgun silencer, which has acoustically absorptive foam rubber on metal plates mounted radially around the airgun. This technology has demonstrated 0–6 dB reductions at frequencies above 700 Hz, and 0–3 dB reductions at frequencies below 700 Hz. This system has been tested only on low pressure airguns and is not a practicable mitigation tool because it needs to be replaced after 100 shots (Spence et al., 2007).

2.3.3.3. Bubble Curtain

Bubble curtains are another technology for reducing the impacts of airguns. Bubble curtains generally consist of a rubber hose or metal pipe with holes to allow air passage and a connector hose attached to an air compressor. They have successfully been tested and used in conjunction with pile driving and at construction sites to frighten away fish and decrease the noise level emitted into the surrounding water (Würsig et al., 2000; Sexton, 2007; Reyff, 2009). They have also been used as stand-alone units or with light and sound to deflect fish away from dams or keep them out of specific areas (Weiser, 2010; Pegg, 2005).

The use of bubbles as a mitigation measure for seismic noise has also been pursued. During an initial test of the concept, the sound source was flanked by two bubble screens; it demonstrated that bubble curtains were capable of attenuating seismic energy up to 28 dB at 80 Hz while stationary in a lake. This two-bubble curtain configuration was field tested from a moving vessel in Venezuela and Aruba where a 12 dB suppression of low frequency sound and a decrease in the level of laterally projecting sound was documented (Sixma, 1996; Sixma and Stubbs, 1998). A different study in the Gulf of Mexico tested an “acoustic blanket” of bubbles as a method to suppress multiple reflections in the seismic data. The results of the acoustic blanket study determined that suppression of multiple

reflections was not practical using the current technology. However, the acoustic blanket measurably suppressed tube waves in boreholes and has the capability of blocking out thruster noises from a laying vessel during an ocean-based cable (OBC) survey, which would allow closer proximity of the shooting vessel and increase productivity (Ross et al., 2004, 2005).

A recent study “Methods to Reduce Lateral Noise Propagation from Seismic Exploration Vessels” was conducted by Stress Engineering Services Inc. under the BOEM Technology Assessment & Research (TA&R) Program. The first phase of the project was spent researching, developing concepts for noise reduction, and evaluating the following three concepts: (1) an air bubble curtain; (2) focusing arrays to create a narrower footprint; and (3) decreasing noise by redesigning airguns. The air bubble curtain was selected as the most promising alternative, which led to more refined studies the second year (Ayers, Hannay, and Jones, 2009). A rigorous 3D acoustic analysis of the preferred bubble curtain design, including shallow-water seafloor effects and sound attenuation within the bubble curtain, was conducted during the second phase of the study. Results of the model indicated that the bubble curtains performed poorly at reducing sound levels and are not viable for mitigation of lateral noise propagation during seismic operations from a moving vessel (Ayers, Hannay, and Jones, 2010).

3.0 STATUS OF LISTED SPECIES AND CRITICAL HABITATS

This section consists of narratives for each of the listed and proposed endangered and threatened species and associated critical habitats that occur in the Action Area and that may be adversely affected by the continued authorization of oil and gas leasing and exploration activities on the OCS in the Chukchi Sea during the First Incremental Step and future steps. In each narrative, we present a summary of information on the population structure and distribution of each species to provide a foundation for the exposure analyses that appear later in this document. Then we summarize information on the threats to the species and critical habitats to provide points of reference for NMFS to determine whether the Proposed Action would jeopardize the continued existence of any listed species or result in the destruction or adverse modification of their critical habitats.

After the Status subsection of each narrative, we present information on the feeding and prey selection, and diving and social behavior of the different species because those behaviors help us determine how certain activities may impact each species, and helps determine whether aerial and ship board surveys are likely to detect each species. We also summarize information on the vocalization and hearing of the different species because that background information lays the foundation for our assessment of how the different species are likely to respond to sounds produced from exploration activities.

More detailed background information on the status of these species can be found in a number of published documents including a stock assessment report on Alaska marine mammals by Allen and Angliss (2014), and recovery plans for fin whales (NMFS, 2010b), humpback whales (NMFS, 1991). Cameron et al. (2010) and Kelly et al. (2010b) provided status reviews of bearded and ringed seals. Richardson et al., (1995a) and Tyack (2000) provided detailed analyses of the functional aspects of cetacean communication and their responses to active sonar and seismic. Finally, Croll et al. (1999), National Research Council (NRC) (2000, 2003a, 2005), and Richardson et al. (1995a) provide information on the potential and probable effects of active seismic and sonar on the marine animals considered in this opinion.

3.1. Status of Listed Species

3.1.1. Bowhead Whale

3.1.1.1. Population Structure

The International Whaling Commission (IWC) historically recognized five stocks of bowhead whales for management purposes (IWC, 1992; Rugh et al., 2003). The Western Arctic stock is the only stock to inhabit the Action Area or any U.S. waters, and it is also the largest (Allen and Angliss, 2014).

3.1.1.2. Distribution

The bowhead whale has a circumpolar distribution in high latitudes in the Northern Hemisphere, and ranges from 54° to 85°N latitude. Animals associate with pack ice for most of the year, typically wintering at the southern limit of ice or in polynyas (large, semi-stable open areas of water within the ice), and move north as the sea ice breaks up and recedes during the spring. In the North Pacific Ocean in the Action Area, bowhead whales are distributed in the seasonally ice-covered waters of the Arctic and near-Arctic, generally occurring north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984; Moore and Reeves, 1993). They have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year. The largest population of bowhead whales can be found in the Bering Sea in winter, migrating north into through the Chukchi Sea in the spring to summer in the Beaufort Sea before returning to the Bering Sea in the

fall (Allen and Angliss, 2014). Some of the animals remain in the eastern Chukchi and western Beaufort seas during the summer (Clarke et al., 2011a; Ireland et al., 2009a).

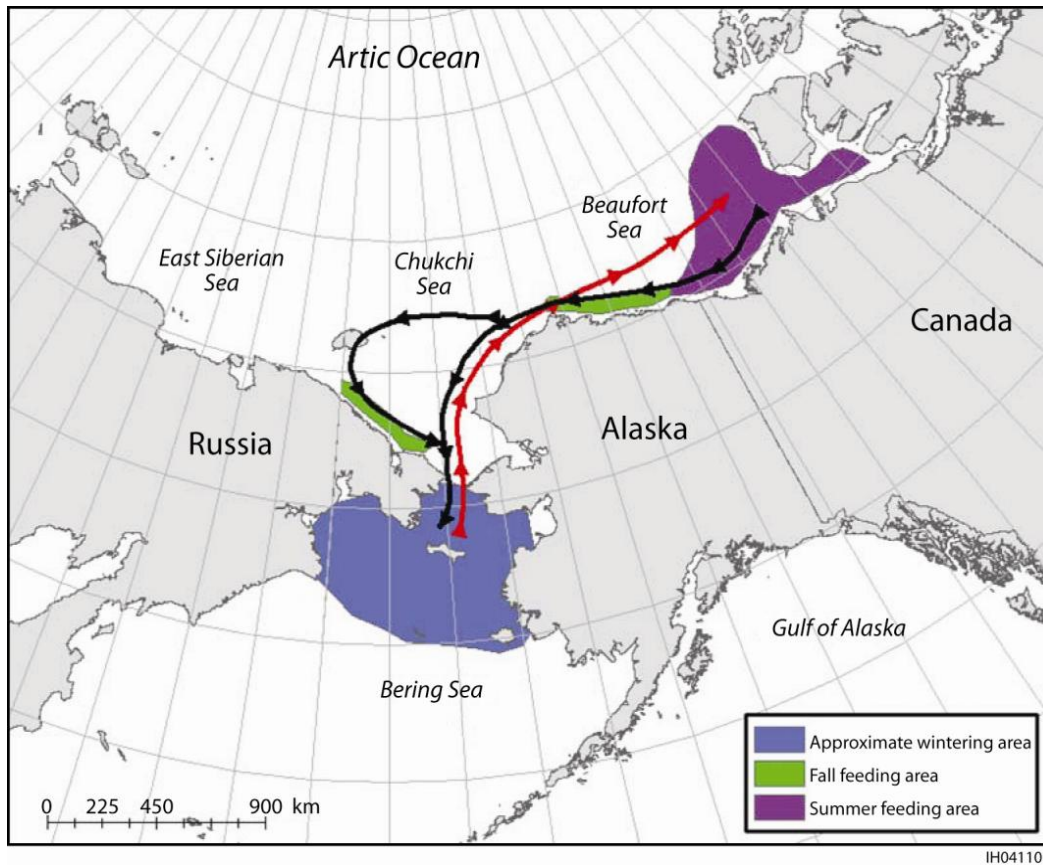


Figure 3-1 Generalized Migration Route, Feeding Areas, and Wintering Area for the Western Arctic Bowhead Whale (Source: Moore and Laidre, 2006).

Data exist on bowhead whale season distribution in the vicinity of the Action Area from a combination of government and industry surveys. Aerial surveys of offshore portions of the Chukchi Sea from 2008–2012 have shown a relatively consistent pattern of few bowhead whales being present near the Action Area in June–August, and then increasing numbers in September and October (Clarke et al., 2011a, 2012, 2013). In the vicinity of the Action Area bowhead densities estimated from data collected on industry vessels in the Chukchi Sea were higher in fall than summer in 2006, 2008, and 2010 (Hartin et al., 2013). Tagged whales spent a considerable amount of time in the north-central Chukchi Sea in 2012, despite ongoing industrial activities in the region, including exploratory drilling (ADFG, 2012). Clarke and Ferguson (*in prep*) and Clarke et al. (2012, 2013) reported 72 sightings (86 individuals) during 22,255 km of on-transect aerial survey effort in waters 36–50 m deep in 2008–2012, the majority of which (53 sightings) were recorded in 2012. The mean group size of the 72 sightings was 1.2.

The estimate of the July–August open-water bowhead whale density in the Chukchi Sea was calculated from the three bowhead sightings (3 individuals) and 22,154 km of survey effort in waters 36–50 m deep in the Chukchi Sea during July–August reported in Clarke and Ferguson (*in prep*) and Clarke et al. (2012, 2013). The mean group size from those sightings was 1. The two sightings recorded during 4,209 km of survey effort in 2011 (Clarke et al., 2012) produced the highest annual bowhead density during July–August (0.0068 bowheads/km²).

Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July–August of 2006–2010 (Hartin et al., 2013) was 0.0002–0.0008/km² (95% CI = 0.0085/km²). The same $f(0)$ and $g(0)$ values that were used for the summer estimates above were used for the fall estimates resulting in an average September–October estimate of 0.0552 bowheads/km². The highest density from the survey periods (0.1320 bowheads/km²; in 2012) was used as the maximum open water density during the fall period. Moore et al. (2000) found that bowheads were detected more often than expected in association with ice in the Chukchi Sea in September–October, so the ice-margin densities that are used are twice the open-water densities. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in September–November of 2006–2010 (Hartin et al., 2013) ranged from 0.0003 to 0.0052/km² (95% Confidence Interval (CI) of 0.051/km²).

3.1.1.3. Threats to the Species

3.1.1.3.1. Natural Threats

Little is known about the natural mortality of bowhead whales (Philo et al., 1993). From 1964 through the early 1990s, at least 36 deaths were reported in Alaska, Norway, Yukon, and Northwest Territories for which the cause could not be established (Philo et al., 1993). Bowhead whales have no known predators except perhaps killer whales. The frequency of attacks by killer whales upon the Western Arctic stock of bowhead whales is assumed to be low (George et al., 1994). Of 195 whales examined from the Alaska subsistence harvest (1976–92), only eight had been wounded by killer whales. In addition, hunters on St. Lawrence Island found two small bowhead whales (<9 m) dead as a result of killer whale attacks (George et al., 1994). Predation could increase if the refuge provided to bowhead whales by sea-ice cover diminishes as a result of climate change.

Predation by killer whales may be a greater source of mortality for the Eastern Canada–Western Greenland population. Inuit have observed killer whales killing bowhead whales and stranded bowhead whales have been reported with damage likely inflicted by killer whales (Nunavut Wildlife Management Board (NWMB), 2000). Most beached carcasses found in the eastern Canadian Arctic are of young bowhead whales, and they may be more vulnerable than adults may to lethal attacks by killer whales (Finley, 1990; Moshenko et al., 2003). About a third of the bowhead whales observed in a study of living animals in Isabella Bay bore scars or wounds inflicted by killer whales (Finley, 1990). A relatively small number of whales likely die as a result of entrapment in ice.

3.1.1.3.2. Anthropogenic Threats

Three human activities are known to threaten bowhead whales: whaling, commercial fishing, and shipping. Historically, bowhead whales were severely depleted by commercial harvesting, which ultimately led to the listing of bowhead whales as an endangered species. They were targeted by hunters because they are slow and big, with large amounts of blubber. Bowhead whales have also been targeted by subsistence whaling. Subsistence harvest is regulated by quotas set by the IWC and is allocated and enforced by the Alaska Eskimo Whaling Commission (AEWC). Bowhead whales are harvested by Alaska Natives in the Beaufort, Bering, and Chukchi Seas. Suydam and George (2012) summarized Alaskan subsistence harvests of bowheads from 1974 to 2011 and reported a total of 1,149 whales landed by hunters from 12 villages with Barrow landing the most whales ($n = 590$) while Shaktoolik landed only one. The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions. The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead quota in 1978. In 1978, the efficiency was about 50%, in 2010 it was 63% (Suydam et al., 2011), and in 2011 it was 76% (Suydam et al., 2012). Suydam et al. (2012) reported that the current mean efficiency, from 2002 to 2011, is 75%. The somewhat low harvest efficiency in 2010 was considered an anomaly, and could be attributed to difficult environmental conditions in the spring of

2010, including ice conditions, struck whales escaping under the shorefast ice, and equipment failures. For 2008–2012, a block quota of 280 bowhead strikes has been allowed, of which 67 (plus up to 15 unharvested in the previous year) could be taken each year. Alaska Native subsistence hunters take approximately 0.1–0.5% of the population per annum, primarily from eleven Alaska communities (Philo et al., 1993; Suydam et al., 2011).

Canadian and Russian Natives are also known to take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996 (Allen and Angliss, 2014). Twelve whales were harvested by Russian subsistence hunters between 1999–2005 (IWC, 2001, 2002, 2003, 2004a, 2004b, 2005a, 2005b, 2006, 2007 in Allen and Angliss, 2014). No catches for Western Arctic bowheads were reported by either Canadian or Russian hunters for 2006–2007 (IWC, 2008, 2009) or by Russia in 2009 (IWC, 2011), but two bowheads were taken in Russia in 2008 (IWC, 2010), and in 2010 (IWC, 2012). The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2007 to 2011 was 39 bowhead whales (Allen and Angliss, 2014).

Some additional mortality may be due to human-induced injuries including embedded shrapnel and harpoon heads from hunting attempts, rope and net entanglement in harpoon lines and crab-pot lines, and from ship strikes (Philo et al., 1993). Several cases of rope or net entanglement have been reported from whales taken in the subsistence hunt (Philo et al., 1993). Further, preliminary counts of similar observations based on reexamination of bowhead harvest records indicate entanglements or scarring attributed to ropes may include over 20 cases (Allen and Angliss, 2014). There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. However, some bowhead whales have historically had interactions with crab pot gear. There are several documented cases of bowheads having ropes or rope scars on them. Alaska Region stranding reports document three bowhead whale entanglements between 2001 and 2005. In 2003, a bowhead whale was found dead in Bristol Bay entangled in line around the peduncle and both flippers; the origin of the line is unknown. In 2004, a bowhead whale near Point Barrow was observed with fishing net and line around the head. A dead bowhead whale found floating in Kotzebue Sound in July 2010 was entangled in crab pot gear similar to that used in the Bering Sea crab fishery (Suydam et al., 2011). During the 2011 spring aerial photographic surveys of bowhead whales near Point Barrow, one entangled bowhead was photographed (Mocklin et al., 2012). The minimum average annual entanglement rate in U.S. commercial fisheries for the 5-year period from 2007–2011 is 0.4; however, the overall rate is currently unknown (Allen and Angliss, 2014). Commercial fishing for crab and other species is prohibited within the Arctic Management Area, which includes all US waters of the Chukchi Sea and the Action Area; however, it is allowed in other parts of the bowhead's range.

Bowhead whales are among the slowest moving of whales, which may make them particularly susceptible to ship strikes although records of strikes on bowhead whales are rare (Laist et al., 2001). About 1% of the bowhead whales taken by Alaska Iñupiat bore scars from ship strikes (George et al., 1994). Until recently, few large ships have passed through most of the bowhead whale's range but this situation may be changing as northern sea routes become more navigable with the decline in sea ice. Exposure to manmade noise and contaminants may have short- and long-term effects (Bratton et al., 1993; Richardson and Malme, 1993) that compromise health and reproductive performance.

3.1.1.4. Status

The bowhead whale was listed as endangered under the ESA in 1970 (35 *FR* 8495). They are also protected by the Convention on International Trade in Endangered Species (CITES) of wild flora and fauna and the MMPA. Critical habitat has not been designated for bowhead whales. The IWC continued a prohibition on commercial whaling, and called for a ban on subsistence whaling in 1977. The U.S. requested a modification of the ban and the IWC responded with a limited quota. Currently, subsistence harvest is limited to nine Alaska villages.

Woodby and Botkin (1993) summarized previous efforts to determine a minimum worldwide population estimate prior to commercial whaling of 50,000, with 10,400–23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Brandon and Wade (2004) used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 (9,190–13,950; 5th and 9th percentiles, respectively) bowheads in 1848 at the start of commercial whaling.

From 1978–2001, the Western Arctic stock of bowhead whales has increased at a rate of 3.4% (95% CI = 1.7.5%) during which time abundance doubled from approximately 5,000 to approximately 10,000 whales (George et al., 2004). The most recent abundance estimate, based on surveys conducted in 2001, is 10,545 (Coefficient of Variation (CV) = 0.128) (updated from George et al., 2004 by Zeh and Punt, 2004) (Table 3–1). Using the 2001 population estimate of 10,545 and its associated CV = 0.128, the minimum population estimate for the Western Arctic stock of bowhead whales is 9,472. The population may be approaching carrying capacity despite showing no sign of a slowing in the population growth rate (Brandon and Wade, 2006).

The highest yet recorded count of 121 calves during the 2001 census was likely a combination of variable recruitment and a large population size (George et al., 2004). The calf count provides corroborating evidence for a healthy and increasing population.

Table 3–1 Summary of population abundance estimates for the Western Arctic stock of bowhead whales. *The historical estimates were made by back-projecting using a simple recruitment model. All other estimates were developed by corrected ice-based census counts. Historical estimates are from Woodby and Botkin (1993); 1978–2001 estimates are from George et al. (2004) and Zeh and Punt (2004).*

Year	Abundance estimate (CV)	Year	Abundance estimate (CV)
Historical estimate	10,40023,000	1985	5,762 (0.253)
End of commercial whaling	1,000–3,000	1986	8,917 (0.215)
1978	4,765 (0.305)	1987	5,298 (0.327)
1980	3,885 (0.343)	1988	6,928 (0.120)
1981	4,467 (0.273)	1993	8,167 (0.017)
1982	7,395 (0.281)	2001	10,545 (0.128)
1983	6,573 (0.345)		

The Sea of Okhotsk stock, estimated at about 3,000–6,500 animals prior to commercial exploitation (Shelden and Rugh, 1995), currently numbers about 150–200, although reliable population estimates are not currently available. It is possible this population has mixed with the Bering Sea population, although the available evidence indicates the two populations are essentially separate (Moore and Reeves, 1993).

3.1.1.5. Reproduction and Growth

Important winter areas in the Bering Sea include polynyas along the northern Gulf of Anadyr, south of St. Matthew Island, and near St. Lawrence Island. Bowheads congregate in these polynyas before migrating (Moore and Reeves, 1993). Most mating occurs in late winter and spring in the Bering Sea, although some mating occurs as late as September and early October (Koski et al., 1993; Reese et al.,

2001). The conception date and length of gestation suggests that calving is likely to occur in mid-May to mid-June, when whales are between the Bering Strait and Point Barrow (USDOI, BOEMRE, 2011a). The calving interval is about three to four years. Juvenile growth is relatively slow. Bowheads reach sexual maturity at about 15 years of age (12 to 14 m [39 to 46 ft] long) (Nerini et al., 1984). Growth for both sexes slows markedly at about 40 to 50 years of age (George et al., 1999).

3.1.1.6. Feeding and Prey Selection

Bowheads are filter feeders, filtering prey from the water through baleen fibers in their mouth. They feed throughout the water column, including bottom feeding as well as surface skim feeding (Würsig et al., 1989). Skim feeding can occur when animals are alone and conversely may occur in coordinated echelons of over a dozen animals (Würsig et al., 1989). Bowhead whales typically spend a high proportion of time on or near the ocean floor. Even when traveling, bowhead whales visit the bottom on a regular basis (Quakenbush et al., 2010). Laidre et al. (2007) and others have identified krill concentrated near the sea bottom and bowhead whales have been observed with mud on heads and bodies and streaming from mouths (Mocklin, 2009). Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods (Moore et al., 2010; Lowry, Sheffield, and George, 2004). Euphausiids and copepods are thought to be their primary prey. Lowry, Sheffield, and George (2004) documented that other crustaceans and fish also were eaten but were minor components in samples consisting mostly of copepods or euphausiids.

Concentrations of zooplankton appear necessary for bowhead whales and other baleen whales to feed efficiently to meet energy requirements (Kenney et al., 1986; Lowry, 1993). It is estimated that a 60 ton (t) bowhead whale eats 1.5 t of krill each day; that 1.5 t of krill will have consumed 5.5 trillion phytoplankton. Estimated rate of consumption is 50,000 individual copepods, each weighing about 0.004 g, per min of feeding time.

Available data indicate that bowhead whales feed in both the Chukchi and Beaufort Sea Planning Areas and that this use varies in degree among years, among individuals, and among areas. It is likely that bowheads continue to feed opportunistically where food is available as they move through or about the Alaskan Beaufort Sea, similar to what they are thought to do during the spring migration. Observations from the 1980s documented that some feeding occurs in the spring in the northeastern Chukchi Sea, but this feeding was not consistently seen (e.g., Ljungblad et al., 1987; Carroll et al., 1987). Stomach contents from bowheads harvested between St. Lawrence Island and Point Barrow during April into June also indicated it is likely that some whales feed during the spring migration (Carroll et al., 1987; Shelden and Rugh, 1995). Carroll et al., (1987) reported that the region west of Point Barrow seems to be of particular importance for feeding, at least in some years, but whales may feed opportunistically at other locations in the lead system where oceanographic conditions produce locally abundant food. A bowhead whale feeding “hotspot” (Okkonen et al., 2011) commonly forms on the western Beaufort Sea shelf off Point Barrow in late summer and fall due to a combination of the physical and oceanographic features of Barrow Canyon, combined with favorable wind conditions (Ashjian et al., 2010; Moore et al., 2010; Okkonen et al., 2011). Lowry (1993) reported that the stomachs of 13 out of 36 spring-migrating bowheads harvested near Point Barrow between 1979 through 1988 contained food. Lowry estimated total volumes of contents in stomachs ranged from less than 1 to 60 liters (L), with an average of 12.2 L in eight specimens (1993). Shelden and Rugh (1995) concluded, “In years when oceanographic conditions are favorable, the lead system near Barrow may serve as an important feeding ground in the spring (Carroll et al., 1987).” Richardson and Thomson (2002) concluded that some, probably limited, feeding occurs in the spring.

The area near Kaktovik appears to be one of the areas important to bowhead whales primarily during the fall (NMFS, 2010c). BOEM-funded Bowhead Whale Aerial Survey Project (BWASP) surveys show areas off Kaktovik as areas that are sometimes of high use by bowhead whales (Clarke et al., 2011b; NMFS, 2010c). Data recently compiled by Clarke et al. (2012) further illustrate the frequency

of use of the area east of Kaktovik by bowhead mothers and calves during August, September, and October.

Industry funded aerial surveys of the Camden Bay area west of Kaktovik reported a number of whales feeding in that region in 2007 and 2008 (Christie et al., 2009); however, more recent BOEM-funded Aerial Surveys of Arctic Marine Mammals (ASAMM) surveys have not noted such behavior in Camden Bay. While data indicate that bowhead whales might feed almost anywhere in the Alaskan Beaufort Sea within the 50-m isobath, feeding in areas outside of the area noted between Smith Bay and Point Barrow and/or in Barrow Canyon are ephemeral and less predictable (J. Clarke, pers. comm., 2013 in NMFS, 2013a).

Bowhead whales feed in the Canadian Beaufort Sea in the summer and early fall (e.g., Würsig et al., 1989), and in the Alaskan Beaufort Sea in late summer/early fall (Lowry and Frost, 1984; Ljungblad et al., 1986; Schell and Saupe, 1993; Lowry, Sheffield, and George, 2004, summarized in Richardson and Thomson, 2002; Ashjian et al., 2010; Okkonen et al., 2011; Clarke et al., 2011a, b, c; Clarke et al., 2012, 2013). Available information indicates it is likely there is considerable inter-annual variability in the locations where feeding occurs during the summer and fall in the Alaska Beaufort Sea, in the length of time individuals spend feeding, and in the number of individuals feeding in various areas in the Beaufort Sea.

The Inupiat believe that whales follow the ocean currents carrying food organisms (e.g., Napageak, 1996, as reported in NMFS, 2001). Bowheads have been observed feeding not more than 1,500 feet (ft) offshore in about 15–20 ft of water near Point Barrow (Rexford, 1997) Nuiqsut Mayor Nukapigak testified at the Nuiqsut Public Hearing on March 19, 2001, that he and others saw a hundred or so bowhead whales and gray whales feeding near Northstar Island (USDOI, MMS, 2002). Some bowheads appear to feed east of Barter Island as they migrate westward (Thomson and Richardson, 1987).

3.1.1.7. Diving and Social Behavior

The bowhead whale usually travels alone or in groups of three to four individuals. However, in one day on a BWASP survey in 2009, researchers observed 297 individual bowheads aggregated near Barrow (Clarke et al., 2011a). During this survey, a group of 180 bowhead whales were seen feeding and milling (Clarke et al., 2011a).

Bowhead whale calls might help maintain social cohesion of groups (Würsig and Clark, 1993). Würsig et al. (1985) indicated that low-frequency tonal calls, believed to be long distance contact calls by a female and higher frequency calls by calf, have been recorded in an instance where the pair were separated and swimming toward each other. Bowhead whales sometimes feed cooperatively. They take efficient advantage of dense swarms of invertebrates.

3.1.1.8. Vocalizations and Hearing

Bowhead whales are among the more vocal of the baleen whales (Clark and Johnson, 1984). They mainly communicate with low frequency sounds. Most underwater calls are at a fairly low frequency and easily audible to the human ear. Vocalization is made up of moans of varying pitch, intensity and duration, and occasionally higher-frequency screeches. Bowhead calls have been distinguished by Würsig and Clark (1993): pulsed tonal calls, pulsive calls, high frequency calls, low-frequency FM calls (upsweeps, inflected, downsweeps, and constant frequency calls). However, no direct link between specific bowhead activities and call types was found. Bowhead whales have been noted to produce a series of repeating units of sounds up to 5000 Hz that are classified as songs, produced primarily by males on the breeding grounds (Delarue, 2011). Also, bowhead whales may use low-frequency sounds to provide information about the ocean floor and locations of ice.

Bowhead whales have well-developed capabilities for navigation and survival in sea ice. Bowhead whales are thought to use the reverberations of their calls off the undersides of ice floes to help them orient and navigate (Ellison, Clarke and Bishop, 1987; George et al., 1989). This species is well adapted to ice-covered waters and can easily move through extensive areas of nearly solid sea ice cover (Citta et al., 2012). Their skull morphology allows them to break through ice up to 18 cm thick to breathe in ice covered waters (George et al., 1989).

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some modifications to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into the outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by the tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear function to transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack, 1999b). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Bowhead whales are grouped among low frequency functional hearing baleen whales (Southall et al., 2007). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz–5 kHz, with maximum sensitivity between 100–500 Hz (Erbe, 2002). Vocalization bandwidths vary. Tonal FM modulated vocalizations have a bandwidth of 25 to 1,200 Hz with the dominant range between 100 and 400 Hz and lasting 0.4– 3.8 sec. Bowhead whale songs have a bandwidth of 20 to 5000 Hz with the dominant frequency at approximately 500 Hz and duration lasting from 1 minute to hours. Pulsive vocalizations range between 25 and 3500 Hz and last 0.3 to 7.2 sec (Clark and Johnson, 1984; Würsig and Clark, 1993; Cummings and Holliday, 1987 in Erbe, 2002).

3.1.1.9. Other Senses

Bowhead whales appear to have good lateral vision. Recognizing this, whalers approach bowheads from the front or from behind, rather than from the side (Noongwook et al., 2007). In addition, whalers wear white parkas on the ice so that they are not visible to the whales when they surface (Rexford, 1997).

Olfaction may also be important to bowhead whales. Recent research on the olfactory bulb and olfactory receptor genes suggest that bowheads not only have a sense of smell but one better developed than in humans (Thewissen et al., 2011). The authors suggest that bowheads may use their sense of smell to find dense aggregations of krill upon which to prey.

3.1.2. Fin Whale

3.1.2.1. Population Structure

The stock structure of fin whales remains uncertain. Fin whales have two recognized subspecies: *Balaenoptera physalus physalus* (Gambell, 1985) occurs in the North Atlantic Ocean while *B. p. quoyi* (Fischer, 1829) occurs in the Southern Ocean. However, most experts consider the North Pacific fin whales a separate unnamed subspecies.

In the North Pacific Ocean, the IWC recognizes two “stocks”: (1) East China Sea and (2) rest of the North Pacific (Donovan, 1991). However, Mizroch et al. (1984) concluded that there were five possible “stocks” of fin whales within the North Pacific based on histological analyses and tagging experiments: (1) East and West Pacific that intermingle around the Aleutian Islands; (2) East China Sea; (3) British Columbia; (4) Southern-Central California to Gulf of Alaska; and (5) Gulf of California. Based on genetic analyses, Bérubé et al. (1998) concluded that fin whales in the Sea of Cortez represent an isolated population that has very little genetic exchange with other populations in the North Pacific Ocean (although the geographic distribution of this population and other populations can overlap seasonally). They also concluded that fin whales in the Gulf of St. Lawrence and Gulf of Maine are distinct from fin whales found off Spain and in the Mediterranean Sea.

Regardless of how different authors structure the fin whale population, mark-recapture studies have demonstrate that individual fin whales migrate between management units (Mitchell, 1974; Rice, 1974), which suggests that these management units are not geographically isolated populations.

3.1.2.2. Distribution

Fin whales are distributed widely in every ocean except the Arctic Ocean (where they have only recently begun to appear). In the North Pacific Ocean, fin whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska; in the eastern Pacific, they occur south to California; in the western Pacific, they occur south to Japan. Fin whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea (Gambell, 1985).

Mizroch et al. (2009) summarized information about the patterns of distribution and movements of fin whales in the North Pacific from whaling harvest records, scientific surveys, opportunistic sightings, acoustic data from offshore hydrophone arrays, and from recoveries of marked whales. Mizroch (2009) notes that fin whales range from the Chukchi Sea south to 35° North on the Sanriku coast of Honshu., to the Subarctic boundary (ca. 42°) in the western and Central Pacific, and to 32° N off the coast of California. Berzin and Rovnin (1966) indicate historically “In the Chukchi Sea the finbacks periodically form aggregations in the region to the north of Cape Serdtse-Kamon’ along the Chukotka coast.” Fin whales have also been observed in the area around Wrangel Island.

Individual and small pods of fin whales seasonally inhabit areas within and near the Action Area during the open water period (USDOI, BOEMRE, 2011a). Based on observations and passive acoustic detection (Delarue et al., 2010, 2012; Crance et al., 2011; Hannay et al., 2011) and direct observations from monitoring and research projects of fin whales from industry (Bisson et al., 2013; Funk et al., 2010; Hartin et al., 2013; Ireland et al., 2009) and government (Aerts et al., 2012, 2013; Clarke et al., 2011d, 2013, 2014; Berchok et al., 2012), fin whales are considered to be in low densities, but regular visitors to the Alaska Chukchi Sea.

3.1.2.3. Threats to the Species

3.1.2.3.1. Natural Threats

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen, 1992). Killer whale or shark attacks may injure or kill very young or sick whales (Perry et al., 1999).

3.1.2.3.2. Anthropogenic Threats

Three human activities are known to threaten fin whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of fin whales and was ultimately responsible for listing fin whales as an endangered species. As early as the mid-seventeenth century, the Japanese were capturing fin, blue (*Balaenoptera musculus*), and other large whales using a fairly primitive open-water netting technique (Tønnessen and Johnsen, 1982; Cherfas, 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. After blue whales were depleted in most areas, fin whales became the focus of whaling operations and more than 700,000 fin whales were landed in the Southern Hemisphere alone between 1904 and 1979 (IWC, 1995).

As its legacy, whaling has reduced fin whales to a fraction of their historic population size. As a result, makes it easier for other human activities to push fin whales closer to extinction. Otherwise, whaling currently does not threaten every fin whale population, although it may threaten specific populations. There is no authorized subsistence take of fin whales in the Northeast Pacific stock (Allen and Angliss, 2011). In the Antarctic Ocean, fin whales are hunted by Japanese whalers who have been allowed to kill up to ten fin whales each year for the 2005–2006 and 2006–2007 seasons under an Antarctic Special Permit. The Japanese whalers plan to kill 50 fin whales per year starting in the 2007–2008 season and continuing for the next 12 years.

Fin whales are also hunted in subsistence fisheries off West Greenland. In 2004, five males and six females were killed and landed; two other fin whales were struck and lost in the same year. In 2003, 2 males and 4 females were landed and 2 other fin whales were struck and lost (IWC, 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery (IWC, 2005); however, the IWC's Scientific Committee recommended limiting the number of fin whale killed in this fishery to one to four individuals until accurate population estimates are produced.

Despite anecdotal observations from fishermen which suggest that large whales swim through their nets rather than get caught in them, fin whales have been entangled by fishing gear off Newfoundland and Labrador in small numbers. A total of 14 fin whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990 (Lien, 1994; Perkins and Beamish, 1979). Of these 14 fin whales, seven are known to have died as a result of that capture, although most of the animals that died were less than 15 meters in length (Lien, 1994). Between 1999 and 2005, there were ten confirmed reports of fin whales becoming entangled in fishing gear along the U.S. Atlantic Coast and the Maritime Provinces of Canada (Cole et al., 2005; Nelson et al., 2007). Of these reports, fin whales were injured in one of the entanglements and killed in three entanglements. Between 2002 and 2006, there was one observed incidental mortality of a fin whale in the Bering Sea/Aleutian Island (BSAI) pollock trawl fishery with a mean annual mortality rate of 0.23 (CV = 0.34) (Allen and Angliss, 2014).

These data suggest that, despite their size and strength, fin whales are likely to be entangled and, in some cases, killed by gear used in modern fisheries. Between 2007 and 2011, there were no observed incidental mortalities of fin whales in any Alaska commercial fishery (Breiwick, 2013 in Allen and Angliss, 2014). Commercial fishing is prohibited within the Arctic Management Area, which includes all US waters of the Chukchi Sea and the Action Area; however, it is allowed in other parts of the fin whale's range.

Fin whales are also killed and injured in collisions with vessels more frequently than any other whale. Of 92 fin whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, 31 (33%) showed evidence of collisions with ships (Laist et al., 2001). Between 1999 and 2005, there were 15 reports of fin whales being struck by vessels along the Atlantic Coast of the U.S. and the Maritime

Provinces of Canada (Cole et al., 2005; Nelson et al., 2007). Of these reports, 13 were confirmed as ship strikes that resulted in the death of 11 fin whales.

There were 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011. Of these, three involved fin whales (Neilson et al., 2012).

Ship strikes were identified as a known or potential cause of death in eight (20%) of 39 fin whales that stranded on the coast of Italy in the Mediterranean Sea between 1986 and 1997 (Laist et al., 2001). Throughout the Mediterranean Sea, 46 of the 287 fin whales that are recorded to have stranded between 1897 and 2001 were confirmed to have died from injuries sustained by ship strikes (Panigada et al., 2006). Most of these fin whales ($n = 43$), were killed between 1972 and 2001 and the highest percentage (37 of 45 or ~82%) killed in the Ligurian Sea and adjacent waters, where the Pelagos Sanctuary for Marine Mammals was established. In addition to these ship strikes, there are numerous reports of fin whales being injured as result of ship strikes off the Atlantic coast of France and the United Kingdom (Jensen and Silber, 2004).

3.1.2.4. Status

Fin whales were listed as endangered under the ESA in 1970. In 1976, the IWC protected fin whales from commercial whaling (Allen, 1980). Fin whales are listed as endangered on the IUCN Red List of Threatened Animals (IUCN, 2012). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for fin whales. A Final Recovery Plan for the Fin Whale (*Balaenoptera physalus*) was published on July 30, 2010 (NMFS, 2010b).

It is difficult to assess the current status of fin whales because (1) there is no general agreement on the size of the fin whale population prior to whaling and (2) estimates of the current size of the different fin whale populations vary widely. We may never know the size of the fin whale population prior to whaling. Sergeant (1977) suggested that between 30,000 and 50,000 fin whales once populated the North Atlantic Ocean based on assumptions about catch levels during the whaling period.

Sigurjónsson (1995) estimated that between 50,000 and 100,000 fin whales once populated the North Atlantic, although he provided no data or evidence to support that estimate. More recently, Palumbi and Roman (2006) estimated that about 360,000 fin whales (95% CI = 249,000–481,000) populated the North Atlantic Ocean before whaling based on mutation rates and estimates of genetic diversity.

Ohsumi and Wada (1974) estimated that the North Pacific fin whale population ranged from 42,000–45,000 before whaling began. Of this, the “American population” (i.e., the component centered in waters east of 180° W longitude), was estimated to be 25,000–27,000. From a crude analysis of catch statistics and whaling effort, Rice (1974) concluded that the population of fin whales in the eastern North Pacific declined by more than half, between 1958 and 1970, from about 20,000 to 9,000 “recruited animals” (i.e., individuals longer than the minimum length limit of 50 ft). Chapman (1976) concluded that the “American stock” had declined to about 38% and the “Asian stock” to 36% below their maximum sustainable yield (MSY) levels (16,000 and 11,000, respectively) by 1975. As pointed out by Barlow (1994), citing IWC (1989) catch per unit effort (CPUE) techniques for estimating abundance are not certain, therefore, the absolute values of the cited abundance estimates should not be relied upon. Based on visual surveys, Moore et al. (2002) estimated 3,368 (CV = 0.29) and 683 (CV = 0.32) fin whales in the central eastern Bering Sea and southeastern Bering Sea, respectively, during summer surveys in 1999 and 2000. However, these estimates are considered provisional because they were never corrected for animals missed on the track line or that may have been submerged when the ship passed.

Similarly, estimates of the current size of the different fin whale populations and estimates of their global abundance also vary widely. The final recovery plan for fin whales accepts a minimum population estimate of 2,269 fin whales for the Western North Atlantic stock (NMFS, 2010b).

However, based on data produced by surveys conducted between 1978–1982 and other data gathered between 1966 and 1989, Hain et al. (1992) estimated that the population of fin whales in the western North Atlantic Ocean (specifically, between Cape Hatteras, North Carolina, and Nova Scotia) numbered about 1,500 whales in the winter and 5,000 whales in the spring and summer. Because authors do not always reconcile “new” estimates with earlier estimates, it is not clear whether the current “best” estimate represents a refinement of the estimate that was based on older data or whether the fin whale population in the North Atlantic has declined by about 50% since the early 1980s.

An increasing trend between 1979/80 and 1993 in the size of the California/Oregon/Washington stock was suggested by the available survey data, but it was not statistically significant (Barlow et al., 1997). Zerbini et al. (2006) estimated rates of increase of fin whales in coastal waters south of the Alaska Peninsula (Kodiak and Shumagin Islands). An annual increase of 4.8% (95% CI = 4.1–5.4%) was estimated for the period 1987–2003. This estimate is the first available for North Pacific fin whales and is consistent with other estimates of population growth rates of large whales. It should be used with caution, however, due to uncertainties in the initial population estimate for the first trend year (1987) and due to uncertainties about the population structure of the fin whales in the area. In addition, the study represented only a small fraction of the range of the northeast Pacific stock. (The full range of the northeast Pacific stock of fin whales in Alaskan waters has not been surveyed.) There are also indications that fin whale distribution in the Bering Sea is related to oceanographic conditions (Friday et al., 2013; Stabeno et al., 2012), making it possible that whales could be double counted when estimates from different years are summed (Moore et al., 2002). Therefore, our best provisional estimate of the fin whale population west of the Kenai Peninsula would be 1,214, the average of the estimates in 2008 and 2010 (Friday et al., in press, in Allen and Angliss, 2014). This is a minimum estimate for the entire stock because it was estimated from surveys that covered only a small portion of the range of this stock. This is considered a minimum estimate for a portion of the range of this stock; therefore, the minimum population estimate for the entire stock is unknown (Allen and Angliss, 2014).

The East Greenland-Iceland fin whale population was estimated at 10,000 animals (95 % CI = 7,600–14,200), based on surveys conducted in 1987 and 1989 (Buckland et al., 1992). The number of eastern Atlantic fin whales, which includes the British Isles-Spain-Portugal population, has been estimated at 17,000 animals (95% CI = 10,400–28,900; Buckland et al., 1992). These estimates are both more than 15 years old and the data available do not allow us to determine if they remain valid. Forcada et al., (1996) estimated the fin whale population in the western Mediterranean numbered 3,583 individuals (standard error (SE) = 967; 95% confidence interval = 2,130–6,027). This is similar to a more recent estimate published by Notarbartolo-di-Sciara et al. (2003). Within the Ligurian Sea, which includes the Pelagos Sanctuary for Marine Mammals and the Gulf of Lions, the fin whale population was estimated to number 901 (SE = 196.1) whales (Forcada et al., 1995).

Regardless of which of these estimates, if any, have the closest correspondence to the actual size and trend of the fin whale population, all of these estimates suggest that the global population of fin whales consists of tens of thousands of individuals and that the North Pacific population consists of at least 5,000 individuals. Ecological theory and demographic patterns derived from several hundred imperiled species and populations show that fin whales appear to exist at large enough population sizes to avoid the demographic phenomena known to increase the extinction probability of species that exist as “small” populations. (That is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself). As a result, we assume that fin whales are likely to be more threatened by exogenous threats such as anthropogenic activities (primarily whaling, entanglement, and ship strikes) or natural phenomena (such as disease, predation, or changes in the

distribution and abundance of their prey in response to changing climate), than endogenous threats caused by their small population size.

Nevertheless, based on the evidence available, the number of fin whales recorded to have been killed or injured in the past 20 years by human activities or natural phenomena, does not appear to be increasing the extinction probability of fin whales. It may, however, slow the rate at which the fin whales recover from population declines caused by commercial whaling.

3.1.2.5. Feeding and Prey Selection

In the North Pacific overall, fin whales apparently prefer euphausiids (mainly *Euphausia pacifica*, *Thysanoessa longipes*, *T. spinifera*, and *T. inermis*) and large copepods (mainly *Calanus cristatus*), followed by schooling fish such as herring, walleye pollock (*Theragra chalcogramma*), and capelin (*Mallotus villosus*) (Nemoto, 1970; Kawamura, 1982).

Fin whales killed off central California in the early twentieth century were described as having either “plankton” (assumed to have been mainly or entirely euphausiids) or “sardines” (assumed to have been anchovies, *Engraulis mordax*) in their stomachs (Clapham et al., 1997). A larger sample of fin whales taken off California in the 1950s and 1960s were feeding mainly on krill, mostly *Euphausia pacifica*, with only about 10% of the individuals having anchovies in their stomachs (Rice, 1963).

Fin whales in the Gulf of California prey mainly on zooplankton such as *Nyctiphanes simplex* (Tershy, 1992).

3.1.2.6. Diving and Social Behavior

The percentage of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5–20 shallow dives with each of these dives lasting 13–20 sec followed by a deep dive lasting between 1.5 and 15 min (Gambell, 1985; Stone et al., 1992; Lafortuna et al., 2003). Other authors have reported that the fin whale’s most common dives last between 2 and 6 minutes, with two to eight blows between dives (Hain et al., 1992; Watkins 1981). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while nonforaging dives are 59 m and 4.2 min (Croll et al., 2001a). However, Lafortuna et al. (1999) found that foraging fin whales have a higher blow rate than when traveling. Foraging dives in excess of 150 m are known (Panigada et al., 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75% of sightings during the Cetacean and Turtle Assessment Program (Hain et al., 1992).

There is considerable variation in grouping frequency by region. In general, fin whales, like all baleen whales, are not very socially organized, and most fin whales are observed as singles. Fin whales are also sometimes seen in social groups that can number two to seven individuals. However, up to 50, and occasionally as many as 300, can travel together on migrations (NMFS, 2010b).

In waters off the Atlantic Coast of the U.S., individual fin whales or pairs represented about 75% of the fin whales observed during the Cetacean and Turtle Assessment Program (Hain et al., 1992). Individual whales or groups of less than five individuals represented about 90% of the observations (out of 2,065 observations of fin whales, the mean group size was 2.9, the modal value was 1, and the range was 1 – 65 individuals; Hain et al., 1992). Fin whales in the Alaska Chukchi Sea have only been observed as individuals or in small groups.

3.1.2.7. Vocalizations and Hearing

The sounds fin whales produce underwater are one of the most studied *Balaenoptera* sounds. Fin whales produce a variety of low-frequency sounds in the 10–200 Hz band (Watkins, 1981; Watkins et al., 1987; Edds, 1988; Thompson et al., 1992). The most typical signals are long, patterned sequences of short duration (0.5–2 sec) infrasonic pulses in the 18–35 Hz range (Patterson and Hamilton, 1964).

Estimated source levels for fin whales are 140–200 dB re 1 μ Pa (rms) (Patterson and Hamilton, 1964; Watkins et al., 1987; Thompson et al., 1992; McDonald et al., 1995; Clark and Gagnon, 2004). In temperate waters intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif, 1998). Short sequences of rapid pulses in the 20–70 Hz band are associated with animals in social groups (McDonald et al., 1995, Clark personal communication, McDonald personal communication). Each pulse lasts about one second and contains twenty cycles (Tyack, 1999a).

During the breeding season, fin whales produce a series of pulses in a regularly repeating pattern. These bouts of pulsing may last for longer than one day (Tyack, 1999a). The seasonality and stereotype of the bouts of patterned sounds suggest that these sounds are male reproductive displays (Watkins et al., 1987), while the individual counter calling data of McDonald et al. (1995) suggest that the more variable calls are contact calls. Some authors feel there are geographic differences in the frequency, duration, and repetition of the pulses (Thompson et al., 1992).

As with other vocalizations produced by baleen whales, the function of fin whale vocalizations is unknown, although there are numerous hypotheses. (These hypotheses include: maintenance of inter-individual distance, species and individual recognition, contextual information transmission, maintenance of social organization, location of topographic features, and location of prey resources; see the review by Thompson et al. (1992) for more information on these hypotheses). Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton, 1997). The low-frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long-distance communication occurs in fin whales (Payne and Webb, 1971; Edds-Walton, 1997). In addition, there is speculation that the sounds may function for long-range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack, 1999a).

3.1.3. Humpback Whale

3.1.3.1. Population Structure

Descriptions of the population structure of humpback whales differ depending on whether an author focuses on where humpback whales winter or where they feed. During winter months in northern or southern hemispheres, adult humpback whales migrate to specific areas in warmer, tropical waters to reproduce and give birth to calves. During summer months, humpback whales migrate to specific areas in northern temperate or sub-Arctic waters to forage. In summer months, humpback whales from different “reproductive areas” will congregate to feed; in the winter months, whales will migrate from different foraging areas to a single wintering area. In either case, humpback whales appear to form “open” populations; that is, populations that are connected through the movement of individual animals.

NMFS’ Stock Assessment Reports recognize three “stocks” or populations of humpback whales in the North Pacific Ocean, based on genetic and photo-identification studies: (1) the California/Oregon/Washington and Mexico stock, (2) the Central North Pacific stock, and (3) the Western North Pacific stock (Baker et al., 1990; Calambokidis et al., 1997; Perry et al., 1999). Individuals from the Western Pacific stock and the Central North Pacific stock could occur in the Bering Sea with access to the Chukchi and Beaufort Seas.

These “stocks” are based on where these humpback whales winter: California-Oregon-Washington-Mexico stock winters along coasts of Central America and Mexico, then migrate to the coast of California to southern British Columbia in the summer/fall. The central North Pacific stock winters in the waters around Hawai’i, and migrates primarily to northern British Columbia/Southeast Alaska, the

Gulf of Alaska, and the Bering Sea/Aleutian Islands. The western North Pacific stock winters off of Asia and migrates primarily to Russia and the Bering Sea/Aleutian Islands. However, Calambokidis et al., (1997) identified humpback whales from Southeast Alaska (central North Pacific), the California-Oregon-Washington (eastern North Pacific), and Ogasawara Islands (Japan, Western Pacific) groups in the Hawai'ian Islands during the winter; humpback whales from the Kodiak Island, Southeast Alaska, and British Columbia groups in the Ogasawara Islands; and whales from the British Columbia, Southeast Alaska, Prince William Sound, and Shumagin-Aleutian Islands groups in Mexico – indicating that while wintering grounds appear to be separate, there may be considerable overlap in summer feeding grounds.

Herman (1979), however, presented extensive evidence and various lines of reasoning to conclude that the humpback whales associated with the main Hawai'i Islands immigrated to those waters only in the past 200 years. Winn and Reichley (1985) identified genetic exchange between the humpback whales that winter off Hawai'i and those that winter off Mexico (with further mixing on feeding areas in Alaska) and suggested that the humpback whales that winter in Hawai'i may have emigrated from wintering areas in Mexico. Based on these patterns of movement, we conclude that the various “stocks” of humpback whales are not true populations or, at least, they represent populations that experience substantial levels of immigration and emigration.

Between 2004 and 2006, an international group of whale researchers coordinated their surveys to conduct a comprehensive assessment of the population structure, levels of abundance, and status of humpback whales in the North Pacific (Calambokidis et al., 2008). That effort identified a total of 7,971 unique individuals from photographs taken during close approaches.

3.1.3.2. Distribution

Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern Oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate or sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, humpback whales tend to occupy shallower, coastal waters; during their seasonal migrations; however, humpback whales disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley, 1985).

In the North Pacific Ocean, the summer range of humpback whales includes coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Nemoto, 1957; Tomlin, 1967; Johnson and Wolman, 1984 as cited in NMFS, 1991). Humpback whales have also been observed during the summer in the Chukchi and Beaufort seas (Allen and Angliss, 2011).

In August 2007, a mother-calf pair was sighted from a barge approximately 87 km (54.1 mi) east of Barrow in the Beaufort Sea (Hashagen et al., 2009). Additionally, Ireland et al., (2008) reported three humpback sightings in 2007 and one in 2008 during surveys of the eastern Chukchi Sea. Hartin et al. (2013) reported four humpback whales during vessel-based surveys in the Chukchi Sea in 2007, two in 2008, and one in 2010. Five humpback sightings (11 individuals) occurred during Chukchi Sea Environmental Studies Program (CSESP) vessel-based surveys in 2009 and 2010 (Aerts et al., 2012), and a single humpback was observed several kilometers west of Barrow during the 2012 CSESP vessel-based survey (Aerts et al., 2013). Humpback whales have been seen and heard with some regularity in recent years) in the southern Chukchi Sea (see Figure 3–2), often feeding and in very close association with feeding gray whales. Sightings have occurred mostly in September, but effort in the southern Chukchi has not been consistent and it is possible that humpback whales are present earlier than September (Hashagen et al., 2009; Anonymous, 2010; Goetz et al., 2010; Clarke et al., 2011a; Crance et al., 2011; NMML and PMEL, 2011). A single humpback was observed between Icy

Cape and Wainwright feeding near a group of gray whales during aerial surveys of the northeastern Chukchi Sea in July 2009 as part of COMIDA (Clarke et al., 2011a). This may be a recent phenomenon as no humpback whales were sighted during the previous COMIDA surveys in the Chukchi Sea from 1982 through 1991 (Clarke et al., 2011a). Additionally, ASAMM aerial surveys reported four humpback whale sightings near the coast between Icy Cape and Pt. Barrow in July and August of 2012, as well as 24 individual humpback whales on 11 September south and east of Pt. Hope (Clarke et al., 2013). In 2013, ASAMM survey efforts reported 2 sightings totaling 4 humpback whales in the northeastern Chukchi Sea (Clarke et al., 2014). Prior to 2012 only a single humpback had been sighted during the ASAMM aerial surveys (Clarke et al., 2012, 2013, 2014). Additional sightings of four humpback whales occurred in 2009 south of Point Hope, while transiting to Nome (Brueggeman, 2010).

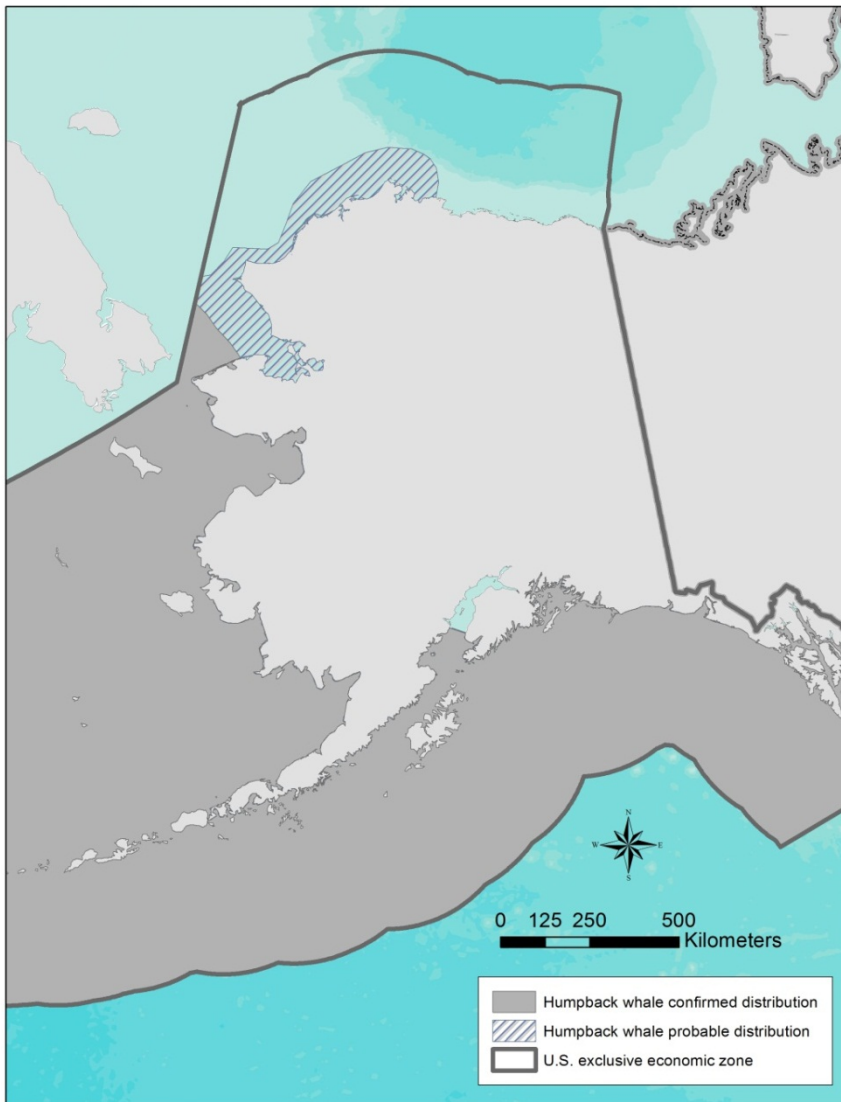


Figure 3-2 Approximate distribution of humpback whales in the Alaskan waters of the western North Pacific. Area within the hash lines (shaded area) is a probable distribution based on sightings in the Beaufort Sea (Hashagen et al., 2009) (Source: Allen and Angliss, 2011).

In the Atlantic Ocean, humpback whales range from the mid-Atlantic bight, the Gulf of Maine, across the southern coast of Greenland and Iceland, and along coast of Norway in the Barents Sea. These humpback whales migrate to the western coast of Africa and the Caribbean Sea during the winter.

In the Southern Ocean, humpback whales occur in waters off Antarctica. These whales migrate to the waters off Venezuela, Brazil, southern Africa, western and eastern Australia, New Zealand, and islands in the southwest Pacific during the austral winter. A separate population of humpback whales appears to reside in the Arabian Sea in the Indian Ocean off the coasts of Oman, Pakistan, and India (Mikhalev, 1997).

3.1.3.3. Threats to the Species

3.1.3.3.1. Natural Threats

There is limited information on natural phenomena that kill or injure humpback whales. Humpback whales are killed by orcas (Whitehead and Glass, 1985; Dolphin, 1987; Florez-González et al., 1994; Perry et al., 1999; Naessig et al., 2004) and are probably killed by false killer whales and sharks. Because 7 female and 7 male humpback whales stranded on the beaches of Cape Cod and had died from toxin produced by dinoflagellates between November 1987 and January 1988, we also know that adult and juvenile humpback whales are killed by naturally-produced biotoxins (Geraci et al., 1976). Entrapments in ice have been documented in the spring ice pack in Newfoundland (Merdsoy et al., 1979 in NMFS, 1991), with up to 25 entrapped in the same event (Lien and Stenson, 1986 in NMFS, 1991) and some mortalities have been reported. No humpback ice entrapments have been reported in the Alaska Chukchi or Beaufort Seas.

Other natural sources of mortality, however, remain largely unknown. Similarly, we do not know whether and to what degree natural mortality limits or restricts patterns of growth or variability in humpback whale populations.

3.1.3.3.2. Anthropogenic Threats

Three human activities are known to threaten humpback whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of humpback whales and was ultimately responsible for listing humpback whales as an endangered species. From 1900 to 1965, nearly 30,000 whales were taken in modern whaling operations of the Pacific Ocean. Prior to that, an unknown number of humpback whales were taken (Perry et al., 1999). In 1965, the International Whaling Commission banned commercial hunting of humpback whales in the Pacific Ocean. As its legacy, whaling has reduced humpback whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push these whales closer to extinction.

Subsistence hunters in Alaska have reported one subsistence take of a humpback whale in South Norton Sound in 2006. There have not been any additional reported takes of humpback whales from this stock by subsistence hunters in Alaska or Russia. The average annual mortality rate from subsistence takes for the 2003– 2007 period is 0.2 (Allen and Angliss, 2011).

Humpback whales are also killed or injured during interactions with commercial fishing gear, although the evidence available suggests that these interactions on humpback whale populations may not have significant, adverse consequence for humpback whale populations. Commercial fishing is prohibited within the Arctic Management Area, which includes all US waters of the Chukchi Sea and the Action Area; however it is allowed in other parts of the humpback's range. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada: a total of 595 humpback whales are reported to have been captured in coastal fisheries in those two provinces between 1969 and 1990 (Lien, 1994; Perkins and Beamish, 1979). Of these whales, 94 are

known to have died as a result of that capture, although, like fin whales, most of the animals that died were smaller: less than 12 meters in length (Lien, 1994).

In recent years, an increasing number of entangled humpback whales have been reported to NMFS Alaska Region stranding program. One hundred eighteen humpback whales were reported (96 confirmed) entangled in Alaska from 1997–2009; the majority of these involved southeast Alaska humpbacks (NMFS Alaska Region, Unpublished Stranding Data, 2010 in NMFS, 2013a). An additional 25 humpback whales entangled or suspected to be entangled in gear were reported in Alaska waters in between 2009 and 2011 (Allen, Helker, and Jameson, 2014). For many of these reports, it is not possible to identify the gear involved in the entanglement to a specific fishery. This is based on a general lack of data in reports received, the difficulty in accurately describing gear at a distance, and the fact that most entanglements are not re-sighted for follow-up analysis (NMFS, 2010c).

In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill et al., 1997). In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. Also in 1996, a vessel from Pacific Missile Range Facility in Hawaii rescued an entangled humpback, removing two crab pot floats from the whale; the gear was traced to a recreational fisherman in southeast Alaska.

Along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al., 2005; Nelson et al., 2007). Of these reports, 95 entanglements were confirmed resulting in the injury of 11 humpback whales and the death of nine whales. No information is available on the number of humpback whales that have been killed or seriously injured by interactions with fishing fleets outside of U.S. waters. These data suggest that, despite their size and strength, humpback whales are likely to be entangled and, in some cases, killed by gear used in modern fisheries.

The number of humpback whales killed by ship strikes is exceeded only by fin whales (Jensen and Silber, 2004). On the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al., 1997). There were 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011. Of these, 93 involved humpback whales (Neilson et al., 2012). There was a significant increase in the number of reports over time between 1978 and 2011 ($r^2 = 0.6999$; $P < 0.001$). The majority of strikes were reported in southeastern Alaska, where the number of humpback whale collisions increased 5.8% annually from 1978 to 2011 (Neilson et al., 2012). Between 2001 and 2009, confirmed reports of vessel collisions with humpback whales indicated an average of five humpback whales struck per year in Alaska; between 2005 and 2009, two humpback deaths were attributed to ship strikes (NMFS, 2010a). However, no vessel collisions or prop strikes involving humpback whales have been documented in the Chukchi Sea (USDOI, BOEMRE, 2011a)

Vessel collisions with humpback whales remains a significant management concern, given the increasing abundance of humpback whales foraging in Alaska, as well as the growing presence of marine traffic in Alaska's coastal waters. Based on these factors, injury and mortality of humpback whales as a result of vessel strike may likely continue into the future (NMFS, 2006a).

The humpback whale calf that was found stranded on Oahu with evidence of vessel collision (propeller cuts) in 1996 suggests that ship collisions might kill adults, juvenile, and calves (NMFS, unpublished data). Of 123 humpback whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, 10 (8.1%) showed evidence of collisions with ships (Laist et al., 2001). Between 1999 and 2005, there were 18 reports of humpback whales being struck by vessels along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole et al., 2005; Nelson et al., 2007). Of these reports, 13 were confirmed as ship strikes which were reported as having resulted in the death of seven humpback whales.

In addition to ship strikes in North America and Hawai‘i, there are several reports of humpback whales being injured as result of ship strikes off the Antarctic Peninsula, in the Caribbean Sea, the Mediterranean Sea, off Australia, Bay of Bengal (Indian Ocean), Brazil, New Zealand, Peru, South Africa (NMFS, 2010a).

3.1.3.4. Status

Humpback whales were listed as endangered under the ESA in 1973. Humpback whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge, 1996). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for humpback whales. A Final Recovery Plan for the Humpback Whale was completed in November of 1991 (NMFS, 1991).

It is difficult to assess the current status of humpback whales for the same reasons that it is difficult to assess the status of fin whales: (1) there is no general agreement on the size of the humpback whale population prior to whaling and (2) estimates of the current size of the different humpback whale populations vary widely and produce estimates that are not always comparable to one another, although robust estimates of humpback whale populations in the western North Atlantic have been published. We may never know the size of the humpback whale population prior to whaling.

Winn and Reichley (1985) argued that the global population of humpback whales consisted of at least 150,000 whales in the early 1900s, with the largest population historically occurring in the Southern Ocean. Based on analyses of mutation rates and estimates of genetic diversity, Palumbi and Roman (2006) concluded that there may have been as many as 240,000 (95% CI = 156,000 – 401,000) humpback whales in the North Atlantic before whaling began. In the western North Atlantic between Davis Strait, Iceland and the West Indies, Mitchell and Reeves (1983) estimated there were at least 4,685 humpback whales in 1865 based on available whaling records (although the authors note that this does not represent a “pre-exploitation estimate” because whalers from Greenland, the Gulf of St. Lawrence, New England, and the Caribbean Sea had been hunting humpback whales before 1865).

Estimates of the number of humpback whales occurring in the different populations that inhabit the Northern Pacific have risen over time. In the 1980s, estimates ranged from 1,407 to 2,100 (Baker, 1985; Darling and Morowitz, 1986; Baker and Herman, 1987), while recent estimates place the population size at about 6,000 whales (SE = 474) in the North Pacific (Calambokidis et al., 1997; Cerchio, 1998; Mobley et al., 1999). Based on data collected between 1980 and 1983, Baker and Herman (1987) used a capture-recapture methodology to produce a population estimate of 1,407 whales (95% CI = 1,113 – 1,701). More recently, (Calambokidis et al., 1997) relied on resightings estimated from photographic records of individuals to produce an estimate of 6,010 humpback whales occurred in the North Pacific Ocean. Because the estimates produced by the different methodologies are not directly comparable, it is not clear which of these estimates is more accurate or if the change from 1,407 to 6,000 individuals results from a real increase in the size of the humpback whale population, sampling bias in one or both studies, or assumptions in the methods used to produce estimates from the individuals that were sampled. Since the last of these estimates was published almost 12 years ago, we do not know if the estimates represent current population sizes.

As discussed previously, between 2004 and 2006, an international group of whale researchers coordinated their surveys to conduct a comprehensive assessment of the population structure, levels of abundance, and status of humpback whales in the North Pacific (Calambokidis et al., 2008). That effort identified a total of 7,971 unique individuals from photographs taken during close approaches. Of this total, 4,516 individuals were identified at wintering regions in at least one of the three seasons in which the study surveyed wintering area and 4,328 individuals were identified at least once at feeding areas in one of the two years in which the study surveyed feeding areas. Based on the results of that effort, Calambokidis et al. (2008) estimated that the current population of humpback whales in the North Pacific Ocean consisted of about 18,300 whales, not counting calves. Almost half of the humpback whales that were estimated to occur in wintering areas, or about 8,000 humpback whales, occupy the Hawai'ian Islands during the winter months.

3.1.3.5. Reproduction and Growth

Humpbacks give birth and presumably mate on low-latitude wintering grounds in January to March in the Northern Hemisphere. Females attain sexual maturity at 5 years in some populations and exhibit a mean calving interval of approximately two years (Barlow and Clapham, 1997; Clapham, 1992). Gestation is about 12 months, and calves probably are weaned by the end of their first year (Perry et al., 1999).

3.1.3.6. Feeding and Prey Selection

Humpback whales tend to feed on summer grounds and not on winter grounds. However, some opportunistic winter feeding has been observed at low-latitudes (Perry et al., 1999). Humpback whales engulf large volumes of water and then filter small crustaceans and fish through their fringed baleen plates.

Humpback whales are relatively generalized in their feeding compared to some other baleen whales. In the Northern Hemisphere, known prey includes: euphausiids (krill); copepods; juvenile salmonids, *Oncorhynchus* spp.; Arctic cod, *Boreogadus saida*; walleye pollock, *Theragra chalcogramma*; pollock, *Pollachius virens*; pteropods; and cephalopods (Johnson and Wolman, 1984; Perry et al., 1999). Foraging is confined primarily to higher latitudes (Stimpert et al., 2007), such as the Action Area.

3.1.3.7. Diving and Social Behavior

In Hawai'i an waters, humpback whales remain almost exclusively within the 1820-m isobath and usually within waters depths less than 182 m. Maximum diving depths are approximately 150 m (492 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton et al., 1997). They may remain submerged for up to 21 min (Dolphin, 1987). Dives on feeding grounds ranged from 2.1–5.1 min in the north Atlantic (Goodyear, unpublished manuscript). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales, with the deepest dives to 148m (Dolphin, 1987), while whales observed feeding on Stellwagon Bank in the North Atlantic dove <40m (Haines et al., 1995). Because most humpback prey is likely found above 300 m depths most humpback dives are probably relatively shallow. Hamilton et al. (1997) tracked one possibly feeding whale near Bermuda to 240 m depth.

In a review of the social behavior of humpback whales, Clapham (1996) reported that they form small, unstable social groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long-periods of times. There is good evidence of some territoriality on feeding (Clapham, 1994, 1996), and calving areas (Tyack, 1981). In calving areas, males sing long complex songs directed

towards females, other males or both. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham, 1996). Intermale competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds which may be as high as 2.4:1.

3.1.3.8. Vocalizations and Hearing

No studies have directly measured the sound sensitivity of humpback whales. Humpback whales are grouped among low frequency functional hearing baleen (mysticete) whales (Southall et al., 2007). In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Humpback whales produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25–5,000 Hz range and intensities as high as 181 dB re 1 μ Pa (rms) (Payne, 1970; Winn et al., 1970; Thompson et al., 1986). Source levels average 155 dB and range from 144 to 174 dB re 1 μ Pa (rms) (Thompson et al., 1979). The songs appear to have an effective range of approximately 10 to 20 km. Animals in mating groups produce a variety of sounds (Tyack, 1981; Silber, 1986).

Humpback whales produce sounds less frequently in their summer feeding areas. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2–0.8 seconds and source levels of 175–192 dB re 1 μ Pa (rms) (Thompson et al., 1986). These sounds are attractive and appear to rally animals to the feeding activity (D' Vincent et al., 1985; Sharpe and Dill, 1997).

In summary, humpback whales produce at least three kinds of sounds:

1. Complex songs with components ranging from at least 20 Hz–5 kHz with estimated source levels from 144–174 dB; these are mostly sung by males on the breeding grounds (Winn et al., 1970; Richardson et al., 1995a; Frazer and Mercado, 2000; Au et al., 2000, 2006);
2. Social sounds in the breeding areas that extend from 50 Hz – more than 10 kHz with most energy below 3 kHz (Tyack and Whitehead, 1983; Richardson et al., 1995a); and
3. Feeding area vocalizations that are less frequent, but tend to be 20 Hz–2 kHz with estimated sources levels in excess of 175 dB re 1 Pa at 1 m (Thompson et al., 1986; Richardson et al., 1995a)

A general description of the anatomy of the ear for cetaceans is provided in the description of the fin whale above; that description is also applicable to humpback whales. Houser et al., (2001) produced a mathematical model of a humpback whale's hearing sensitivity based on the anatomy of the whale's ear. Based on that model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 kHz to 10 kHz, with a maximum sensitivity between 2 and 6 kHz, and good sensitivity between 700 Hz and 10 kHz (Houser et al., 2001).

3.1.4. Bearded Seal

3.1.4.1. Population Structure

There are two recognized subspecies of the bearded seal: *E. b. barbatus*, often described as inhabiting the Atlantic sector (Laptev, Kara, and Barents seas, North Atlantic Ocean, and Hudson Bay; Rice 1998); and *E. b. nauticus*, which inhabits the Pacific sector (remaining portions of the Arctic Ocean and the Bering and Okhotsk seas; Ognev, 1935; Scheffer, 1958; Manning, 1974; Heptner et al., 1976). The geographic distributions of these subspecies are not separated by conspicuous gaps. There are regions of intergrading generally described as somewhere along the northern Russian and central Canadian coasts (Burns, 1981; Kelly, 1988; Rice, 1998). Consequently, geographic boundaries for the divisions between the two subspecies are subject to the strong caveat that distinct boundaries do not appear to exist in the actual populations; and therefore, there is considerable uncertainty about the

best locations for the boundaries. Two DPS were identified for the *E. b. nauticus* subspecies—the Okhotsk DPS in the Sea of Okhotsk, and the Beringia DPS, encompassing the remainder of the range of this subspecies. Only the Beringia DPS of bearded seals is found in U.S. waters (and the Action Area), and these are of a single recognized Alaska stock.

3.1.4.2. Distribution

Bearded seals are a boreoarctic species with a circumpolar distribution (Fedoseev, 1965; Johnson et al., 1966; Burns, 1967; Burns and Frost, 1979; Burns, 1981; Smith, 1981; Kelly, 1988). Their normal range extends from the Arctic Ocean (85°N) south to Sakhalin Island (45°N) in the Pacific, and south to Hudson Bay (55°N) in the Atlantic (Allen, 1880; Ognev, 1935; King, 1983). The range of the Beringia DPS of the bearded seal is defined as extending from an east-west Eurasian dividing line at Novosibirskiye in the East Siberian Sea, south into the Bering Sea (Kamchatka Peninsula and 157°E division between the Beringia and Okhotsk DPSs), and to a north American dividing line (between the Beringia DPS of the *E. b. nauticus* subspecies and the *E. B. barbatus* subspecies) at 122°W (midpoint between the Beaufort Sea and Pelly Bay).

Bearded seals are closely associated with sea ice – particularly during the critical life history periods related to reproduction and molting – and can be found in a broad range of ice types. They generally prefer ice habitat that is in constant motion and produces natural openings and areas of open water such as leads, fractures, and polynyas, for breathing, hauling out on the ice, and access to water for foraging (Heptner et al., 1976; Fedoseev, 1984; Nelson et al., 1984). The bearded seal’s effective range is generally restricted to areas where seasonal sea ice occurs over relatively shallow waters. Based on the best available data, Cameron et al. (2010) therefore defined the core distribution of bearded seals as those areas over waters less than 500 m deep.

The region that includes the Bering and Chukchi seas is the largest area of continuous habitat for bearded seals (Burns 1981; Nelson et al., 1984). The Bering-Chukchi Platform is a shallow intercontinental shelf that encompasses half of the Bering Sea, spans the Bering Strait, and covers nearly all of the Chukchi Sea. Bearded seals can reach the bottom everywhere along the shallow shelf and so it provides them favorable foraging habitat (Burns, 1967). The Bering and Chukchi seas are generally covered by sea ice in late winter and spring and are then mostly ice free in late summer and fall, a process that helps to drive a seasonal pattern in the movements and distribution of bearded seals in this area (Burns 1967, 1981; Nelson et al., 1984). During winter, most bearded seals in Alaska waters are found in the Bering Sea, while smaller numbers of year-round residents remain in the Beaufort and Chukchi Seas, mostly around lead systems, and polynyas. From mid-April to June, as the ice recedes, many bearded seals that overwinter in the Bering Sea migrate northward through the Bering Strait into the Chukchi and Beaufort Seas, where they spend the summer and early fall at the southern edge of the Chukchi and Beaufort Sea pack ice at the wide, fragmented margins of multiyear ice. A small number of bearded seals, mostly juveniles, remain near the coasts of the Bering and Chukchi seas for the summer and early fall instead of moving with the ice edge. These seals are found in bays, brackish water estuaries, river mouths, and have been observed up some rivers (Burns, 1967; Heptner et al., 1976; Burns, 1981).

3.1.4.3. Threats to the Species

Current threats to the Beringia DPS of bearded seal are described in detail the species’ Status Review (Cameron et al., 2010) and the proposed listing rule (75 FR 77496), and are briefly summarized below. Details about individual threats in the Action Area will also be discussed in the Section 4-1.

3.1.4.3.1. Predation

Polar bears are the primary predator of bearded seals. Other predators include brown bears, killer whales, sharks, and walrus (seemingly infrequent). Predation under the future scenario of reduced sea ice is difficult to assess; polar bear predation may decrease, but predation by killer whales, sharks and walrus may increase (Cameron et al., 2010).

The range of plausible scenarios is large, making it impossible to predict the direction or magnitude of the net impact on bearded seal mortality.

3.1.4.3.2. Parasites and Diseases

A variety of diseases and parasites have been documented to occur in bearded seals. The seals have likely coevolved with many of these and the observed prevalence is typical and similar to other species of seals. However, since July 2011, over 100 sick or dead seals and walrus have been reported in Alaska. An unusual mortality event (UME) was declared by NOAA in December 2011. The cause of the Northern Pinniped UME remains unknown, investigation continues, although the number of new cases decreased substantially after 2011 (NOAA, 2013; NOAA and USFWS, 2014). Cameron et al. (2010) noted that abiotic and biotic changes to bearded seal habitat could lead to exposure to new pathogens or new levels of virulence, but the potential threats to ringed seals were considered low.

3.1.4.3.3. Climate Change: Sea Ice Loss

For at least some part of the year, bearded seals rely on the presence of sea ice over the productive and shallow waters of the continental shelves where they have access to food—primarily benthic and epibenthic organisms—and a platform for hauling out of the water. Further, the spring and summer ice edge may retreat to deep waters of the Arctic Ocean basin, which could separate sea ice suitable for pup maturation and molting from benthic feeding areas.

3.1.4.3.4. Climate Change: Ocean Acidification

The process of ocean acidification has long been recognized, but the ecological implications of such chemical changes have only recently begun to be appreciated. The waters of the Arctic and adjacent seas are among the most vulnerable to ocean acidification. The most likely impact of ocean acidification on bearded seals will be through the loss of benthic calcifiers and lower trophic levels on which the species' prey depends. Cascading effects are likely both in the marine and freshwater environments. Our limited understanding of planktonic and benthic calcifiers in the Arctic (e.g., even their baseline geographical distributions) means that future changes will be difficult to detect and evaluate. However, due to the bearded seals' apparent dietary flexibility, these threats are of less concern than the direct effects of potential sea ice degradation.

Ocean acidification may also impact bearded seals by affecting the propagation of sound in the marine environment. Researchers have suggested that effects of ocean acidification will cause low-frequency sounds to propagate more than 1.5 times as far (Hester et al., 2008, Brewer and Hester, 2009), which, while potentially extending the range bearded seals can communicate under quiet conditions, will increase the potential for masking when man-made noise is present.

3.1.4.3.5. Harvest

Bearded seals were among those species hunted by early Arctic inhabitants (Krupnik, 1984), and today they remain a central nutritional and cultural resource for many northern communities (Hart and Amos, 2004; ACIA, 2005; Hovelsrud et al., 2008). The solitary nature of bearded seals has made them less suitable for commercial exploitation than many other seal species. Still, within the Beringia

DPS they may have been depleted by commercial harvests in the Bering Sea during the mid-20th century. There is currently no significant commercial harvest of bearded seals and significant harvests seem unlikely in the foreseeable future.

Alaska Native hunters mostly take bearded seals of the Beringia DPS during their northward migration in the late spring and early summer, using small boats in open leads among ice floes close to shore (Kelly, 1988). Allen and Angliss (2010, 2014) reported that based on subsistence harvest data maintained by ADF&G primarily for the years 1990 to 1998, the mean estimated annual harvest level in Alaska averaged 6,788 bearded seals as of August 2000 (Coffing et al., 1998; Georgette et al., 1998; Wolfe and Hutchinson-Scarborough, 1999; Allen and Angliss, 2014). The estimate of 6,788 bearded seals is considered by Allen and Angliss (2014) to be the best estimate of the subsistence harvest level in Alaska.

Cameron et al. (2010) noted that ice cover in hunting locations can dramatically affect the availability of bearded seals and the success of hunters in retrieving seals that have been shot, which can range from 50-75% success in the ice (Burns and Frost, 1979; Reeves et al., 1992) to as low as 30% in open water (Burns, 1967; Smith and Taylor, 1977; Riewe and Amsden, 1979; Davis et al., 1980). Using the mean annual harvest reported from 1990-1998, assuming 25 to 50% of seals struck are lost, they estimated the total annual hunt by Alaska Natives would range from 8,485 to 10,182 bearded seals. Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 258 bearded seals were harvested during 2012 (Ice Seal Committee, 2013).

Assuming contemporary harvest levels in eastern Siberia are similar to Alaska, as was the pattern in the 1970s and 1980s, and a comparable struck-loss rate of 25-50%, the total annual take from the entire Bering and Chukchi Seas would range from 16,970 to 20,364 bearded seals (Cameron et al., 2010). In the western Canadian Beaufort Sea, bearded seal hunting has historically been secondary to ringed seal harvest, and its importance has declined further in recent times (Cleator, 1996). Cameron et al., (2010) concluded that although the current subsistence harvest is substantial in some areas, there is little or no evidence that subsistence harvests have or are likely to pose serious risks to the Beringia DPS (Cameron et al., 2010).

3.1.4.3.6. Commercial Fisheries Interactions

Commercial fisheries may impact bearded seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. Commercial fishing is prohibited within the Arctic Management Area, which includes all US waters of the Chukchi Sea and the Action Area; however it is allowed in other parts of the bearded seal's range. Estimates of bearded seal bycatch could only be found for commercial fisheries that operate in Alaska waters. Based on data from 2007 to 2011, there has been an annual average of 1.8 mortalities of bearded seals incidental to commercial fishing operations (Allen and Angliss, 2014). For indirect impacts, Cameron et al. (2010) noted that commercial fisheries target a number of known bearded seal prey species, such as walleye pollock and cod. Bottom trawl fisheries also have the potential to indirectly affect bearded seals through destruction or modification of benthic prey and/or their habitat.

3.1.4.3.7. Shipping

Current shipping activities in the Arctic pose varying levels of threats to bearded seals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with bearded seal habitats. These factors are inherently difficult to know or predict, making threat assessment highly uncertain. Most ships in the Arctic purposefully avoid areas of ice and thus prefer periods and areas which minimize the chance of encountering ice. This necessarily mitigates many of the risks of shipping to populations of bearded seals, since they are closely associated with ice throughout the year. Icebreakers pose special risks to bearded seals because they are capable of

operating year-round in all but the heaviest ice conditions and are often used to escort other types of vessels (e.g., tankers and bulk carriers) through ice-covered areas.

3.1.4.3.8. Contamination

Research on contaminants and bearded seals is limited compared to the extensive information available for ringed seals. Pollutants such as organochlorine compounds (OC) and heavy metals have been found in most bearded seal populations. The variety, sources, and transport mechanisms of the contaminants vary across the bearded seal's range, but these compounds appear to be ubiquitous in the Arctic marine food chain. Statistical analysis of OCs in marine mammals has shown that, for most OCs, the European Arctic is more contaminated than the Canadian and U.S. Arctic. Tynan and DeMaster (1997) noted climate change has the potential to increase the transport of pollutants from lower latitudes to the Arctic, highlighting the importance of continued monitoring of bearded seal contaminant levels.

3.1.4.3.9. Oil and Gas

Within the range of the Beringia DPS, offshore oil and gas exploration and production activities are currently underway in the United States, Canada, and Russia; however, relatively little activity has occurred in the Action Area. Oil and gas exploration, development, and production activities include, but are not limited to: seismic surveys; exploratory, delineation, and production drilling operations; construction of artificial islands, causeways, ice roads, shore-based facilities, and pipelines; and vessel and aircraft operations. These activities have the potential to impact bearded seals, primarily through noise, physical disturbance, and pollution, particularly in the event of a large oil spill or very large oil spill.

In the United States, oil and gas activities have been conducted off the coast of Arctic Alaska since the 1970s, with most of the activity occurring in the Beaufort Sea. Five exploratory wells have been drilled in the Action Area with no success of discovering oil and gas.

Although planning, management, and use of best practices can help reduce risks and impacts, the history of oil and gas activities, including recent events, indicates that accidents cannot be eliminated. Tanker spills, pipeline leaks, and oil blowouts have varying potential to occur in the future, even under the most stringent regulatory and safety systems. To date there have been no large spills in the U.S. Arctic marine environment from oil and gas activities.

3.1.4.3.10. Summary

Loss of sea ice due to environmental warming was identified as the greatest challenge to the persistence of the Beringia DPS. A substantial portion of the Beringia DPS currently whelps in the Bering Sea, where a longer ice-free period is projected in May and June, concurrent with nursing, rearing, and molting. Other threats evaluated included those associated with ocean acidification, predation, parasites and diseases, harvest, commercial fishing, shipping, and environmental contaminants. None of these other threats was found to individually or cumulatively raise concern about them placing the Beringia DPS at risk of becoming endangered. However, it was noted that the significance of these threats would become more significant for populations diminished by the effects of climate change or other threats (Cameron et al., 2010, 75 *FR* 77496).

3.1.4.4. Status

NMFS listed the Beringia DPS of bearded seals as threatened under the ESA on December 28, 2012 (77 *FR* 76740). Critical habitat for the Beringia DPS in U.S. waters will be proposed in future rulemaking.

Although the present population of the Beringia DPS is highly uncertain, it has been estimated to be about 155,000 individuals. Based on extrapolation from existing aerial survey data, Cameron et al. (2010) considered the current population of bearded seals in the Bering Sea to be about double the 63,200 estimate reported by Ver Hoef et al., (2010; corrected for seals in the water) for U.S. waters, or approximately 125,000 individuals. In addition, Cameron et al. (2010) derived crude estimates of: 3,150 bearded seals for the Beaufort Sea (uncorrected for seals in the water), which was noted as likely a substantial underestimate given the known subsistence harvest of bearded seals in this region; and about 27,000 seals for the Chukchi Sea based on extrapolation from limited aerial surveys (also uncorrected for seals in the water). Hartin et al. (2013) reported bearded seal densities ranging from 0.03 to 0.23 seals/mi² (0.01 to 0.09 seals/km²) in the summer and fall, respectively, during vessel-based surveys in the Chukchi Sea. These densities were lower than those reported by Bengtson et al. (2005) but are not directly comparable since the latter densities were based on aerial surveys of seals on sea ice in late May and early June. Vessel-based surveys conducted annually from 2008–2011 as a part of the CSESP reported between 9 and 45 bearded seals on the Burger prospect annually. Density estimates from these sightings ranged from 0.014 to 0.035 seals/km² (0.036 to 0.091 seals/mi²; Aerts et al., 2012).

In the East Siberian Sea, sightings were rare, with Obukhov (1974) sighting typically one bearded seal during every 200–250 km of travel. Geller (1957) described the zone between the Kola Peninsula and Chukotka as comparatively poor in marine mammals relative to the more western and eastern portions of the northern Russian coasts. The BRT was not aware of any other information about bearded seal abundance in the East Siberian Sea (Cameron et al., 2010).

3.1.4.5. Feeding and Prey Selection

Bearded seals feed primarily on a variety of invertebrates (crabs, shrimp, clams, worms, and snails) and some fishes found on or near the sea bottom (Kelly, 1988; Reeves et al., 1992; ADFG, 1994; Cameron et al., 2010; Burns, 1981; Hjelset et al., 1999). They primarily feed on or near the bottom, diving to depths of less than 100 m (though dives of adults have been recorded up to 300 m and young-of-the-year have been recorded diving down to almost 500 m; Gjertz et al., 2000). Unlike walrus that “root” in the soft sediment for benthic organisms, bearded seals are believed to “scan” the surface of the seafloor with their highly sensitive whiskers, burrowing only in the pursuit of prey (Marshall et al., 2006, 2008). They are also able to switch their diet to include schooling pelagic fishes when advantageous. Satellite tagging indicates that adults, subadults, and to some extent pups, show some level of fidelity to feeding areas, often remaining in the same general area for weeks or months at a time (Cameron, 2005; Cameron and Boveng, 2009). Diets may vary with age, location, season, and possible changes in prey availability (Kelly, 1988).

Quakenbush et al. (2011a) reported that fish consumption appeared to increase between the 1970s and 2000s for Alaska bearded seals sampled in the Bering and Chukchi Seas, although the difference was not statistically significant. Bearded seals also commonly consumed invertebrates, which were found in 95% of the stomachs sampled. In the 2000s, sculpin, cod, and flatfish were the dominant fish taxa consumed (Quakenbush et al. 2011a). The majority of invertebrate prey items identified in the 2000s were mysids, isopods, amphipods, and decapods. Decapods were the most dominant class of invertebrates, and were strongly correlated with the occurrence of shrimp and somewhat correlated with the occurrence of crab. Mollusks were also common prey, occurring in more than half of the stomachs examined throughout the years of the study.

3.1.4.6. Diving, Hauling out, and Social Behavior

The diving behavior of adult bearded seals is closely related to their benthic foraging habits and in the few studies conducted so far, dive depths have largely reflected local bathymetry (Gjertz et al., 2000; Krafft et al., 2000). Studies using depth recording devices have until recently focused on lactating

mothers and their pups. These studies showed that mothers in the Svalbard Archipelago make relatively shallow dives, generally <100 m in depth, and for short periods, generally less than 10 min in duration. Nursing mothers dived deeper on average than their pups, but by six weeks of age most pups had exceeded the maximum dive depth of lactating females (448-480 m versus 168-472 m) (Gjertz et al., 2000). Adult females spent most of their dive time (47-92%) performing U-shaped dives, believed to represent bottom feeding (Krafft et al., 2000); U-shaped dives are also common in nursing pups (Lydersen et al., 1994b). Unlike walrus that “root” in the soft sediment for benthic organisms, bearded seals are believed to “scan” the surface of the seafloor with their highly sensitive whiskers, burrowing only in the pursuit of prey (Marshall et al., 2006).

There are only a few quantitative studies concerning the activity patterns of bearded seals. Based on limited observations in the southern Kara Sea and Sea of Okhotsk it has been suggested that from late May to July bearded seals haul out more frequently on ice in the afternoon and early evening (Heptner et al., 1976). From July to April, three males (two subadults and one young adult) tagged as part of a study in the Bering and Chukchi Seas rarely hauled out at all, even when occupying ice covered areas.¹ This is similar to both male and female young-of-year bearded seals instrumented in Kotzebue Sound, Alaska (Frost et al., 2008); suggesting that, at least in the Bering and Chukchi Seas, bearded seals may not require the presence sea ice for a significant part of the year. The timing of haulout was different between the age classes in these two studies however, with more of the younger animals hauling out in the late evening (Frost et al., 2008) while adults favored afternoon (M. Cameron, Unpubl. Data, NMML, in Cameron et al., 2010).

Other studies using data recorders and telemetry on lactating females and their dependent pups showed that, unlike other large phocid seals, they are highly aquatic during a nursing period of about 3 weeks (Lydersen and Kovacs, 1999). At Svalbard Archipelago, nursing mothers spent more than 90% of their time in the water, split equally between near-surface activity and diving/foraging (Holsvik, 1998; Krafft et al., 2000), while dependent pups spent about 50% of their time in the water, split between the surface (30%) and diving (20%) (Lydersen et al., 1994a; 1996; Watanabe et al., 2009). The time spent in water during the nursing period is remarkable when compared to most other sympatric phocids, such as harp (*Pagophilus groenlandica*); (71%:0%), grey (*Halichoerus grypus*); (28%:0%), and hooded seals (0%:0%); however, it is similar to that of ringed seals (*Phoca hispida*); (mothers 82% : pups 50%) (Lydersen and Hammill, 1993; Lydersen et al., 1994b, Lydersen, 1995; Lydersen and Kovacs, 1999; Krafft et al., 2000). In addition to acquiring resources for lactation, time spent in the water may function to minimize exposure to surface predators (Lydersen and Kovacs, 1999; Krafft et al., 2000). Mothers traveled an average 48 km per day and alternated time in the water with one to four short bouts on the ice to nurse their pups usually between 0900 hr and 2100 hr (Krafft et al., 2000). This diurnal pattern also coincides with the timing of underwater mating calls by breeding males (Cleator et al., 1989, Van Parijs et al., 2001). In the spring, adult males are suspected to spend a majority of their time in the water vocalizing and defending territories, though a few observations suggest they are not entirely aquatic and may haul out near females with or without pups (Krylov et al., 1964; Burns, 1967; Fedoseev 1971; Finley and Renaud, 1980).

The social dynamics of mating in bearded seals are not well known because detailed observations of social interactions are rare, especially underwater where copulations are believed to occur. Theories regarding their mating system have centered around serial monogamy and promiscuity, and more specifically on the nature of competition among breeding males to attract and gain access to females (Stirling, 1983; Budelsky, 1992; Stirling and Thomas, 2003). Whichever mating system is favored, sexual selection driven by female choice is predicted to have strongly influenced the evolution of male displays, and possibly size dimorphism, and caused the distinct geographical vocal repertoires recorded from male bearded seals in the Arctic (Stirling, 1983; Atkinson, 1997; Risch et al., 2007). Bearded seals are solitary throughout most of the year except for the breeding season.

3.1.4.7. Vocalizations and Hearing

Pinnipeds have a well-developed more conventional vestibular apparatus that likely provides multiple sensory cues similar to those of most land mammals (Southall et al., 2007). Bearded seals are believed to scan the surface of the seafloor with their highly sensitive whiskers, burrowing only in pursuit of prey (Marshall et al., 2006). It is possible that marine mammals may be subject to noise-induced effects on vestibular function as has been shown in land mammals and humans (Southall et al., 2007). Responses to underwater sound exposures in human divers and other immersed land mammals suggest that vestibular effects are produced from intense underwater sound at some lower frequencies (Steevens et al., 1997).

The facial whisker pads of bearded seals have 1300 nerve endings associated with each whisker, making them among the most sensitive in the Animal kingdom (Marshall et al., 2006, as reported in Burns, 2009). Schusterman (1981) speculated sightless seals use sound localization and other non-visual, perhaps tactile, cues to locate food. Harbor seals have the known ability to detect and follow hydrodynamic trails out to 180 meters away (Dehnhardt et al., 2001) and research data supports the position that pinniped vibrissae are sensitive active-touch receptor systems enabling seals to distinguish between different types of trail generators (i.e. prey items, currents) (Supin et al., 2001; Marshall et al., 2006; Wieskotten et al., 2010). Mills and Renouf (1986) determined harbor seal vibrissae are least sensitive at lower frequencies (100, 250, and 500 Hz), and more sensitive at higher frequencies (750+ Hz) where the smallest detectable vibration occurred at 1,000 Hz.

Most phocid seals spend greater than 80% of their time submerged in the water (Gordon et al., 2003); consequently, they will be exposed to sounds from seismic surveys that occur in their vicinity. Phocids have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as those from seismic surveys (Gordon et al., 2003).

Bearded seals vocalize underwater in association with territorial and mating behaviors. The predominant calls produced by males during breeding, termed trills, are described as frequency-modulated vocalizations. Trills show marked individual and geographical variation, are uniquely identifiable over long periods, can propagate up to 30 km, are up to 60 s in duration, and are usually associated with stereotyped dive displays (Cleator et al., 1989; Van Parijs et al., 2001; Van Parijs 2003; Van Parijs et al., 2003; Van Parijs et al., 2004; Van Parijs and Clark, 2006).

Underwater audiograms for ice seals suggest that they have very little hearing sensitivity below 1 kHz; but hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al., 1995a). According to Southall et al. (2007), bearded seals (as with other pinnipeds) have an estimated auditory bandwidth of 75 Hz to 75 kHz in water, and 75 Hz to 30 kHz in air.

Masking of biologically important sounds by anthropogenic noise could be considered a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individual marine mammals. There are few situations or circumstances where low frequency sounds could mask biologically important signals. While seismic surveys can contain sounds up to 1 kHz, most of the emitted sound is <200 Hz. Seismic surveys generate periodic sounds that have little potential to mask sounds important to seals.

3.1.5. Ringed Seal

3.1.5.1. Population Structure

A single stock of ringed seal is currently recognized in U.S. waters, the Alaska stock (Allen and Angliss, 2014). This stock is part of the Arctic ringed seal subspecies. The genetic structuring of the Arctic subspecies has yet to be thoroughly investigated, and Kelly et al. (2010b) cautioned that it may prove to be composed of multiple distinct populations.

3.1.5.2. Distribution

Arctic ringed seals have a circumpolar distribution. They occur in all seas of the Arctic Ocean, and range seasonally into adjacent seas including the Bering Sea. In the Chukchi and Beaufort seas, where they are year-round residents, they are the most widespread seal species.

Arctic ringed seals have an affinity for ice-covered waters and are able to occupy areas of even continuous ice cover by abrading breathing holes in that ice (Hall, 1865; Bailey and Hendee, 1926; McLaren, 1958a). Throughout most of their range, Arctic ringed seals do not come ashore and use sea ice as a substrate for resting, pupping, and molting (Kelly 1988; Kelly et al., 2010). Outside the breeding and molting seasons, they are distributed in waters of nearly any depth; their distribution is strongly correlated with seasonally and permanently ice-covered waters and food availability (e.g. Simpkins et al., 2003; Freitas et al., 2008).

The seasonality of ice cover strongly influences ringed seal movements, foraging, reproductive behavior, and vulnerability to predation. Three ecological seasons have been described as important to ringed seals: the “open-water” or “foraging” period when ringed seals forage most intensively, the subnivean period in early winter through spring when seals rest primarily in subnivean lairs on the ice, and the basking period between lair abandonment and ice break-up (Born et al., 2004; Kelly et al., 2010).

Overall, the record from satellite tracking indicates that during the foraging period, ringed seals breeding in shorefast ice either forage within 100 km of their shorefast breeding habitat or they make extensive movements of hundreds or thousands of kilometers to forage in highly productive areas and along the pack ice edge (Freitas et al., 2008 in Kelly et al., 2010). Movements during the foraging period by ringed seals that breed in the pack ice are unknown. During the winter subnivean period, ringed seals excavate lairs in the snow above breathing holes where the snow depth is sufficient. These lairs are occupied for resting, pupping, and nursing young in annual shorefast and pack ice. Movements during the subnivean period are typically limited, especially when ice cover is extensive. During the (late) spring basking period, ringed seals haul out on the surface of the ice for their annual molt.

Because Arctic ringed seals are most readily observed during the spring basking period, aerial surveys to assess abundance are conducted during this period. Frost et al. (2004) reported that water depth, location relative to the fast ice edge, and ice deformation showed substantial and consistent effects on ringed seal densities during May and June in their central Beaufort Sea study area—densities were highest in relatively flat ice and near the fast ice edge, as well as at depths between 5 and 35 m. Bengtson et al., (2005) found that in their eastern Chukchi Sea study area during May and June, ringed seals were four to ten times more abundant in nearshore fast and pack ice than in offshore pack ice, and that ringed seal preference for nearshore or offshore habitat was independent of water depth. They observed higher densities of ringed seals in the southern region of the study area south of Kivalina and near Kotzebue Sound.

3.1.5.3. Threats to the Species

Current threats to Arctic ringed seals are described in detail the species' Status Review (Kelly et al., 2010) and the proposed listing rule (75 *FR* 77476), and are briefly summarized below. Details about individual threats in the Action Area will also be discussed in Section 4–1.

3.1.5.3.1. Predation

Polar bears are the main predator of ringed seals, but other predators include Arctic and red foxes, walrus, wolves, wolverines, killer whales, and ravens (Burns and Eley, 1976; Heptner et al., 1976; Fay et al., 1990; Sipliä, 2003; Derocher et al., 2004; Melnikov and Zagrebin, 2005). The threat currently posed to ringed seals by predation is moderate, but predation risk is expected to increase as snow and sea ice conditions change with a warming climate (75 *FR* 77476).

3.1.5.3.2. Parasites and Diseases

Ringed seals have co-evolved with numerous parasites and diseases, and these relationships are presumed to be stable. An unusual mortality event (UME) was declared by NOAA in December 2011. The cause of the Northern Pinniped UME remains unknown, investigation continues, although the number of new cases decreased substantially after 2011 (NOAA, 2013; NOAA and USFWS, 2014). Kelly et al. (2010) noted that abiotic and biotic changes to ringed seal habitat could lead to exposure to new pathogens or new levels of virulence, but the potential threats to ringed seals were considered low.

3.1.5.3.3. Climate Change: Loss of Sea Ice and Snow Cover

Diminishing sea ice and snow cover were identified as the greatest challenges to the persistence of Arctic ringed seals. Within this century, snow cover was projected to be inadequate for the formation and occupation of birth lairs over a substantial portion of the subspecies' range. Without the protection of the lairs, ringed seals—especially newborn—are vulnerable to freezing and predation (75 *FR* 77476). Additionally, high fidelity to birthing sites exhibited by ringed seals makes them more susceptible to localized degradation of snow cover (Kelly et al., 2010).

3.1.5.3.4. Climate Change: Ocean Acidification

Although no scientific studies have directly addressed the impacts of ocean acidification on ringed seals, the effects would likely be through their ability to find food. Ocean acidification could further exacerbate the stress regime species are already facing. The loss of prey species from the ecosystem may have a cascading effect on ringed seals (Kelly et al., 2010).

3.1.5.3.5. Harvest

Ringed seals were harvested commercially in large numbers during the 20th century, which led to the depletion of their stocks in many parts of their range. Arctic ringed seals have been hunted by humans for millennia and remain a fundamental subsistence resource for many northern coastal communities today. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. Currently there is no comprehensive effort to quantify harvest levels of seals in Alaska. The best estimate of the statewide annual ringed seal subsistence harvest is 9,567 (Allen and Angliss, 2014). Kelly et al. (2010) concluded that although subsistence harvest of Arctic ringed seals is currently substantial in some parts of their range, harvest levels appear to be sustainable.

3.1.5.3.6. Commercial Fisheries Interactions

Commercial fisheries may impact ringed seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. Based on data from 2007 to 2011, there has been an annual average of 3.52 mortalities of Arctic ringed seals incidental to commercial fishing operations in Alaskan waters (Allen and Angliss, 2014).

For indirect interactions, Kelly et al. (2010) noted that commercial fisheries target a number of known ringed seal prey species such as walleye pollock (*Theragra chalcogramma*), Pacific cod, herring (*Clupea* sp.), and capelin. These fisheries may affect ringed seals indirectly through reductions in prey biomass and through other fishing mediated changes in ringed seal prey species. The extent that reduced numbers in individual fish stocks affect the viability of Arctic ringed seals is unknown. However, Arctic ringed seals were not believed to be significantly competing with or affected by commercial fisheries in the waters of Alaska (Frost, 1985; Kelly, 1988). Commercial fishing is prohibited within the Arctic Management Area, which includes all US waters of the Chukchi Sea and the Action Area; however it is allowed in other parts of the ringed seal's range.

3.1.5.3.7. Shipping

Current shipping activities in the Arctic pose varying levels of threats to Arctic ringed seals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with ringed seal habitats. These factors are inherently difficult to know or predict, making threat assessment highly uncertain. Most ships in the Arctic purposefully avoid areas of ice and thus prefer periods and areas which minimize the chance of encountering ice. This necessarily mitigates many of the risks of shipping to populations of ringed seals, since they are closely associated with ice throughout the year. Icebreakers pose special risks to ringed seals because they are capable of operating year-round in all but the heaviest ice conditions and are often used to escort other types of vessels (e.g., tankers and bulk carriers) through ice-covered areas.

3.1.5.3.8. Contamination

Contaminants research on Arctic ringed seals is very extensive and has been conducted in most parts of the subspecies' range. Pollutants such as OC compounds and heavy metals have been found in Arctic ringed seals. The variety, sources, and transport mechanisms of the contaminants vary across the ringed seal's range, but these compounds appear to be ubiquitous in the Arctic marine food chain. Statistical analysis of OCs in marine mammals has shown that for most OCs, the European Arctic is more contaminated than the Canadian and U.S. Arctic. Tynan and DeMaster (1997) noted that climate change has the potential to increase the transport of pollutants from lower latitudes to the Arctic, highlighting the importance of continued monitoring of contaminant levels.

Oil and gas activities have the potential to impact ringed seals primarily through noise, physical disturbance, and pollution, particularly in the event of a large oil spill or very large oil spill. Within the range of the Arctic ringed seal, offshore oil and gas exploration and production activities are currently underway in the United States, Canada, Greenland, Norway, and Russia. In the United States, oil and gas activities have been conducted off the coast of Alaska since the 1970s, with most of the activity occurring in the Beaufort Sea. Although five exploratory wells have been drilled in the past, no oil fields have been developed or brought into production in the Chukchi Sea to date.

In general, historical data show that loss of well control events resulting in oil spills are infrequent and that those resulting in large accidental oil spills are even rarer events (Anderson and Labelle, 2000; Bercha Group, Inc., 2006, 2008; Izon et al., 2007; Anderson et al., 2012). The Norwegian SINTEF Offshore Blowout Database, which tracks worldwide offshore oil and gas blowouts, where risk-comparable drilling operations are analyzed, supports the same conclusion (IAOGP, 2010; DNV, 2010, 2011).

Blowout frequency analyses of the SINTEF database suggest that the highest risk operations are associated with exploration drilling in high-pressure, high-temperature conditions (DNV 2010, 2011). New drilling regulations and recent advances in containment technology may further reduce the frequency and size of oil spills from OCS operations (DNV, 2010, 2011).

3.1.5.3.9. Summary

Diminishing sea ice and snow cover were identified as the greatest challenges to the persistence of Arctic ringed seals. Additional threats including ocean acidification, predation, parasites and diseases, harvest, commercial fishing, shipping, and environmental contaminants were not found to individually or cumulatively raise concern about them placing Arctic ringed seals at risk of becoming endangered. However, it was noted that the significance of these threats could become more significant for populations diminished by the effects of climate change or other threats (Kelly et al., 2010; 75 *FR* 77476).

3.1.5.4. Status

NMFS listed the Arctic ringed seal as threatened under the ESA on December 28, 2012 (77 *FR* 76706). Critical habitat for the Arctic ringed seal in U.S. waters was proposed on December 9, 2014 (79 *FR* 73010).

There are no specific estimates of population size available for the Arctic subspecies of the ringed seal, but most experts would postulate that the population numbers in the millions. Based on the available abundance estimates for study areas within the Chukchi-Beaufort Sea region and extrapolations for pack ice areas without survey data, Kelly et al. (2010b) indicated that a reasonable estimate for the Chukchi and Beaufort Seas is 1 million seals, and that the Alaskan portions of these seas is at least 300,000 seals.

Bengtson et al., (2005) estimated the abundance of ringed seals from spring aerial surveys conducted along the eastern Chukchi coast from Shishmaref to Barrow at 252,000 seals in 1999 and 208,000 in 2000 (corrected for seals not hauled out). Frost et al., (2004) conducted spring aerial surveys along the Beaufort Sea coast from Oliktok Point to Kaktovik in 1996–1999. They reported density estimates for these surveys, but did not derive abundance estimates. Based on the average density reported by Frost et al., (2004) for all years and ice types and the size of the survey area ($0.98/\text{km}^2$), Allen and Angliss (2011) derived an estimate of approximately 18,000 seals hauled out in that survey portion of the Beaufort Sea (uncorrected for seals not hauled out). Combining this with the average abundance estimate of 230,673, (from Bengtson et al., (2005) for the eastern Chukchi Sea) results in a total of approximately 249,000 seals. This is a minimum population estimate because it does not include much of the geographic range of the stock and the estimate for the Beaufort Sea has not been corrected for the number of ringed seals not hauled out at the time of the surveys (Allen and Angliss, 2011).

During vessel-based observations from industry activities in the Chukchi Sea, Hartin et al. (2013) reported seal densities (assumed to be primarily ringed seals) from 0.125 to 2.1 seals/ mi^2 (0.048 to 0.807 seals/ km^2). CSESP vessel-based surveys from 2008–2012 recorded 311 ringed seals and 756 seals classified as either ringed or spotted (Aerts et al., 2013). Estimated densities from CSESP vessel-based surveys from 2008–2012 for the combined ringed/spotted seal category ranged from 0.01 seals/ mi^2 (0.004 seals/ km^2) in July/August of 2009 to 0.3 seals/ mi^2 (0.1 seals/ km^2) in July/August of 2008 (Aerts et al., 2013).

3.1.5.5. Feeding and Prey Selection

Many studies of the diet of Arctic ringed seal have been conducted and although there is considerable variation in the diet regionally, several patterns emerge. Most ringed seal prey is small, and preferred

prey tends to be schooling species that form dense aggregations. Ringed seals rarely prey upon more than 10–15 prey species in any one area, and not more than 2–4 of those species are considered important prey. Fishes are generally more commonly eaten than invertebrate prey, but diet is determined to some extent by availability of various types of prey during particular seasons as well as preference, which in part is guided by energy content of various available prey (Reeves, 1998; Wathne et al., 2000). Invertebrate prey seem to become more important in the diet of Arctic ringed seals in the open water season and often dominate the diet of young animals (e.g., Lowry et al., 1980; Holst et al., 2001).

Despite regional and seasonal variations in the diet of Arctic ringed seals, fishes of the cod family tend to dominate the diet from late autumn through early spring in many areas (Kovacs 2007). Arctic cod (*Boreogadus saida*) is often reported to be the most important prey species for ringed seals, especially during the ice-covered periods of the year (Lowry et al., 1980; Smith, 1987; Holst et al., 2001; Labansen et al., 2007). Quakenbush et al., (2011b) reported evidence that in general, the diet of Alaska ringed seals sampled consisted of cod, amphipods, and shrimp. They found that fish were consumed more frequently in the 2000s than during the 1960s and 1970s, and identified the five dominant species or taxa of fishes in the diet during the 2000s as: Arctic cod, saffron cod, sculpin, rainbow smelt, and walleye pollock. Invertebrate prey were predominantly mysids, amphipods, and shrimp, with shrimp most dominant.

3.1.5.6. Diving, Hauling out, and Social Behavior

Behavior of ringed seals is poorly understood because both males and females spend much of their time in lairs built in pressure ridges or under snowdrifts for protection from predators and severe weather (ADFG, 1994). Figure 3.3 summarizes the approximate annual timing of reproduction and molting for Arctic ringed seals.

Arctic Ringed Seals

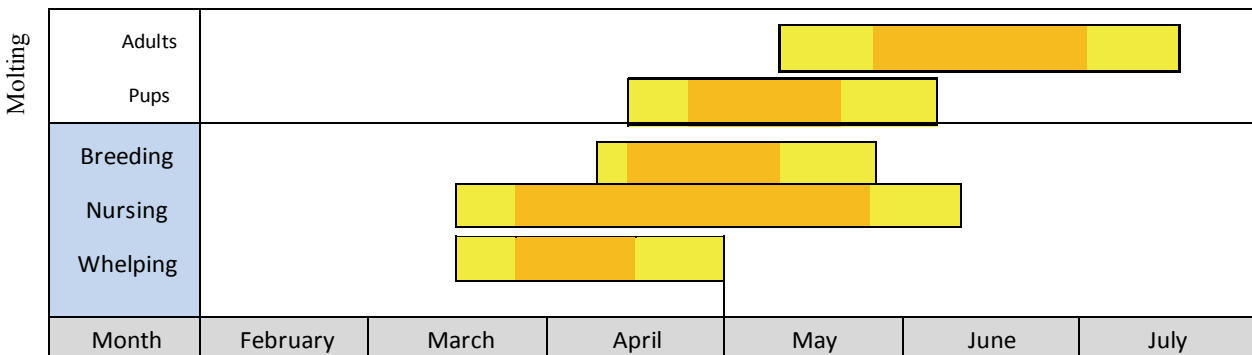


Figure 3-3. Approximate annual timing of reproduction and molting for Arctic ringed seals. Yellow bars indicate the “normal” range over which each event is reported to occur and orange bars indicated the “peak” timing of each event (source: Kelly et al., 2010).

Arctic ringed seals use sea ice as a platform for resting throughout the year, and they make and maintain breathing holes in the ice from freeze-up until breakup (Frost et al., 2002). They normally give birth in late winter-early spring in subnivean lairs constructed in the snow on the sea ice above breathing holes, and mating takes place typically in May shortly after parturition. In the spring, as day length and temperature increase, ringed seals haul out in large numbers on the surface of the ice near breathing holes or lairs. This behavior is associated with the annual May–July molt (Figure 3–3).

Ringed seal pups are very aquatic, spending about 50% of their time in the water during the nursing period, diving for up to 12 minutes and as deep as 89 m (Lydersen and Hammill, 1993). The pups' large proportion of time spent in the water, early development of diving skills, use of multiple breathing holes and nursing/resting lairs, and prolonged lanugo stage were interpreted as adaptive responses to strong predation pressure, mainly by polar bears (*Ursus maritimus*) and Arctic foxes (*Alopex lagopus*) (Smith et al., 1991; Lydersen and Hammill, 1993).

Tagging studies revealed that Arctic ringed seals are capable of diving for at least 39 min (Teilmann et al., 1999) and to depths of over 500 m (Born et al., 2004); however, most dives reportedly lasted less than 10 min and dive depths were highly variable and were often limited by the relative shallowness of the areas in which the studies took place (Lydersen 1991, Kelly and Wartzok, 1996; Teilmann et al., 1999; Gjertz et al., 2000). Based on three-dimensional tracking, Simpkins et al. (2001) categorized ringed seal dives as either travel, exploratory, or foraging/social dives. Ringed seals tend to come out of the water during the daytime and dive at night during the spring to early summer breeding and molting periods, while the inverse tended to be true during the late summer, fall, and winter (Kelly and Quakenbush 1990; Lydersen 1991; Teilmann et al., 1999; Carlens et al., 2006, Kelly et al., 2010). Captive diving experiments conducted by Elsner et al. (1989) indicated that ringed seals primarily use vision to locate breathing holes from under the ice, followed by their auditory and vibrissal senses for short-range pilotage.

3.1.5.7. Vocalizations and Hearing

Ringed seals vocalize underwater in association with territorial and mating behaviors. Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, though they can hear underwater sounds at frequencies up to 60 kHz and make calls between 90 Hz and 16 kHz (Richardson et al., 1995a). A more recent review suggests that the auditory bandwidth for pinnipeds in water should be considered to be 75 Hz to 75 kHz (Southall et al., 2007). The airgun sound source being proposed for this project is anticipated to be between 100 Hz to 3 kHz, and should be well within the auditory bandwidth for the Arctic ringed seal.

Most phocid seals spend greater than 80% of their time submerged in the water (Gordon et al., 2003); consequently, they will be exposed to sounds from seismic surveys that occur in their vicinity. Phocids have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as those from seismic surveys (Gordon et al., 2003). Masking of biologically important sounds by anthropogenic noise could be considered a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individual ringed seals. The consequences might be more serious in areas where many surveys are occurring simultaneously (Kelly et al., 2010). There is no specific evidence that exposure to pulses of airgun sound can cause permanent threshold shifts to the hearing of any marine mammal, even with large arrays of airguns. Nevertheless, direct impacts causing injury from seismic surveys may occur only if animals entered the zone immediately surrounding the sound source (Kelly et al., 2010).

In addition, noise exposure may affect the vestibular and neurosensory systems. Unlike cetaceans, pinnipeds have a well-developed more conventional vestibular apparatus that likely provides multiple sensory cues similar to those of most land mammals. There is a direct coupling through the vestibule of the vestibular and auditory systems; therefore, it is possible that marine mammals may be subject to noise-induced effects on vestibular function as has been shown in land mammals and humans (Southall et al., 2007). Noise-induced effects on vestibular function may be even more pronounced than in land mammals considering a single vibrissa on a ringed seal contains ten times the number of nerve fibers typically found in one vibrissa of a land mammal (Hyvärinen, 1989). Responses to underwater sound exposures in human divers and other immersed land mammals suggest that vestibular effects are produced from intense underwater sound at some lower frequencies (Steevens et

al., 1997). However, more data are needed to more fully assess potential impacts of underwater sound exposure on non-auditory systems in pinnipeds.

Elsner et al. (1989) indicated that ringed seals primarily use vision to locate breathing holes from under the ice, followed by their auditory and vibrissal senses for short-range pilotage. Hyvärinen (1989) suggested that ringed seals in Lake Saimaa may use a simple form of echolocation along with a highly developed vibrissal sense for orientation and feeding in dark, murky waters. The vibrissae likely are important in detecting prey by sensing their turbulent wakes as demonstrated experimentally for harbor seals (Dehnhardt et al., 1998). Sound waves could be received by way of the blood sinuses and by tissue conduction through the vibrissae (Riedman, 1990).

3.2. Status of Critical Habitat

That status of critical habitat is focused primarily on the physical and biological features that are essential to the conservation of the associated listed species. No designated critical habitat exists for any of the species in this consultation. However, critical habitat has been proposed within the Action Area for the Arctic ringed seal, and potential exists for it to be impacted by the Proposed Action.

3.2.1. Critical Habitat for the Arctic Ringed Seal

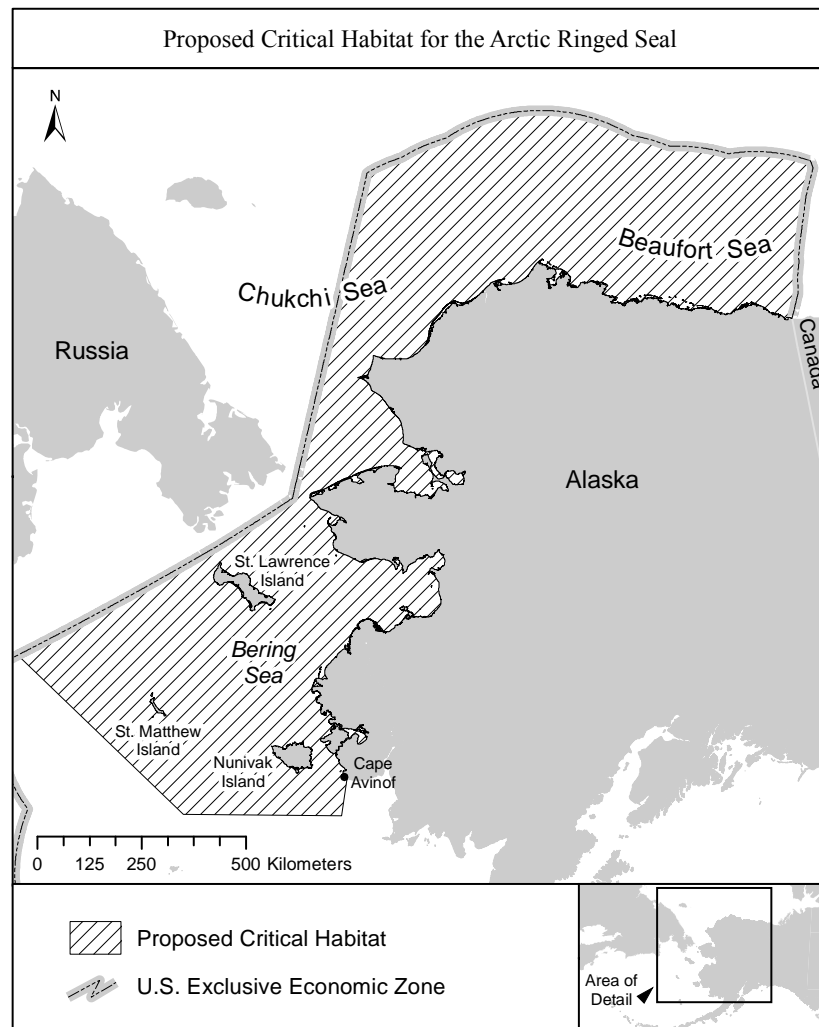


Figure 3-4. Proposed Critical Habitat for the Arctic Ringed Seal

Critical habitat was proposed for the Arctic ringed seal on December 9, 2014 (79 *FR* 73010) but has not yet been finalized. The proposal encompasses one large area of marine habitat that is based on the extent of the outer boundary of the U.S. Exclusive Economic Zone (EEZ) in the Chukchi and Beaufort seas, and south into the Bering Sea, as far south as Bristol Bay in years with extensive ice coverage (Figure 3–4). The shoreward extent is the coastline of Alaska as defined in the Submerged Lands Act (i.e., the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters), 43 U.S.C. 1301(c). The project area occurs within the proposed critical habitat.

Proposed critical habitat for Arctic ringed seals includes the following features essential to the conservation of the species (also known as essential features and primary constituent elements): (1) sea ice habitat suitable for the formation and maintenance of subnivean birth lairs, (2) Sea ice habitat suitable as a platform for basking and molting, and (3) primary prey resources to support Arctic ringed seals, which are defined to be Arctic cod, saffron cod, shrimps, and amphipods.

3.2.1.1. Essential Feature: Sea Ice Habitat for Subnivean Birth Lairs

Ringed seals use subnivean lairs for sheltering pups during whelping and nursing. Sea ice habitat suitable for the formation and maintenance of subnivean birth lairs is essential to conservation of the Arctic ringed seal because without the protection of lairs, ringed seal pups are more vulnerable to freezing and predation. The critical habitat proposal defines this essential feature as (1) seasonal landfast (shorefast) ice, except for any bottom-fast ice extending seaward from the coast line in waters less than 2 m deep, or (2) dense, stable pack ice that has undergone deformation and contains snowdrifts at least 54 cm deep.

Arctic ringed seals appear to favor landfast ice as whelping habitat. However, during winter, landfast ice in very shallow water generally freezes to the sea bottom and is unsuitable for lairs. Therefore, only landfast ice extending seaward from the coast line in waters at least 2 m deep is essential to the conservation of the ringed seal.

Whelping has also been observed on both nearshore and offshore drifting pack ice.

Snowdrifts of sufficient depth for birth lair formation and maintenance typically occur in deformed ice along pressure ridges or ice hummocks (Smith and Stirling, 1975; Lydersen and Gjertz, 1986; Kelly, 1988; Furgal et al., 1996; Lydersen, 1998). NMFS identified 54 cm as the minimum snowdrift depth because this was the average minimum depth reported in several studies of ringed seal lairs.

3.2.1.2. Essential Feature: Sea Ice Habitat as a Platform for Basking and Molting

During their annual molt (May–July), Arctic ringed seals spend long periods of time basking on the surface of the ice near breathing holes. Molting is a biologically important, energy intensive process that could incur increased energetic costs if it were to occur in water. Predation risk might increase if seals were forced to molt on land. There are no known observations of seals successfully molting in water, or of healthy seals molting on land.

The proposed critical habitat rule defines suitable platforms as sea ice of 15% or more concentrated, except for any bottom-fast ice extending seaward from the coast line in waters less than 2 m deep.

3.2.1.3. Essential Feature: Primary Prey Resources

The proposed critical habitat rule defines primary prey resources of ringed seals as Arctic cod, saffron cod, shrimps, and amphipods. Arctic ringed seals likely rely on these prey resources the most to meet

their annual energy budgets. The seals also feed on other vertebrates and invertebrates, but the primary prey resources appear to occupy a prominent dietary role in waters along the Alaska coast.

3.2.2. Threats to Essential Features of Critical Habitat

The proposed rule for ringed seal critical habitat identified several categories of human activities and associated threats that could affect the features identified as essential to conservation of the species. They are greenhouse gas emissions; oil and gas exploration, development, and production; shipping and transportation; and commercial fishing. With the exception of commercial fishing, which would only affect primary prey resources, all of the activities could potentially affect all three of the essential features.

3.2.2.1. Greenhouse Gas Emissions

Activities that release carbon dioxide and other heat-trapping GHGs into the atmosphere, most notably those that involve fossil fuel combustion, are a major contributing factor to climate change and loss of sea ice (IPCC, 2013). Such activities may adversely affect the essential features of Arctic ringed seal habitat by diminishing sea ice suitable for birth lairs and molting, and by causing changes in the distribution and/or species composition of prey resources. The best scientific data currently available do not allow identification of a causal linkage between any particular single source of GHG emissions and identifiable effects on the physical and biological features essential to Arctic ringed seals.

3.2.2.2. Oil and Gas Activities

Oil and gas activities include seismic surveys; exploratory, delineation, and production drilling operations; construction of artificial islands, causeways, ice roads, shore-based facilities, and pipelines; and vessel and aircraft operations. These activities have the potential to affect Arctic ringed seals and their habitat, primarily through noise, physical disturbance, and pollution, particularly in the event of an oil spill, and especially a large oil spill. All three of the essential features could be impacted by oil and gas activities.

3.2.2.3. Shipping and Transportation

Shipping and transportation in Arctic waters have the potential to affect Arctic ringed seals and their habitat primarily through noise, physical disturbance, and the accidental and illegal discharge of oil or other toxic substances carried by ships. Both the physical disturbance and noise associated with these activities could displace seals from favored habitat that contains the essential features, thus altering the quantity and/or quality of these features. In the event of an oil spill, sea ice essential for birth lairs and for molting could become oiled, and the quantity and/or quality of the primary prey resources could be adversely affected.

3.2.2.4. Commercial Fishing

Commercial fisheries may affect the primary prey resources identified as essential to conservation of the ringed seal, through removal of prey biomass and potentially through modification of benthic habitat by bottom-trawl gear. Commercial fishing is currently prohibited within the Arctic Management Area, which includes all US waters of the Chukchi Sea and the Action Area. The prohibition could be lifted in the future if sufficient data is acquired to support the sustainable management of the commercial fishery resources. However, this is not reasonably foreseeable at this time.

4.0 ENVIRONMENTAL BASELINE

The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

A number of human activities have contributed to the current status of populations of large whales and seals in the Action Area. Some of those activities, most notably commercial whaling, occurred extensively in the past, ended, and no longer appear to affect these whale populations, although the effects of these reductions likely persist today. Other human activities are ongoing and appear to continue to affect populations of endangered whales and threatened ice seals.

4.1. Stressors for Species in the Action Area

The following discussion summarizes the principal stressors that are known to affect the likelihood that these endangered and threatened species will survive and recover in the wild. The stressors that will be covered in this discussion include:

- Targeted Hunts;
- Acoustic Noise;
- Ship Strike;
- Commercial Fishing Interactions;
- Pollutants and Contaminants; and
- Climate Change.

4.1.1. Targeted Hunts

Whaling in the Alaskan Arctic and subarctic has taken place for at least 2,000 years. Stoker and Krupnik (1993) documented prehistoric hunts of bowhead whales by indigenous peoples of the Arctic and subarctic regions. Alaska Natives continue this tradition of subsistence whaling as they conduct yearly hunts for bowhead whales, to the present day. In addition to subsistence hunting, a period of commercial whaling, discussed below, occurred during the late 19th and early 20th centuries.

4.1.1.1. Historical Commercial Whaling.

4.1.1.1.1. Bowhead Whale

Pelagic commercial whaling for the Western Arctic stock of bowheads was conducted from 1849 to 1914 in the Bering, Chukchi, and Beaufort Seas (Bockstoce et al., 2005). Woodby and Botkin (1993) estimated that the historic abundance of bowhead whales in this population was between 10,400 and 23,000 whales before commercial whaling began in 1848. Within the first two decades of the fishery (1850–1870), over 60% of the estimated pre-whaling abundance was harvested, although effort remained high into the 20th century (Braham, 1984). It is estimated that the pelagic whaling industry harvested 18,684 whales from this stock (Woodby and Botkin, 1993). During 1848–1919, shore-based whaling operations (including landings as well as struck and lost estimates from U. S., Canada, and Russia) took an additional 1,527 animals (Woodby and Botkin, 1993). An unknown percentage of the animals taken by the shore-based operations were harvested for subsistence and not commercial purposes. Estimates of mortality likely underestimate the actual harvest as a result of under-reporting of the Soviet catches (Yablokov, 1994) and incomplete reporting of struck and lost animals.

Commercial whaling also may have caused the extinction of some subpopulations and some temporary changes in distribution.

4.1.1.1.2. Fin Whale

Between 1925 and 1975, 47,645 fin whales were reported killed throughout the North Pacific (International Whaling Commission, BIWS catch data, February 2003 version, unpublished, as cited in Allen and Angliss, 2011)), although newly revealed information about illegal Soviet catches indicates that the Soviets over-reported catches of about 1,200 fin whales, presumably to hide catches of other protected species (Doroshenko, 2000). There are no reports of direct human-related injuries or mortalities to fin whales in Alaska waters included in the Alaska Region stranding database for 2001–2005 (NMFS AKR, unpublished data, as cited in Allen and Angliss, 2011).

4.1.1.1.3. Humpback Whale

Much of the information provided in the *Alaska Marine Mammal Stock Assessments* by Allen and Angliss (2010), does not include reliable data differentiating the number of Western North Pacific stock taken by commercial whaling from the number of Central North Pacific stocks taken by commercial whaling. However, it is the best information available.

Rice (1978) estimated that the number of humpback whales in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based upon incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century (Rice, 1978). A total of 3,277 reported catches occurred in Asia between 1910 and 1964, with 817 catches from Ogasawara between 1924 and 1944 (Nishiwaki, 1966; Rice, 1978). After World War II, substantial catches occurred in Asia near Okinawa (including 970 between 1958 and 1961), as well as around the main islands of Japan and the Ogasawara Islands. On the feeding grounds, substantial catches occurred around the Commander Islands and western Aleutian Islands, as well as in the Gulf of Anadyr (Springer et al., 2006).

Humpback whales in the North Pacific were theoretically fully protected in 1965, but illegal catches by the USSR continued until 1972 (Ivashchenko et al., 2007). From 1961 to 1971, over 6,793 humpback whales were killed illegally by the USSR. Many animals during this period were taken from the Gulf of Alaska and Bering Sea (Doroshenko, 2000); however, additional illegal catches were made across the North Pacific, from the Kuril Islands to the Queen Charlotte Islands, and other takes in earlier years may have gone unrecorded.

4.1.1.1.4. Ringed and Bearded Seals

While there was substantial commercial harvest of both ringed and bearded seals in the late 19th and 20th centuries which lead to local depletions, commercial harvesting of ice seals has been prohibited in U.S. waters since 1972 by the MMPA. Since that time, the only harvest of ringed and bearded seals allowed in U.S. waters is for subsistence for Alaska Native communities as discussed below.

4.1.1.1.5. Proposed Critical Habitat for Ringed Seal

Targeted hunts do not affect proposed critical habitat for ringed seal, and has not influenced the environmental baseline.

4.1.1.2. Subsistence Harvest

The subsections below summarize subsistence harvest information for each species. This information is further detailed in each species-specific section of Section 3.1.

4.1.1.2.1. Bowhead Whale

Alaska Natives have been taking bowhead whales for subsistence purposes for at least 2,000 years (Marquette and Bockstoe, 1980; Stoker and Krupnik, 1993). Subsistence takes have been regulated by a quota system under the authority of the IWC since 1977. This harvest represents the largest known human-related cause of mortality in the Western Arctic stock. Alaska Native subsistence hunters take approximately 0.1–0.5% of the population per annum, primarily from eleven Alaska communities (Philo et al., 1993). Under this quota, the number of kills has ranged between 14 and 72 per year, the number depending in part on changes in management strategy and in part on higher abundance estimates in recent years (Stoker and Krupnik, 1993). Suydam and George (2012) summarized Alaskan subsistence harvests of bowheads from 1974 to 2011 and reported a total of 1,149 whales landed by hunters from 12 villages with Barrow landing the most whales ($n = 590$) while Shaktoolik landed only one. Alaska Natives landed 37 bowheads in 2004 (Suydam et al., 2005, 2006), 55 in 2005 (Suydam et al., 2006), 31 in 2006 (Suydam et al., 2007), 41 in 2007 (Suydam et al., 2008), and 38 in 2008 (Suydam et al., 2009). The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions. The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead quota in 1978. In 1978 the efficiency was about 50% and currently it is about 65% (mean for 1998–2007; Suydam et al., 2009). Available evidence indicates that subsistence hunting has caused disturbance to the other whales, changed their behavior, and sometimes temporarily affects habitat use, including migration paths (NMFS, 2008a).

Canadian and Russian Natives are also known to take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. Repulse Bay has had four successful harvests since 1996, the latest occurring August 2012. Hunters in the community of Taloyoak are now preparing to head out in search of this year's third whale, but few of them have ever been on a bowhead hunt.² Eight whales were harvested by Russian subsistence hunters between 1999–2005 (Borodin, 2004, 2005; IWC, 2007a). No catches were reported by either Canadian or Russian hunters for 2006–2007 (IWC, 2008), but two bowheads were taken in Russia in 2008 (IWC, 2009). The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2004 to 2008 was 41.2 bowhead whales.

4.1.1.2.2. Fin Whale

Subsistence hunters in Alaska and Russia have not been reported to take fin whales from this stock (Allen and Angliss, 2014).

4.1.1.2.3. Humpback Whale

Subsistence hunters in Alaska have reported one subsistence take of a humpback whale in South Norton Sound in 2006. There have not been any additional reported takes of humpback whales from this stock by modern-day subsistence hunters in Alaska or Russia (Allen and Angliss, 2014).

4.1.1.2.4. Bearded Seal

Information on subsistence harvest of bearded seals has been compiled for 129 villages from reports from the Division of Subsistence (Coffing et al., 1998; Georgette et al., 1998; Wolfe and Hutchinson-Scarborough, 1999) and a report from the Eskimo Walrus Commission (EWC) (Sherrod, 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990 to 1998 were used. Allen and Angliss

² August 14, 2012, Alaska Dispatch article based on a report from the Canadian Broadcasting Corporation.

(2010, 2014) reported that based on subsistence harvest data maintained by ADF&G primarily for the years 1990 to 1998, the mean estimated annual harvest level in Alaska averaged 6,788 bearded seals as of August 2000 (Coffing et al., 1998; Georgette et al., 1998; Wolfe and Hutchinson-Scarborough, 1999; Allen and Angliss, 2014). Cameron et al. (2010) noted that ice cover in hunting locations can dramatically affect the availability of bearded seals and the success of hunters in retrieving seals that have been shot, which can range from 50-75% success in the ice (Burns and Frost, 1979; Reeves et al., 1992) to as low as 30% in open water (Burns, 1967; Smith and Taylor 1977; Riewe and Amsden 1979; Davis et al., 1980). Using the mean annual harvest reported from 1990-1998, assuming 25 to 50% of seals struck are lost, they estimated the total annual hunt by Alaska Natives would range from 8,485 to 10,182 bearded seals (Cameron et al., 2010).

At this time, there are no efforts to quantify the current level of harvest of bearded seals by all Alaska communities.

4.1.1.2.5. Ringed Seal

Ringed seals are an important species for Alaska Native subsistence hunters. The estimated annual subsistence harvest in Alaska dropped from 7,000 to 15,000 in the period from 1962 to 1972 to an estimated 2,000–3,000 in 1979 (Frost, 1985). Based on data from two villages on St. Lawrence Island, the annual take in Alaska during the mid-1980s likely exceeded 3,000 seals (Kelly, 1988).

The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. Currently there is no comprehensive effort to quantify harvest levels of seals in Alaska. The best estimate of the statewide annual ringed seal subsistence harvest is 9,567 (Allen and Angliss, 2014). Kelly et al. (2010) concluded that although subsistence harvest of Arctic ringed seals is currently substantial in some parts of their range, harvest levels appear to be sustainable.

4.1.1.2.6. Proposed Critical Habitat for Ringed Seal

Subsistence hunting does not affect proposed critical habitat for ringed seal, and has not influenced the environmental baseline.

4.1.2. Acoustic Noise

Rather than presenting a tutorial on acoustics here, we refer the reader to Bradley and Stern (2008), Richardson et al. (1995a), and www.dosits.org for background and additional information.

Below we describe the ambient and anthropogenic sounds that currently occur in the Action Area.

4.1.2.1. Ambient Noise

Ambient noise is background noise in the environment absent obvious human influence. For example, close approaches by vessels will likely result in higher sound levels and these are considered obvious human influences. When one considers the distance from its source that a signal can be detected, the intensity and frequency characteristics of ambient noise are important factors to consider in combination with the rate at which sound is lost as it is transmitted from its source to a receiver (Richardson et al., 1995a). Generally, a signal would be detectable or salient only if it is stronger than the ambient noise at similar frequencies. The lower the intensity of ambient noise, the farther signals would travel and remain salient. There are many sources of ambient noise in the ocean, including wind and waves, ice, rain and hail; sounds produced by living organisms; seismic noise from volcanic and tectonic activity; and thermal noise that results from molecular agitation (which is important at frequencies greater than 30 kHz). We discuss two general categories of ambient noise: (1) variability in environmental conditions (i.e. sea ice, temperature, wind, etc.); and (2) the presence of marine life.

4.1.2.1.1. Environmental Conditions

The presence of ice can contribute substantially to ambient sound levels and affects sound propagation. While sea ice can produce substantial amounts of ambient sounds, it also can function to dampen ambient sound. As ice forms, especially in very shallow water, the sound propagation properties of the underlying water are affected in a way that can reduce the transmission efficiency of low frequency sound (Blackwell and Greene, 2001). Temperature affects the mechanical properties of the ice, and temperature changes can result in cracking. The spectrum of cracking ice sounds typically displays a broad range from 100 Hz to 1 kHz, and the spectrum level has been observed to vary as much as 15 dB within 24 hours due to the diurnal change of air temperature (USDOI, BOEMRE, 2011a). Urick (1984) discussed variability of ambient noise in water including under Arctic ice; he states that "...the ambient background depends upon the nature of ice, whether continuous, broken, moving or shore-fast, the temperature of air, and the speed of the wind." Data are limited, but in at least one instance it has been shown that ice-deformation sounds produced frequencies of 4–200 Hz (Greene, 1981). As icebergs melt, they produce additional background sound as the icebergs tumble and collide.

During the open-water season in the Arctic, wind and waves are important sources of ambient sound with levels tending to increase with increased wind and sea state, all other factors being equal (Greene 1995). Wind, wave, and precipitation noise originating close to the point of measurement dominate frequencies from 500 to 50,000 Hz. The frequency spectrum and level of ambient noise can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force, or sea state) (Urick, 1983). For frequencies between 100 and 500 Hz, Urick (1983) has estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas. The marginal ice zone, the area near the edge of large sheets of ice, usually is characterized by quite high levels of ambient sound compared to other areas, in large part due to the impact of waves against the ice edge and the breaking up and rafting of ice floes (Milne and Ganton, 1964).

4.1.2.1.2. Presence of Marine Life

At least seasonally, marine mammals can contribute to the background sounds in the acoustic environment of the Beaufort and Chukchi Seas. Frequencies and levels are highly dependent on seasons. For example, source levels of bearded seal songs have been estimated to be up to 178 dB re 1 μ Pa at 1 m (Ray et al., 1969, as cited in Richardson et al., 1995a; Stirling et al., 1983; Thomson and Richardson, 1995a). Ringed seal calls have a source level of 95–130 dB re 1 μ Pa at 1 m, with the dominant frequency under 5 kHz (Stirling, 1973; Cummings et al., 1984 as cited in Thomson and Richardson, 1995). Bowhead whales, which are present in the Arctic region from early spring to mid-to late fall, produce sounds with estimated source levels ranging from 128–189 dB re 1 μ Pa at 1 m in frequency ranges from 20–3,500 Hz. Thomson and Richardson (1995) summarized that most bowhead whale calls are "tonal frequency-modulated" sounds at 50–400 Hz. There are many other species of marine mammals in the Arctic marine environment whose vocalizations contribute to ambient sound including, but not limited to, the gray whale, walrus, ringed seal, beluga whale, spotted seal, fin whale (in the southwestern areas) and, potentially but less likely, the humpback whale. Walrus, seals, and seabirds (especially near breeding colonies) all produce sound that can be heard above water.

4.1.2.2. Anthropogenic Noise

Levels of anthropogenic (human-caused) sound can vary dramatically depending on the season, type of activity, and local conditions. Anthropogenic noises that could affect ambient noise arise from the following general types of activities in and near the sea, any combination of which can contribute to

the total noise at any one place and time. These noises include transportation, dredging, construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities (Richardson et al., 1995a).

Noise in the marine environment has received a lot of attention in recent years and is likely to continue to receive attention in the foreseeable future. Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (Jasny et al., 2005; NRC 1994, 1996, 2000, 2003, 2005; Richardson et al., 1995a). As discussed in the preceding section, much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (NRC, 2003). Sources of anthropogenic sounds in the Beaufort and Chukchi Seas include vessels and aircraft, scientific and military equipment, oil and gas exploration and development, and human settlements. Vessels include motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc. Aircraft includes airplanes and helicopters. Levels of anthropogenic sound can vary dramatically depending on the season, local conditions and size of a community, and the type of activity.

4.1.2.2.1. Sounds from Vessels

Commercial shipping traffic is a major source of low frequency (5 to 500 Hz) human generated sound in the world's oceans (NRC, 2003; Simmonds and Hutchinson, 1996).

The types of vessels in the Chukchi Sea typically include barges, skiffs with outboard motors, icebreakers, tourism and scientific research vessels, and vessels associated with oil and gas exploration, development, and production. Vessel traffic and associated noise in the Chukchi Sea presently is limited primarily to late spring, summer, and early autumn.

Shipping sounds are often at source levels of 150–190 dB re 1 μ Pa at 1m (rms) (USDOI, BOEMRE, 2011a). Shipping traffic is mostly at frequencies from 20–300 Hz (Greene, 1995). Sound produced by smaller boats typically is at a higher frequency, around 300 Hz (Greene, 1995). In shallow water, vessels more than 10 km (6.2 mi) away from a receiver generally contribute only to background-sound levels (Greene and Moore, 1995). Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Greene and Moore, 1995). The greatest sound generated during ice-breaking operations is produced by cavitations of the propeller during active ice breaking as opposed to the engines or the ice on the hull; extremely variable increases in broad-band (10–10,000 Hz) noise levels of 5–10 dB are caused by propeller cavitation (Greene and Moore, 1995). Greene and Moore (1995) reported estimated source levels for icebreakers to range from 177–191 dB re 1 μ Pa-m (rms). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (3 mi) (Greene and Moore, 1995). In some instances, icebreaking sounds are detectable from more than 50 m (31 mi) away. JASCO measured SPL for vessel activities during Shell's 2012 exploratory drilling operations in the Leased Area (Bisson et al., 2013). Ice management activities were conducted by the *M/V Fennica* and *M/V Tor Viking*. Noise levels reached 180 dB re 1 μ Pa less than 10 m from the vessels, 160 dB re 1 μ Pa 60 m away, and 120 dB re 1 μ Pa 9.6 km from the vessels.

4.1.2.2.2. Sound from Oil and Gas Activities

Anthropogenic noise levels in the Beaufort Sea region are higher than the Chukchi Sea due to the oil and gas developments of the nearshore and onshore regions of the North Slope, particularly in the vicinity of Prudhoe Bay. Sound from oil and gas exploration and development activities include seismic surveys, drilling, and production activities.

The oil and gas industry in Alaska conducts marine (open-water) surveys in the summer and fall, and on-ice or in-ice seismic surveys from late fall to late winter to locate geological structures potentially

capable of containing petroleum accumulations and to better characterize ocean substrates or subsea terrain. The OCS leaseholders also conduct low-energy, high-resolution geophysical surveys to evaluate geohazards, biological communities, and archaeological resources on their leases.

2D seismic surveys have been conducted in the Chukchi Sea and Beaufort Sea since the late 1960s and early 1970s, resulting in extensive coverage over the area. Seismic surveys vary, but a typical 2D/3D seismic survey with multiple guns would emit sound at frequencies at about 10–120 Hz, and pulses can contain sound at frequencies up to 500–1,000 Hz (Greene and Moore, 1995). Seismic airgun sound waves are directed towards the ocean bottom, but can propagate horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994 as cited in Greene and Moore 1995). Analysis of sound associated with seismic operations in the Beaufort Sea and central Arctic Ocean during ice-free conditions also documented propagation distances up to 1300 km (Richardson 1998, 1999; Thode et al., 2010). While seismic energy does have the capability of propagating for long distances it generally decreases to a level at or below the ambient noise level at a distance of 10 km from the source (Richardson 1998, 1999; Thode et al., 2010). The shelf region in the Beaufort Sea (water depths 10–250 m) has similar depth and acoustic properties to the Chukchi shelf environment. Recent seismic surveys have been performed on the Beaufort Sea shelf in Camden and Harrison Bays that have generated exploration noise footprints similar to those produced by exploration over the Chukchi Sea lease areas. Because the Chukchi Sea continental shelf has a highly uniform depth of 30–50m, it strongly supports sound propagation in the 50–500 Hz frequency band (Funk et al., 2008). This is of particular interest because most of the industrial sounds from large vessels, seismic sources, and drilling are in this band and this likely overlaps with the greatest hearing sensitivity of our listed cetacean species under consideration in this opinion.

Oil and gas exploration has also occurred in the Canadian Arctic, specifically in the eastern Beaufort Sea, off the Mackenzie River Delta, Mackenzie Delta and in the Arctic Islands. Characteristics are similar to exploration activities in Alaska (shallow hazards, site clearance, 2D and 3D seismic surveys, exploratory drilling), except that the majority of support is provided by road access and coastal barges. Oil and gas exploration has also occurred in offshore areas of the Russian Arctic and in areas around Sakhalin Island to the south of the Bering Straits (NMFS, 2011c).

Greene and Moore (1995) summarized that typical signals associated with vibroseis sound source used for on-ice seismic surveys sweep from 10–70 Hz, but harmonics extend to about 1.5 kHz.

Sound levels produced by drillships were modeled based on measurements from *Northern Explorer II*. The modeled sound-level radii indicate that the sound would not exceed the 180 dB. The ≥ 160 -dB radius for the drillship was modeled to be 172 ft (52.5 m); the ≥ 120 -dB radius was modeled to be 4.6 mi (7.4 km). The area estimated to be exposed to ≥ 160 dB at the modeled drill sites would be ~ 0.01 km² (0.004 mi²). Data from the floating platform *Kulluk* in Camden Bay, indicated broadband source levels (20–10,000 Hz) during drilling were estimated to be 191 and 179 dB re μ Pa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (Greene and Moore, 1995). Shell Gulf of Mexico, Inc. measured the sounds produced by the *Discoverer* while drilling on the Burger Prospect (within the Leased Area) in 2012. A broadband (10 Hz – 32 kHz) source level of 182 dB was calculated for the *Discoverer* based on the measurements recorded when drilling the 26-inch hole interval (Shell, 2014). These estimates are considered representative of a typical industry-standard, ice-reinforced drillship that would be used for exploration drilling in the Arctic OCS. Shell's measurements showed source levels from drilling would fall below 160 dB (rms) within 10-m from the drillship. The 2012 measurement of the distance to the 120-dB (rms) threshold for normal drilling activity by the *Discoverer* was 0.93 mi (1.5 km) while the distance of the ≥ 120 dB (rms) radius during mudline cellar (MLC) construction was 5.1 mi (8.2 km) (Shell, 2014). There currently are no oil-production facilities in the Chukchi Sea. However, in state waters of the Beaufort Sea, there are three operating oil-production facilities on man-made islands (Northstar, Oooguruk, Nikaitchug) and two production facilities on a man-made peninsula/causeway. Much of the

production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km (2.5 mi) and often not detectable beyond 9.3 km (5.8 mi) away. Studies conducted as part of a monitoring program for the Northstar project (a drilling facility located on an artificial island in the Beaufort Sea) indicate that in one of the 3 years of monitoring efforts, the southern edge of the bowhead whale fall migration path may have been slightly (2–3 mi) further offshore during periods when higher sound levels were recorded; there was no significant effect of sound detected on the migration path during the other two monitored years (Richardson et al., 2004). Evidence indicated that deflection of the southern portion of the migration in 2001 occurred during periods when there were certain vessels in the area and did not occur as a result of sound emanating from the Northstar facility itself (USDOI, BOEMRE, 2011a).

The level and duration of sound received underwater from aircraft depends on altitude and water depth. Received sound level decreases with increasing altitude. For a helicopter operating at an altitude of 1,000 ft (305 m), there were no measured sound levels at a water depth of 121 ft (37 m) (Greene, 1985).

4.1.2.2.3. Miscellaneous Sound Sources

Other acoustic systems that may be used in the Arctic by researchers, military personnel, or commercial vessel operators, include high-resolution geophysical equipment (see Section 2.2.1.1.1), acoustic Doppler current profilers, mid-frequency sonar systems, and navigational acoustic pingers (LGL, 2005, 2006). These active sonar systems emit transient, and at times, intense sounds that vary widely in intensity and frequency (USDOI, BOEMRE, 2011a).

4.1.3. Ship Strike

Marine vessel traffic can pose a threat to marine mammals because of the risk of ship strikes and the disturbance associated with the presence of the vessel. Although there is no official reporting system for ship strikes, numerous incidents of vessel collisions with marine mammals have been documented in Alaska (NMFS, 2010a). Records of vessel collisions with large whales in Alaska indicate that strikes have involved cruise ships, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs. Discussion of ship strikes specific to individual species are presented in Section 3.1

According to the Catch in Areas database (accessed April 10, 2012), the number of fishing vessels with active vessel monitoring systems (VMS) that transited in and out of Dutch Harbor between 1 July and 31 December in 2010 and 2011 totaled between 1,400 and 1,820 transits respectively. This is anticipated to be an underestimate of total fishing vessel activity because it focuses on groundfish vessels with active VMS and may miss halibut, sablefish, salmon, and crab vessels. It also does not reflect the number on non-fishing vessels that utilize the harbor and nearby areas. However, it does show that thousands of vessels are anticipated to transit in and out of Dutch Harbor per year.

Shipping and vessel traffic is expected to increase in the Arctic Region OCS if warming trends continue. In addition, increases in large vessel traffic in the Russian Chukchi Sea (outside of the Action Area) are currently occurring.

The frequency of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales is low. Between 1976 and 1992, only two ship-strike injuries were documented out of a total of 236 bowhead whales examined from the Alaska subsistence harvest (George et al., 1994). The low number of observations of ship-strike injuries suggests that bowhead whales either do not often encounter vessels or they avoid interactions with vessels.

There were 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011. Of these, 93 involved humpback whales, and 3 involved fin whales (Neilson et al., 2012). There was a significant increase in the number of reports over time between 1978 and 2011 ($r^2 = 0.6999$; p

<0.001). One potential strike of a humpback whale was documented just west of Dutch Harbor in King Cove in 2010. The majority of strikes were reported in southeastern Alaska, where the number of humpback whale collisions increased 5.8% annually from 1978 to 2011 (Neilson et al., 2012). Between 2001 and 2009, confirmed reports of vessel collisions with humpback whales indicated an average of five humpback whales struck per year in Alaska; between 2005 and 2009, two humpback deaths were attributed to ship strikes (NMFS, 2010a).

Vessel collisions with humpback whales remains a significant management concern, given the increasing abundance of humpback whales foraging in Alaska, as well as the growing presence of marine traffic in Alaska's coastal waters. Based on these factors, injury and mortality of humpback whales as a result of vessel strike may likely continue into the future (NMFS, 2006b).

Current shipping activities in the Arctic pose varying levels of threats to ice seals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with ice seal habitats. The presence and movements of ships in the vicinity of some seals can affect their normal behavior (Jansen et al., 2010) and may cause ringed seals to abandon their preferred breeding habitats in areas with high traffic (Smiley and Milne, 1979; Mansfield, 1983). To date, no bearded or ringed seal carcasses have been found with propeller marks. However, Sternfield (2004) documented a singled spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike. Icebreakers pose special risks to ice seals because they are capable of operating year-round in all but the heaviest ice conditions and are often used to escort other types of vessels (e.g., tankers and bulk carriers) through ice-covered areas. Reeves (1998) noted that some ringed seals have been killed by ice-breakers moving through fast-ice breeding areas.

4.1.4. Commercial Fishing Interaction

While there is currently no commercial fishing activities authorized in the Chukchi Sea Planning Area, the species present in the Action Area may be impacted by commercial fishing interactions as they migrate through the Bering Sea to the Chukchi and Beaufort seas.

4.1.4.1. Bowhead Whale

Several cases of rope or net entanglement have been reported from bowhead whales taken in the subsistence hunt (Philo et al., 1993). Further, preliminary counts of similar observations based on reexamination of bowhead harvest records indicate entanglements or scarring attributed to ropes may include over 20 cases (Craig George, Department of Wildlife Management, North Slope Borough, pers. comm., as cited in Allen and Angliss, 2011).

There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. However, some bowhead whales have historically had interactions with crab pot gear. There are several documented cases of bowheads having ropes or rope scars on them. Alaska Region stranding reports document three bowhead whale entanglements between 2001 and 2005. In 2003 a bowhead whale was found dead in Bristol Bay entangled in line around the peduncle and both flippers; the origin of the line is unknown. In 2004 a bowhead whale near Point Barrow was observed with fishing net and line around the head. During the 2011 spring aerial photographic surveys of bowhead whales near Point Barrow, one entangled bowhead was photographed (Mocklin et al., 2012). The minimum average annual entanglement rate in U.S. commercial fisheries for the 5-year period from 2007–2011 is 0.4; however, the overall rate is currently unknown (Allen and Angliss, 2014). The average annual entanglement rate in U.S. commercial fisheries is currently unknown (Allen and Angliss, 2014).

4.1.4.2. Fin Whale

Between 2002 and 2006, there was one observed incidental mortality of a fin whale in the Bering Sea/Aleutian Island (BSAI) pollock trawl fishery. Estimates of marine mammal serious injury/mortality in observed fisheries are provided in Perez (unpubl. ms., as cited in Allen and Angliss, 2011). Between 2007 and 2012, there were no observed incidental mortalities of fin whales due to commercial fisheries in Alaska waters (Allen and Angliss, 2014).

4.1.4.3. Humpback Whale

Until 2004, there were six different federally-regulated commercial fisheries in Alaska that occurred within the range of the Western North Pacific humpback whale stock that were monitored for incidental mortality by fishery observers (Allen and Angliss, 2014). As of 2004, changes in fishery definitions in the List of Fisheries have resulted in separating these six fisheries into 22 fisheries (69 *FR* 70094). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that contributes to the incidental serious injury or mortality of marine mammal stocks in Alaska. Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Breiwick, 2013 (as cited in Allen and Angliss, 2014). Between 2002 and 2006, there were incidental serious injuries and mortalities of Western North Pacific humpback whales in the BSAI sablefish pot fishery (Allen and Angliss, 2011). However, between 2007 and 2009, there were no incidental serious injuries and mortalities of Western North Pacific humpback whales in the BSAI sablefish pot fishery (Allen and Angliss, 2011). Between 2007 and 2011, there was one mortality of a Western North Pacific humpback whale in the BSAI pollock trawl fishery and one in the BSAI flatfish trawl. Average minimum annual mortality from observed fisheries was 0.40 humpbacks from this stock (Allen and Angliss, 2014). Note, however, that the stock identification is uncertain and the mortality may have involved a whale from the central North Pacific stock of humpback whales. Thus, this mortality is assigned to both the central and western stocks. However, this estimate is considered a minimum because there are no data concerning fishery-related mortalities in Japanese, Russian, or international waters.

The mean annual human-caused mortality and serious injury rate for 2007–2011 based on fishery and gear entanglements reported in the NMFS Alaska Regional Office stranding database is 0.45 (Allen and Angliss, 2014). These events have not been attributed to a specific fishery listed on the List of Fisheries (76 *FR* 73912; 29 November 2011).

In recent years, an increasing number of entangled humpback whales have been reported to NMFS Alaska Region stranding program. One hundred eighteen humpback whales were reported (96 confirmed) entangled in Alaska from 1997–2009; the majority of these involved southeast Alaska humpbacks (NMFS Alaska Region Stranding Data, 2010). For many of these reports, it is not possible to identify the gear involved in the entanglement to a specific fishery. This is based on a general lack of data in reports received, the difficulty in accurately describing gear at a distance, and the fact that most entanglements are not re-sighted for follow-up analysis (NMFS, 2010a).

Strandings of humpback whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. The only fishery-related humpback stranding in an area thought to be occupied by animals from this stock was reported by a U. S. Coast Guard vessel in late June 1997 operating near the Bering Strait. The whale was found floating dead entangled in netting and trailing orange buoys (NMML, Platforms of Opportunity Program, unpubl. Data in NMFS, 2013a). With the given data it is not possible to determine which fishery (or even which country) caused the mortality. Note, that this mortality has been attributed the Western North Pacific stock, but without a tissue sample (for genetic analysis) or a photograph (for matching to known Japanese animals) it is not possible to be certain (i.e., it may have belonged to the Central North Pacific stock).

No strandings or sightings of entangled humpback whales of this stock were reported between 2001 and 2005; however, effort in western Alaska is low.

Brownell et al. (2000) compiled records of bycatch in Japanese and Korean commercial fisheries between 1993 and 2000. During the period 1995–99, there were six humpback whales indicated as “bycatch”. In addition, two strandings were reported during this period. Furthermore, analysis of four samples from meat found in markets indicated that humpback whales are being sold. At this time, it is not known whether any or all strandings were caused by incidental interactions with commercial fisheries; similarly, it is not known whether the humpback whales identified in market samples were killed as a result of incidental interactions with commercial fisheries. It is also not known which fishery may be responsible for the bycatch. Regardless, these data indicate a minimum mortality level of 1.1/year (using bycatch data only) to 2.4/year (using bycatch, stranding, and market data) in the waters of Japan and Korea. Because many fatalities pass unreported, the actual rate in these areas is likely much higher. An analysis of entanglement rates from photographs collected for SPLASH (Structure of Populations, Levels of Abundance and Status of Humpback Whales) found a minimum entanglement rate of 31% for humpback whales from the Asia breeding grounds (Cascadia Research, 2003).

The estimated annual mortality rate due to interactions with all fisheries is 0.85 ($0.4 + 0.45$) (Allen and Angliss, 2014).

4.1.4.4. Ringed Seal

Until 2003, there were three different federally-regulated commercial fisheries in Alaska that could have interacted with ringed seals and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these three fisheries into 12 fisheries (69 *FR* 70094). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that contributes to the incidental serious injury or mortality of marine mammal stocks in Alaska. Between 2002 and 2006, there were incidental serious injuries and mortalities of ringed seals in the BSAI flatfish trawl fishery. Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Breiwick, 2013 (as cited in Allen and Angliss, 2014). Based on data from 2002 to 2006, there has been an average of 0.46 mortalities of ringed seals incidental to commercial fishing operations (Allen and Angliss, 2011). Between 2007 and 2009, there were incidental serious injuries and mortalities of ringed seals in the BSAI flatfish trawl fishery and the BSAI pollock trawl (Allen and Angliss, 2012). Based on data from 2007 to 2009, there were an average of 1.75 ($CV = 0.01$) mortalities of ringed seals incidental to commercial fishing operations. Between 2007 and 2011, incidental serious injuries and mortalities of ringed seals resulted from activities of the BSAI flatfish trawl fishery, the BSAI pollock trawl, BSAI Pacific cod trawl, and the BSAI Pacific cod longline (Allen and Angliss, 2014). Based on data from 2007 to 2011, there have been an average of 3.52 ($CV = 0.06$) mortalities of ringed seals incidental to commercial fishing operations (Allen and Angliss, 2014).

4.1.4.5. Proposed Critical Habitat for Ringed Seal

Commercial fishing could affect proposed critical habitat for ringed seal through depletion of the essential feature of primary prey resources. However, because commercial fishing has not been authorized within the Chukchi Sea or other portions of the Action Area, the environmental baseline has not been modified by this activity.

4.1.4.6. Bearded Seal

Similar to ringed seals, the monitoring of incidental serious injury or mortality of bearded seals changed as of 2003, and provided managers a better insight into how each fishery in Alaska was potentially impacting the species (Allen and Angliss, 2014).

Until 2003, there were three different federally-regulated commercial fisheries in Alaska that could have interacted with bearded seals and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these 3 fisheries into 12 fisheries (69 *FR* 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that contributes to the incidental serious injury or mortality of marine mammal stocks in Alaska. Between 2007 and 2009, there were incidental serious injuries and mortalities of bearded seals in the BSAI pollock trawl and the BSAI flatfish trawl (Allen and Angliss, 2011). The estimated minimum mortality rate incidental to commercial fisheries was 2.70 (CV = 0.21) bearded seals per year, based exclusively on observer data (Allen and Angliss, 2012). Between 2007 and 2011, there were incidental serious injuries and mortalities of bearded seals in the BSAI pollock trawl and the BSAI flatfish trawl fisheries (Allen and Angliss, 2014). The estimated minimum mortality rate incidental to commercial fisheries is 1.8 (CV = 0.05) bearded seals per year, based exclusively on observer data.

4.1.5. Pollutants and Contaminants

4.1.5.1. Authorized Discharges

Currently, the water quality of the Chukchi Sea meets the qualitative criteria for protection of marine life described in Section 403 of the Clean Water Act (CWA). As of the most recent listing by the State of Alaska Department of Environmental Quality (ADEQ, 2014), no water bodies are identified as impaired, as defined by the Section 303d of the CWA, within the Arctic region.

Anthropogenic pollution in the Chukchi Sea have primarily originated outside of the region, and transported by water, sea ice, air or biota. Sources include discharges from international ship traffic and carbon dioxide in the atmosphere (AMAP, 1997, 2004, 2011, 2014). Regional industrial activities that influence water quality include the Red Dog port and mine that have been operating since 1989, five offshore exploration wells that were drilled in the Chukchi Sea between 1989 and 1991, and the “top hole” exploratory well drilled in 2012.

Although drilling fluids and cuttings can be disposed of through onsite injection into a permitted disposal well, or transported offsite to a permitted disposal location, some drilling fluids are discharged at the sea floor before well casings are in place. Drill cuttings and fluids contain relatively high concentrations of contaminants that have high potential for bioaccumulation, such as dibenzofuran and PAHs (Table 4–1). Historically, drill cuttings and fluids have been discharged from oil and gas developments in the project area, and residues from historical discharges may be present in the affected environment (Brown et al., 2010).

Table 4–1. Water Quality Data for Drill Cuttings

Pollutant	Range of Concentrations Before Washing	Range of Concentrations After Washing
Conventional Parameters		
pH	5.70 – 8.42	7.00 – 9.20
Specific gravity (kg/L)	1.26 – 2.07	0.98 – 1.59
BOD-5 (mg/kg) (Biological Oxygen Demand)	325 – 4,130	3,890 – 8,950
UOD-20 (mg/kg) (Universal Oxygen Demand)	2,640 – 10,500	12,800 – 26,600
TOC (mg/kg) (Total Organic Carbon)	58,300 – 64,100	23,000 – 27,200
COD (mg/kg) (Chemical Oxygen Demand)	190,000 – 291,000	90,600 – 272,000
Oil & Grease (mg/kg)	54,200 – 130,000	8,290 – 108,000
Metals (mg/kg) (average of duplicate samples on a dry weight basis)		
Zinc	107 – 2,710	114 – 3,200
Beryllium	<1.0	<1.0
Aluminum	6,020 – 10,900	5,160 – 10,500
Barium	34 – 84.8	27.2 – 235
Iron	16,600 – 30,800	17,400 – 20,600
Cadmium	0.402 – 16.4	0.408 – 15.8
Chromium	9.48 – 11.7	10.7 – 12
Copper	20.6 – 55.3	20.4 – 42.6
Nickel	<6 – 12.1	6.2 – 15.9
Lead	21.4 – 298	47.6 – 264
Mercury	0.09333 – 0.4893	0.0920 – 0.944
Silver	0.447 – 0.574	0.222 – 0.568
Arsenic	7.07 – 10.3	7.0 – 10.6
Selenium	<3.0	<3.0
Antimony	<0.06 – <0.35	<0.06 – <0.35
Thallium	0.235 – 0.57	0.134 – 0.866
Organics (µg/kg) (wet weight basis)		
Acenaphthene	677 – 38,800	
Naphthalene	3582 – 149,000	63,500
4-Nitrophenol	30,400	

Pollutant	Range of Concentrations Before Washing	After Washing
N-Nitrosodiphenylamine	2,870 – 56,500	3,150 – 24,300
Bis (2-ethylhexyl) Phthalate	17,300	
Phenanthrene	59,900 – 145,000	25,800 – 65,700
Pyrene	18,900	7,860
Dibenzothiophene	37,300	15,000
Dibenzofuran	2,150 – 33,700	21,700
N-Dodecane	23,000 – 403,000	6,300 – 185,000
Diphenylamine	56,500	5,900 – 23,400
Alphaterpineol	6,310	
Biphenyl	4,230 – 69,400	1,170 – 33,000

Source: (CENTEC, 1984; EPA, , 2005, 2006b in NMFS, 2013).

While chemical concentration data are useful for determining the relative degrees of contamination among sampling sites, they provide neither a measure of adverse biological effects nor an estimate of the potential for ecological effects (Forbes and Calow, 2003). One way to relate chemical concentrations to the potential for adverse effects involves comparisons of measured values to established threshold values. Previous studies in the Alaska Arctic OCS have employed the system described by Long and Morgan (1990), and Long et al. (1995) for comparison of measured values to the Effects Range Low (ERL) and Effects Range Median (ERM) concentrations for contaminants in marine and estuarine sediments. Brown et al. (2010) used ERL concentration values as the thresholds above which adverse effects are predicted to occur to sensitive life stages and/or species. The ERM values for the chemicals were the concentrations equivalent to the 50 percentile point in the screened available data. They were used as the concentration above which effects were frequently or always observed or predicted among most species. Because the ERL and ERM concentrations account for the effects of individual chemical stressors on multiple species from different trophic levels, this approach may provide a basis for predicting the likelihood of ecosystem-level impacts that could result from inputs of chemical contaminants.

Many of the organic contaminants associated with past development in the project area (e.g., PAH) have low solubility in water due to their nonpolar molecular structures. As a result of low aqueous solubility, these compounds tend to associate with organic material or solid-phase particles (such as sediments) in the environment. Similarly, the elemental forms of some potentially toxic metals, such as lead and mercury, have low aqueous solubility. However, these metals may react with other naturally occurring chemical species to form soluble compounds.

The aqueous solubility of a contaminant is an important parameter for determining its behavior in the environment, and the potential pathways through which organisms could be exposed to the contaminant.

The behavior of a contaminant in the environment, and the potential pathways for exposure of organisms, depend upon the aqueous solubility of the contaminant as well as the physical, chemical, and biological characteristics of the environment. For these reasons, chemical concentration data from different matrices (e.g., water, sediments, and biota) must be considered in combination with an

understanding of the processes that connect ecosystem components in order to meaningfully predict the impacts of chemical contaminants on ecosystem processes.

The principal regulatory method for controlling pollutant discharges from vessels (grey water, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Arctic Region OCS is the CWA of 1972. Section 402 establishes the National Pollution Discharge Elimination System (NPDES). The Environmental Protection Agency (EPA) issued an NPDES Vessel General Permit (VGP) for “Discharges Incidental to the Normal Operation of a Vessel” for Alaska was finalized in February, 2009. The final VGP applies to owners and operators of non-recreational vessels that are 24 m (79 ft) and greater in length, as well as to owners and operators of commercial vessels of less than 79 ft which discharge ballast water.

The EPA Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Chukchi expires in 2017. NMFS was consulted on the issuance of the NPDES permit, and concurred with the EPA’s determination that the planned actions, “may affect, but are not likely to adversely affect” bowhead, fin, and humpback whales, or the proposed listed bearded and ringed seals in the Beaufort Sea or Chukchi Sea area of coverage (NMFS 2012a, 2012b). Discharges from regulated activities must meet the permit requirements, including any maximum concentration limits.

4.1.5.2. Accidental Discharges – Oil Spills and Gas Releases

Offshore petroleum exploration activities have been conducted in State of Alaska waters and the OCS of the Beaufort and Chukchi Sea Planning Areas since the late 1960’s. However, historical data on offshore oil spills for the Alaska Arctic OCS regions consists of all small spills and cannot be utilized to create a distribution for statistical analysis (NMFS, 2011b). For this reason, agencies use a fault tree model to represent expected frequency and BOEM and NMFS determine the severity of oil spills in these regions (Bercha International Inc., 2006, 2008).

From 1971–2010 industry drilled 84 exploration wells in the entire Alaska OCS (USDOJ, BOEMRE, 2011a). Within the Action Area of the Beaufort and Chukchi OCS, the oil industry drilled 35 exploratory wells. During the time of this drilling, industry has had 35 small spills totaling 26.7 bbl or 1,120 gallons (gal). Of the 26.7 bbl spilled, approximately 24 bbl were recovered or cleaned up (USDOJ, BOEMRE, 2011a).

No exploratory drilling blowouts have occurred on the Alaska OCS. However, one exploration drilling blowout of shallow gas occurred on the Canadian Beaufort Sea out of the 85 exploratory wells that were drilled in the Canadian Beaufort Sea (USDOJ, BOEMRE, 2011a).

Increasing oil and gas development in the U.S. Arctic has led to an increased risk of various forms of pollution to whale and seal habitat, including oil spills, other pollutants, and nontoxic waste (Allen and Angliss, 2014).

4.1.5.2.1. Bowhead Whale

Some environmental contaminants, such as chlorinated pesticides, are lipophilic and can be found in the blubber of marine mammals (Becker et al., 1995). Tissues collected from whales landed at Barrow in 1992 (Becker et al., 1995) indicate that bowhead whales have very low levels of mercury, PCB’s, and chlorinated hydrocarbons, but they have elevated concentrations of cadmium in their liver and kidneys. Bratton et al. (1993) measured organic arsenic in the liver tissue of one bowhead whale

and found that about 98% of the total arsenic was arsenobetaine. Arsenobetaine is a common substance in marine biological systems and is relatively non-toxic.

Bratton et al. (1993) looked at eight metals (arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc) in the kidneys, liver, muscle, blubber, and visceral fat from bowhead whales harvested from 1983–1990. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time between 1983 and 1990. Based on metal levels reported in the literature for other baleen whales, the metal levels observed in all tissues of the bowhead are similar to levels in other baleen whales. The bowhead whale has little metal contamination as compared to other Arctic marine mammals, except for cadmium.

Mössner and Ballschmiter (1997) reported that total levels of polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific/Arctic Ocean many times lower than that of beluga whales; northern fur seals from the North Pacific or Arctic Ocean. However, while total levels were low, the combined level of three isomers of the hexachlorocyclohexanes chlorinated pesticides was higher in the bowhead blubber tested than in the North Atlantic's pilot whale, the common dolphin, and the harbor seal. These results were believed to be due to the lower trophic level of the bowhead relative to the other marine mammals tested.

4.1.5.2.2. Fin Whale

Based on studies of contaminants in baleen whales, including fin whales, and other marine mammals, habitat pollutants do not appear to be a major threat to fin whales in most areas where fin whales are found (NMFS, 2010b). O'Shea and Brownell (1994) state that concentrations of organochlorine and metal contaminants in tissues of baleen whales are low, and lower than other marine mammal species. They further state that there is no firm evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally are high enough to cause toxic or other damaging effects. Among baleen whales, Aguilar (1983) observed that mean levels of DDT and PCBs in a study of North Atlantic fin whales were significantly lower (0.74 and 12.65 respectively) than in a study of North Atlantic sperm whales (4.68 and 26.88 respectively).

In general, the threat from contaminants and pollutants occurs at a low severity and there is a medium level of uncertainty. Thus, the relative impact to recovery of fin whales due to contaminants and pollution is ranked as low (NMFS, 2010b).

4.1.5.2.3. Humpback Whale

Concentrations of organochlorine pesticides, heavy metals, and PCB's have been reported in humpback whale tissues from Canadian, United States, and Caribbean waters (Taruski et al., 1975). Biopsy blubber samples from male individuals ($n = 67$) were collected through SPLASH, a multi-national research project, in eight North Pacific feeding grounds. Persistent organic pollutants (POPs) were measured in the samples and used to assess contaminant distribution throughout the feeding areas, as well as to investigate the potential for health impacts on the study populations.

Concentrations of PCBs, DDTs, and polybrominated diphenyl ethers (PBDEs) were more prevalent along the U.S. West Coast, with highest concentrations detected in southern California and Washington whales. A different pattern was observed for chlordanes and hexachlorocyclohexanes (HCHs), with highest concentrations detected in the western Gulf of Alaska whales and those from other high latitude regions, including southeast Alaska and eastern Aleutian Islands. In general, contaminant levels in humpback whales were comparable to other mysticetes, and lower than those found in odontocete cetaceans and pinnipeds. Concentration levels likely do not represent a significant conservation threat (Elfes, 2010).

4.1.5.2.4. Ringed Seal

Contaminants research on ringed seals is very extensive throughout the Arctic environment where ringed seals are an important part of the diet for coastal human communities. Pollutants such as OCs and heavy metals have been found in all of the subspecies of ringed seal (with the exception of the Okhotsk ringed seal). The variety, sources, and transport mechanisms of contaminants vary across ringed seal ecosystems.

Becker et al. (1995) report ringed seals had higher levels of arsenic in the Norton Sound than ringed seals taken by residents of Chukchi Sea villages of Point Hope, Point Lay, as well by Barrow residents. Arsenic levels in ringed seals from Norton Sound were quite high for marine mammals. Although this might reflect the localized natural arsenic source (from the food web) for these animals, these arsenic levels are probably of no concern with regard to toxicity.

Present and future impacts of contaminants on ringed seal populations should remain a high priority issue. Tynan and DeMaster (1997) noted climate change has the potential to increase the transport of pollutants from lower latitudes to the Arctic, highlighting the importance of continued monitoring of ringed seal contaminant levels.

4.1.5.2.5. Proposed Critical Habitat for Ringed Seal

Contaminants could affect all three essential features of proposed critical habitat for ringed seal: sea ice suitable for the formation and maintenance of subnival birth lairs, sea ice habitat suitable as a platform for basking and molting, and primary prey resources to support Arctic ringed seals. Large oil spills represent the main threat of contamination to all three essential features, but to date, no large spills have occurred in the Planning Area or have influenced the environmental baseline. Pollutants such as OCs and heavy metals found in the Arctic subspecies of ringed seal were likely acquired through the primary prey resources and other items in the food chain.

4.1.5.2.6. Bearded Seal

Research on contaminants and bearded seals is limited compared to the extensive information for ringed seals. However, pollutants such as OC compounds and heavy metals have been found in most bearded seal populations. Similar to ringed seals, climate change has the potential to increase the transport of pollutant from lower latitudes to the Arctic (75 *FR* 77502) (Tynan and DeMaster, 1997).

4.1.6. Climate Change

“The Arctic marine environment has shown changes over the past several decades, and these changes are part of a broader global warming that exceeds the range of natural variability over the past 1,000 years” (Walsh, 2008). The changes have been sufficiently large in some areas of the marine Arctic (e.g., the Bering Sea and Chukchi Sea) that consequences for marine ecosystems appear to be underway (Walsh, 2008). The proximate effects of climate change in the Arctic are being expressed as increased average winter and spring temperatures and changes in precipitation amount, timing, and type (Serreze et al., 2000). Increases of approximately 75 days or more days in the number of days with open water in parts of the present-day season sea ice zone occur north of the Bering Strait in the Beaufort, Chukchi, and East Siberian Seas; and increases by 0–50 days elsewhere in the Arctic Ocean have been seen (Walsh, 2008). These changes in turn result in physical changes such as reduced sea ice, increased coastal erosion, changes in hydrology, depth to permafrost, and carbon availability (ACIA, 2005).

An analysis by Rigor, Colony, and Martin (2000) for the entire Arctic Ocean for the period 1979–1997, indicates an increase in surface air temperature of about 1.0 °C (1.8 °F) per decade in the eastern Arctic, whereas the western Arctic shows no trend, or even a slight cooling, in the Canadian

Beaufort Sea. During fall, the trends show cooling of about 1.0 °C (1.8 °F) per decade over the Beaufort Sea and Alaska (Rigor, Colony, and Martin, 2000). During spring, a significant warming trend of 2 °C (3.6 °F) per decade can be seen over most of the Arctic. Summer shows no significant trend.

A trend analysis for first-order observing stations in Alaska for the period of 1949–2007 shows an average temperature change of 1.9 °C (3.4 °F). The largest increase was seen in winter and spring, with the smallest change in autumn. The trend has been far from linear. There was a decrease in temperature in the period from 1949–1976 followed by an abrupt increase in temperature in the period from 1973–1979. Since 1979, only a little additional warming has occurred in Alaska with the exception of Barrow and a few other locations (Rigor, Colony, and Martin, 2000). IPCC (2007) reported that warming will be greatest over land areas and at most high northern latitudes. They also predicted the continuation of recent observed trends such as contraction of snow cover area, increases in thaw depth over most permafrost regions, and decrease in sea ice extent. Projected surface temperature changes along the North Slope of Alaska may increase by 6.0–6.5°C for the late 21st century (2090–2099), relative to the period 1980–1999 (IPCC, 2007).

The extent of winter sea ice, generally measured at the maximum in March, began changing in the late 1990's and has declined through 2006 (Comiso, 2006; Stroeve et al., 2007; Francis and Hunter, 2006). Comiso (2006) attributed the changes to corresponding changes in increasing surface temperature and wind-driven ice motion. The factors causing the reduction in the winter sea-ice extent are different from those in the summer. The reduction of the winter sea-ice extent in the Bering Sea preconditions the environment during the melt season for the Chukchi Sea. The end-of-winter perennial sea-ice extent was the smallest on record in March 2007 (Nghiem et al., 2007). The Arctic sea ice reached its maximum on 10 March, 2008. Although the maximum in 2008 was greater than in 2007, it was below average and was thinner than normal (Martin and Comiso, 2008; University of Colorado, NSDIC, 2008).

A general summary of the changes attributed to the current trends of Arctic warming indicate sea ice in the Arctic is undergoing rapid changes with little slowing down forecasted for the future (Budikova, 2009). There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general, the sea-ice extent is becoming much less in the Arctic summer and slightly less in winter. The eight lowest sea ice extents since 1979 have occurred in the last eight years (2007–2014; NOAA, 2014). The thickness of Arctic ice is decreasing. The distribution of ice is changing, and its age is decreasing. The melt duration is increasing. These factors lead to a decreasing perennial Arctic ice pack.

Predictions of future sea-ice extent, using several climate models and taking the mean of all the models, estimate that the Arctic will be ice free during summer in the latter part of the 21st century (IPCC, 2007). There is considerable uncertainty in the estimates of summer sea ice in these climate models, with some predicting 40–60% summer ice loss by the middle of the 21st century (Holland, 2006). Using a suite of models, a 40% loss is estimated for the Beaufort and Chukchi seas (Overland and Wang, 2007). Some investigators, citing the current rate of decline of the summer sea-ice extent believe it may be sooner than predicted by the models (Stroeve et al., 2007). Other investigators suggest that variability at the local and regional level is very important for making estimates of future changes. While the annual minimum of sea ice extent is often taken as an index of the state of Arctic sea ice, the recent reductions of the area of multi-year sea ice and the reduction of sea ice thickness is of greater physical importance. It would take many years to restore the ice thickness through annual growth, and the loss of multi-year sea ice makes it unlikely that the Arctic will return to previous climatological conditions. Continued loss of sea ice will be a major driver of changes across the Arctic over the next decades, especially in late summer and autumn. While changes in the reduction of summer sea-ice extent are apparent, the cause(s) of change are not fully established. The evidence suggests that it may be a combination of oceanic and atmospheric conditions that are causing the

change. Incremental solar heating and ocean heat flux, long wave radiation fluxes, changes in surface circulation, and less multiyear sea ice all may play a role.

These changes are resulting, or are expected to result, in changes to the biological environment, causing shifts, expansion, or retraction of home range, changes in behavior, and changes in population parameters of plant and animal species. Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA, 2005). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice. Threats posed by the direct and indirect effects of global climatic change are or will be common to Northern species. These threats will be most pronounced for ice-obligate species such as the polar bear, walrus, and ice seals.

The main concern about the conservation status of ice seals stems from the likelihood that their sea ice habitat has been modified by the warming climate and, more so, that the scientific consensus projects accelerated warming in the foreseeable future. A second concern, related by the common driver of carbon dioxide emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem (75 FR 77502). Ice seals are vulnerable to habitat loss from changes in the extent or concentration of sea ice because they depend on this habitat for pupping, nursing, molting, and resting, all of which are identified as essential features of proposed critical habitat. The ringed seal's broad distribution, ability to undertake long movements, diverse diet, and association with widely varying ice conditions suggest resilience in the face of environmental variability.

Bearded seals, on the other hand, are restricted to areas where seasonal sea ice occurs over relatively shallow waters where they may forage on the bottom (Fedoseev, 2000; Kovaks, 2002), and although bearded seals usually associate with sea ice, young seals may be found in ice-free areas such as bays and estuaries (ADFG, 1994). The retreat of the spring and summer ice edge in the Arctic may separate suitable sea ice for pup maturation and molting from benthic feeding areas. When early melting prematurely exposes pups – they become vulnerable to predation by polar bears, wolves, and foxes (Lukin, 1980; Stirling and Smith, 2004). Ringed seal's long generation time and ability to produce only a single pup each year may limit its ability to respond to environmental challenges such as the diminishing ice and snow cover projected in a matter of decades. When lack of snow cover has forced birthing to occur in the open, some studies have reported that nearly 100% of pups died from predation (Smith et al., 1991; Smith and Lydersen, 1991).

However, not all Arctic species are likely to be adversely influenced by global climate change. Conceptual models by Moore and Laidre (2006) suggested that, overall reductions in sea ice cover should increase the Western Arctic stock of bowhead whale prey availability.

This theory may be substantiated by the steady increase in the Western Arctic bowhead population during the nearly 20 years of sea ice reductions (Walsh, 2008). Moore and Huntington (2008) anticipate that bowhead whales will alter migration routes and occupy new feeding areas in response to climate related environmental change. Sheldon et al. (2003) notes that there is a high probability that bowhead abundance will increase under a warming global climate.

The recent observations of humpback and fin whales in the eastern Chukchi and western Beaufort seas may be due to reoccupation of previous habitats following the population's recovery from whaling; however, given the virtual absence of these species in the region in historical data, it is also possible that these sightings reflect a northward range expansion related to the effects of climate change. The feeding range of fin whales is larger than that of other species and consequently, it is likely that the fin whale may be more resilient to climate change, should it affect prey, than a species with a narrower range. Range expansions in response to habitat change are not uncommon among

cetaceans. Gray whales in Alaska have shown pronounced change over the last several decades; overwintering at higher latitudes and occupying previously lesser-used feeding areas in the Beaufort Sea. However, this phenomenon may also be a byproduct of reduced prey bases in areas they previously occupied, and gray whales shifted habitats to seek out new areas with greater prey densities. Since humpback and fin whales are not ice-obligate or ice-associated species, it is unknown how long this habitat will remain viable for the species. However, it is logical to assume these whales will continue to utilize these waters as long as the availability of prey remains.

4.1.7. Summary of Stressors Affecting Listed Species within the Action Area

Several of the activities described in the *Environmental Baseline* have adversely affected listed marine mammals that occur in the Action Area:

Commercial whaling reduced large whale populations in the North Pacific down to a fraction of historic population sizes. However, the Western Arctic stock of the bowhead whale is showing marked recovery with numbers approaching the low end of the historic population estimates. Fin whales, while still recovering, remain at a fraction of historic population numbers.

Subsistence whaling for bowhead by Alaska Natives represents the largest known human-related cause of mortality for the Western Arctic stock (0.1–0.5% of the stock per year). However, the long-term growth of this stock indicates that the level of subsistence take has been sustainable. There are no authorized subsistence hunts for fin whales in the Action Area. Humpback whales are not typically taken by subsistence hunters, and there is only one record of this occurring back in 2006. Subsistence harvest of the Arctic ringed seals and bearded seals is currently substantial in some regions. However, there is little or no evidence that subsistence harvests have or are likely to jeopardize the continued existence of these species.

The main factors impacting ambient noise in the Arctic are the nature of ice, whether continuous, broken, moving or shore-fast, the temperature of air, and the speed of the wind.

Levels of anthropogenic noise can vary dramatically depending on the season, type of activity, and local conditions. These noise levels may be within the harassment and injury thresholds for marine mammals.

Numerous incidents of vessel collisions with large whales have been documented in Alaska. Strikes have involved cruise ships, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs. Shipping and vessel traffic is expected to increase in the Arctic Region OCS if warming trends continue; however, no substantial increase in shipping and vessel traffic has occurred in the U.S. Arctic, and no ship strikes have been documented in the U.S. Arctic.

Shipping activities in the U.S. Arctic pose varying levels of threats to ice seals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with ice seal habitats. The presence and movements of ships in the vicinity of some seals may cause ringed and bearded seals to abandon their preferred breeding habitats in areas with high traffic, and ice-breaker activities have been known to kill ringed seals when ice breaking occurs in breeding areas.

Concentrations of OCs and metal contaminants in tissues of baleen whales are low, and lower than other marine mammal species, and are not thought to be high enough to cause toxic or other damaging effects. The relative impact to the recovery of baleen whales due to contaminants and pollution is thought to be low.

Pollutants such as OC compounds and heavy metals have been found in both bearded and ringed seals in the Arctic.

Currently, there are insufficient data to make reliable predictions of the effects of Arctic climate change on baleen whales. A study reported in George et al. (2006) showed that landed bowheads had better body condition during years of light ice cover. This, together with high calf production in recent years, suggests that the stock is tolerating the recent ice-retreat at least at present (Allen and Angliss, 2011). The feeding range of fin whales is larger than that of other species and consequently, as feeding generalists, it is likely that the fin whale may be more resilient to climate change, should it affect prey, than a species with a narrower range (i.e. feeding specialists). The recent observations of humpback whales in the Beaufort and Chukchi seas may be indicative of seasonal habitat expansion in response to receding sea ice or increases in prey availability which these whales now exploit.

The ringed seal's broad distribution, ability to undertake long movements, diverse diet, and association with widely varying ice conditions suggest resilience in the face of environmental variability. However, ringed seal's long generation time and ability to produce only a single pup each year may limit its ability to respond to environmental challenges such as the diminishing ice and snow cover. Bearded seals, on the other hand, are restricted to areas where seasonal sea ice occurs over relatively shallow waters where they may forage on the bottom. The retreat of the spring and summer ice edge in the Arctic may separate suitable sea ice for pup maturation and molting from benthic feeding areas.

5.0 EFFECTS OF THE PROPOSED ACTION

In this section, we determine the potential effect of the Proposed Action (See Section 2) on species under the jurisdiction of the NMFS in the Action Area (see Section 2). The species list for this consultation includes the bowhead whale (*Balaena mysticetus*, endangered), fin whales (*Balaenoptera physalus*, endangered), the humpback whale (*Megaptera novaeangliae*, endangered), the ringed seal (*Phoca hispida*, threatened), and the bearded seal (*Erignathus barbatus*, under appeal. On July 25, 2014, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit challenging the listing of bearded seals under the ESA (Alaska Oil and Gas Association v. Pritzker, Case No. 4:13-cv-00018-RPB). The decision vacated NMFS's listing of the Beringia DPS of bearded seals as a threatened species. NMFS is presently appealing that decision (Notice of Appeal, Case No. 4:13-cv-00018-RRB).

In the interim, this BA will continue to address effects to bearded seals (Beringia DPS) so that action agencies have the benefit of NMFS's analysis of the consequences of proposed actions on this DPS, even though the listing of the species is not in effect). In previous consultations with NMFS, BOEM and BSEE have included species proposed for listing (USDOJ, BOEMRE, 2011a). No NMFS species proposed for listing occurs in the Action Area of the current consultation. In addition, this BA considers all associated critical habitat for the species listed above. Although none of these species has designated critical habitat, NMFS proposed critical habitat for ringed seals (December 9, 2014, 79 FR 73010-73025) which BOEM and BSEE include in this conference.

As detailed earlier in this document, the Proposed Action entails oil and gas exploration, development, production, and decommissioning in connection with the 460 leased blocks from Lease Sale 193 in the Chukchi Sea. Lease Sale 193 was held in 2008; however, due to subsequent legal proceedings and new information, BOEM is supplementing its environmental analyses for the lease sale and USDOJ will determine whether or not to reaffirm the currently suspended leases issued as a result of Lease Sale 193. In supplementing the environmental analyses, BOEM also updated its scenario for reasonably foreseeable activities and effects that may result from the Lease Sale. BOEM and BSEE have reinitiated consultation with NMFS as it relates to the Sale 193 current leases; the consultation had previously culminated in a Biological Opinion (BO) issued in 2013 (NMFS, 2013a), covering lease sales and activities in the Chukchi and Beaufort seas. The updated scenario provided considers potential exploration, development, and other activities in connection with the 460 current leases. This reinitiated consultation applies only to the Leased Area. Lease sales and oil and gas activities in the Chukchi and Beaufort seas that occur outside of the Leased Area continue to be subject to findings of the 2013 Biological Opinion (NMFS, 2013a).

As an incremental step consultation, this BA examines activities in the first step and Future Incremental Steps that may result from the Proposed Action, with the primary focus of the BA being assessment of potential impacts from the First Incremental Step. The First Incremental Step includes all activities associated with the exploration and delineation of the anchor field (large, initial field that is effectively a prerequisite to any future development) up to submission of a Development and Production Plan (DPP). Future Incremental Steps include all steps that would occur after anchor field is explored and delineated. These steps include development and production of the anchor field; exploration, development and production of a satellite field (smaller, secondary field); and decommissioning of both fields. This BA also considers potential impacts through the endpoint of the actions as described in the hypothetical development and production scenario.

The Proposed Action is based on the Scenario presented in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014), which presents BOEM and BSEE's best estimates of the reasonably foreseeable levels and types of activities during oil and gas exploration, development, and production in the Leased Area. The activities comprising the Proposed Action are further described in and in Section 2.2 of this BA and in the Scenario BOEM presented in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014). Section 2.3 of this BA also describes typical mitigating measures that

could avoid or reduce the potential for adverse effects. BOEM and BSEE will reinitiate consultation with NMFS for any future DPP.

BOEM and BSEE have divided the discussion of effects in this BA into three sections: (1) overall approach to analysis, (2) First Incremental Step, and (3) Future Incremental Steps. These sections reflect the incremental analysis of the consequences of the phases of oil and gas activities with emphasis for this document on the exploration of the Anchor field and addressing the more speculative later phase of exploration of a Satellite field, and development and production of the entire Lease Sale 193 to allow NMFS, in generating a BO, to assess the potential for the Proposed Action to jeopardize the continued existence of the species or adversely modify critical habitat.

5.1. Overall Approach to Analysis

The following components are provided in our effects analyses:

- Scope of the analysis (Section 5.1.1).
- Levels of effects (Section 5.1.2).
- Key considerations about the action and the analyses (Section 5.1.3).
- Potential Impact-Producing-Factors (pathways) by which listed species could be affected by different parts of the Proposed Action (Section 5.1.4).
- General background information about how proposed activities could potentially affect listed species and their critical habitat (Section 5.1.4).

Description of effects for Exploration (Section 5.2) and Development and Production (Section 5.3), cumulative effects (Section 5.4), and an ESA effect determination for each listed species (Section 5.5).

5.1.1. Scope of the Analysis

For ESA consultation on the Proposed Action, BOEM and BSEE specifically request incremental Section 7 consultation. Regulations at 50 CFR 402.14 (k) allow consultation on part of the entire action as long as that step does not violate Section 7(a)(2); there is a reasonable likelihood that the entire action will not violate Section 7(a)(2); and the agency continues consultation with respect to the entire action, obtaining a biological opinion for each step. Accordingly, BOEM and BSEE consult on the early lease activities (seismic surveying, ancillary activities, and exploration drilling) to ensure that activities under any leases issued will not result in jeopardy to a listed species or cause adverse modification of proposed or designated critical habitat. Prior to development and production activities, BOEM and BSEE will reinstate consultation for that next increment of the Proposed Action, to verify that that increment does not violate Section 7(a)(2), and to obtain a BO for that increment.

There are multiple potential pathways through which listed species could be impacted by exploration, development and production activities in the Action Area (Section 2.1). This BA will primarily assess the proposed exploration activities and consider the later phases of development and production more generally. BOEM and BSEE weighed more heavily those activities that were more certain to occur and that were closer in time. Enough detail on development and production activities will be provided so NMFS can determine whether or not the Proposed Action would jeopardize the continued existence of listed species.

5.1.2. Definitions and Levels of Effects

For the purposes of this BA, BOEM and BSEE use the term “disturb” as meaning “to cause disruption of behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal” (USDOI, BOEMRE, 2011a). “Injury” is used to describe a wound or other physical harm. Taken to an extreme, disturbances or injuries could occur in sufficient frequency, intensity, or duration to result in a loss of biological fitness that could pose a discernible risk to an individual animal’s survival or productivity.

The following definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS Endangered Species Consultation Handbook (USFWS and NMFS 1998).

- “*No effect*” is the appropriate conclusion when a listed species will not be affected, either because the species will not be present or because the project does not have any elements

with the potential to affect the species. “No effect” does not include a small effect or an effect that is unlikely to occur.

- If effects are insignificant (in size) or discountable (extremely unlikely) or beneficial to the species, a “*may affect, but not likely to adversely affect*” determination is appropriate. Insignificant effects relate to the magnitude or extent of the effect (i.e., they must be small and would not rise to the level of a take of a species). Discountable effects are those extremely unlikely to occur.
- A “*may affect, and is likely to adversely affect*” determination is based on responses to disturbances that are not beneficial, insignificant or discountable, meaning that negative consequences may happen as a result to the species responses to disturbance with the action. The negative consequences may be manifested as harassment or harm as defined by the ESA. A “may affect and is likely to adversely affect” determination requires initiation of formal consultation with the NMFS.

Provisions of the ESA also require a determination of whether proposed Federal actions may affect critical habitat for listed threatened or endangered species. Within the Action Area, no designated critical habitat exists for NMFS-managed species. Proposed critical habitat for ringed seals does occur within the Action Area and effects of the Proposed Action on this habitat are analyzed and presented later in Sections 5.2.2 and Section 5.3.2.

5.1.3. Key Considerations

The effects analysis presented in this chapter considers the following important considerations in determining the potential effects from the Proposed Action.

- **Timing.** Activities can occur at different times of the year. For example, most exploration activity occurs during the open-water period (July–November); but in-ice seismic surveys may occur during late fall/early winter when new ice is forming. Nearshore on-ice seismic operations occur in late winter/early spring. Seismic activities are typically restricted in the spring lead systems until after July 1.
- **Residence Time and Periodicity.** Effects can vary based on the duration, frequency and intensity of exposure to certain activities in an area during one or more seasons. Effects can be short- or long-term. For example, seismic operations may operate for up to 90 days, but over a large area.
- **Spatial Extent.** The Action Area is large, and areas explored in any given season vary widely in the Action Area. Beyond the footprint of a seismic vessel or on-ice operations, MODUs, or other facilities, consideration must be given to the area affected by noise, support-vessels, or aircraft traffic.
- **Environmental Factors.** Weather, currents, wind, ice, and other environmental variables could influence the intensity or magnitude of potential effects.
- **Biological Principles/Factors.** Each species may have sensitive population components (e.g., females with young), key habitats (e.g., seal denning areas, the spring polynya system, breeding and birthing habitats) or specific behavioral responses to certain activities.
- **Best Available Information.** We use the best available scientific information to conduct our Biological Assessment. The primary source of our information is published, peer-reviewed journal articles, or reference texts. There are times when agency technical or survey reports may shed relevant light on a particular topic. On occasion, the best available information could come from unpublished reports by agency personnel, industry, or conservation groups. Anecdotal information or personal communications are used infrequently; primarily for

background or if this is the only information available to support an important point or concept.

In some cases or when conducting certain analyses, we make use of research on similar species or imply consequences from similar effects on those related species. For example, baleen whales likely are more similar physiologically and behaviorally than toothed whales or pinnipeds. Another example is the similarity of ice seals as a group as compared to other seals, such as harbor or gray seals. In most cases, comparisons between listed species and more dissimilar species (e.g., manatees or sea otters) or humans, birds, or marine fish, are considered less useful.

- **Use of Mitigation Measures.** Monitoring and mitigation measures similar to those typically required in the most recent IHAs for oil and gas exploration activities in the Arctic are anticipated to be required for future IHAs. Mitigation measures typically instigated to minimize impacts to NMFS-managed species are presented in Section 2.3. These include measures commonly included in IHAs, as well as lease stipulations and other Federal agency stipulations and BMPs.

5.1.4. Impact Producing Factors

The oil and gas activities associated with the First Incremental Step are seismic, geotechnical, and geohazard surveys; exploratory drilling operations; discharges; and vessel and aircraft traffic associated with both the above activities and with onshore construction of exploration-support bases. These oil and gas activities have the potential to affect resources in various ways. BOEM refers to Impact Producing Factors (IPFs) relevant in understanding the impacts on a given resource. The IPFs associated with oil and gas activities are: Noise, Physical Presence, Discharges, Habitat Alteration, and Accidental Oil Spills and Gas Releases (USDOI, BOEM, 2014).

These same IPFs could be associated with Future Incremental Steps installation of OCS platforms, production and service well drilling, installation of offshore and onshore oil pipelines, construction of a shorebase, construction of a processing and a waste facility, and associated vessel and aircraft traffic.

Emissions from exploration vessels, particularly drillships, were determined to not have an adverse effect in the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014). As described in Section 3.0 of this BA, listed whales and ice seals were considered to have olfactory abilities that help them locate food or avoid predators. The analysis in the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014) indicated there would be little opportunity for NMFS-managed species to be exposed to emissions. Furthermore, if listed whales and ice seals are able to detect and orient towards prey resources, they are assumed to be able to detect and orient away from any emissions they encounter. Therefore, this impact-producing factor is not considered further in this BA.

Background information on understanding sound in the marine environment is presented in Section 4 of this BA. The effects of underwater noise on listed species are presented below.

5.1.4.1. Potential Effects of Underwater Noise on Listed Species

Hearing is a particularly important sensory system for marine mammals because they rely on sound to communicate, find mates, navigate, orient, detect predators and prey, and to gain other information about their environment. There is concern about the impacts of anthropogenic noise on marine mammals (NRC, 2003a, b, 2005; Southall et al., 2007). The following subsection provides a review of the potential impacts of anthropogenic underwater noise to listed marine mammals in order to provide context to the effects analysis that BOEM and BSEE present in this BA.

The impacts of underwater noise on marine mammals can be divided into physiological and behavioral effects. Potential physiological effects include damage to hearing to auditory (hearing)

systems or induction of a stress response. Potential behavioral effects include disrupted communication and masking effects or displacement. (Olesiuk et al., 1995; Richardson, 1995a; Richardson, 1995c; Kraus et al., 1997; NRC, 2003a, b, 2005; Southall et al., 2007).

Many factors collectively determine the likelihood of potential effects of underwater noise to listed species. For example, auditory systems and sensitivity ranges are species-specific as well as habitat-dependent. The fate of sound after it is produced is also habitat- and, especially in the Arctic, season- and weather-dependent. Because of differences in bathymetry and seabed characteristics of sites throughout the Chukchi Sea, the distances that sounds of various frequencies, intensities, and pressures will propagate, and the resulting effects of such sounds, can be expected to differ greatly amongst specific sites (e.g., sound will propagate differently among lease blocks that differ in seabed properties, bathymetry, and amount of wave action). Thus, the exact source location of any source will determine the fate of sound released at that site and, therefore, will affect the possibility of impact on listed species in or near the source area. The time of year such sound is released will determine whether there is potential for individuals to be exposed to that sound. Several important documents that summarize information on the topic of environmental influence of noise propagation and attenuation include Richardson (1995a, c); Hoffman (2002); Tasker et al. (1998); NRC (2003a, b, 2005); IWC (2004a) and Southall et al. (2007).

While there is some general information available, evaluation of the impacts of noise on marine mammal species, particularly on cetaceans, is greatly hampered by a considerable uncertainty about their hearing capabilities and the range of sounds used by the whales for different functions (Richardson, 1995a; Richardson, 1995b; Gordon et al., 1998; NRC, 2003a, b, 2005). This is particularly true for baleen whales. Very little is known about the actual hearing capabilities of the large whales or the physical impacts of sound on them, because they are exceedingly difficult to study. There are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al., 1995b:205–206; Southall et al., 2007). Thus, predictions about probable impacts on baleen whales generally are based on assumptions about their hearing rather than actual studies of their hearing (Richardson, 1995b; Gordon et al., 1998; Ketten, 1998). These assumptions are based on 1) observed responses to sounds of various frequencies, 2) vocalization frequencies most often used, 3) body size, 4) ambient noise levels, and 5) cochlear morphometry.

Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies <1,000 Hz. Bowhead whale songs can approach 4,000 Hz and calls can range between 50 and 400 Hz, with a few extending to 1,200 Hz (Thomson and Richardson, 1995). Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies < 1,000 Hz but appear able to hear sounds up to higher frequency. At present, the lower and upper frequencies for functional hearing in baleen whales collectively are estimated to be 7 Hz and 22 kHz (Ketten et al., 2007). The suspected vocalization frequency range for humpback whales varies from 10–3,700 Hz. Most baleen whale sounds are concentrated at frequencies <1 kHz, but humpback whales produce some signals with low level harmonics extending above 24 kHz. The presence of high-frequency harmonics does not necessarily indicate they are audible to the whales, but it does indicate high-frequency energy is present and may need to be reassessed as knowledge emerges.

Most of the manmade sounds that elicited reactions by baleen whales were at frequencies < 1,000 Hz (Thomson and Richardson, 1995; Richardson, 1995c). Seismic airguns are meant to produce low-frequency noise, generally below 200 Hz. However, the impulsive nature of the collapse of air bubbles inevitably results in broadband sound characteristics. Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz. Even if the range of sensitive hearing does not extend below 20–50 Hz, whales may hear strong infrasounds at considerably lower

frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al., 1995b).

Bowhead whales, as well as blue and fin whales, are predicted to hear at frequencies as low as 10–15 Hz. McDonald, Hildebrand, and Webb (1995) summarize that many baleen whales produce loud low-frequency sounds underwater a substantial part of the time. Thus, species that are likely to be impacted by low-frequency sound include baleen whales including bowhead, fin and humpback whales. Most marine mammal species also have the ability to hear beyond their peak range (Richardson, 1995b). This broader range of hearing probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey.

5.1.4.1.1. Potential Physiological Effects

Ketten (1998) reported that hearing loss can be caused by exposure to sound that exceeds an ear's tolerance (i.e., exhaustion or overextension of one or more ear components). Hearing loss to a marine mammal could result in an inability to communicate effectively with other members of its species, or detect approaching predators or vessels.

Hearing loss resulting from exposure to sound often is referred to as a threshold shift. Some studies have shown that following exposure to a sufficiently intense sound, marine mammals may exhibit an increased hearing threshold, a threshold shift, after the sound has ceased (Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002). Thus, a threshold shift indicates that the sound exposure resulted in hearing loss causing decreased sensitivity. This type of hearing loss is called a temporary threshold shift (TTS) if the individual recovers its pre-exposure sensitivity of hearing over time, or a permanent threshold shift (PTS) if it does not. A TTS is a temporary loss of hearing sensitivity that rarely affects the entire frequency range that a marine mammal can be capable of detecting; instead a TTS affects the frequency ranges that are roughly equivalent to or slightly higher than the frequency range of the noise itself (NMFS, 2011c). Ketten (1998) reported that whether or not a TTS or a PTS occurs will be determined primarily based on the extent of inner ear damage that the received sound level causes. In general, whether a given species will tend to be damaged by a given sound depends on the frequency-sensitivity of the species.

Most experiments have looked at the characteristics (e.g., intensity, frequency) of sounds at which TTS and permanent threshold shift occurred. However, while research on this issue is occurring, it is still uncertain what the impacts may be of repeated exposure to such sounds and whether the marine mammals would avoid such sounds after exposure, even if the exposure was causing temporary or permanent hearing damage, if they were sufficiently motivated to remain in the area (e.g., a concentrated food resource). There are no data on which to determine the kinds or intensities of sound that could cause TTS in a baleen whale (Southall et al., 2007).

PTS are less species-dependent and more dependent on the length of time the peak pressure lasts and the signal rise time. Usually, if exposure time is short, hearing sensitivity is recoverable. Hearing loss might be permanent if exposure to a sound is long, or if the sound is broadband in higher frequencies and has intense sudden onset. Long-lasting increases in hearing thresholds, which also can be described as long-lasting impairment of hearing ability, could impair the ability of the affected marine mammal to hear important communication signals or to interpret auditory signals.

A very powerful sound at close range can cause death due to rupture and hemorrhage of tissues in lungs, ears, or other parts of the body. At greater distance, that same sound can cause temporary or permanent hearing loss. Noise can cause modification of an animal's behavior (for example, approach or avoidance behavior, or startle response). These types of blast/explosive sounds are not part of the Proposed Action.

Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson, 1995b; Ketten, 1998). Because of suspected differences in hearing sensitivity, it is likely that baleen whales are more likely to be harmed by direct acoustic impact than odontocetes

(toothed whales). As a consequence, comparisons of effects on listed baleen species with results from studies on toothed whales are not necessarily applicable or appropriate. We believe, however, it is prudent and appropriate to assume in our analyses that sensitivities shown by one species of baleen whale also could apply to another. This reasonable approach provides the means to infer possible impacts on one species to another similar species. While useful for analytical purposes, this does not imply that all closely-related species respond the same way to the same sound or activities (see key considerations, Section 5.1.3).

5.1.4.1.2. Potential Physical Effects

Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, resonance effects, and other types of organ or tissue damage.

Gas-filled structures in marine mammals have inherent fundamental resonance frequency. If stimulated, the ensuing resonance could cause damage to the animal. Diving marine mammals may be subject to decompression injury if they ascend unusually rapidly when exposed to aversive sounds; however this interpretation remains unproven and is likely irrelevant to this analysis because most water depths in the Action Area are relatively shallow with a mean depth of 50 m.

The cumulative effects of multiple exposures annually to long-lived marine mammals are difficult to assess or study. Present day science and technology do not allow controlled research regarding marine mammal exposure to underwater sounds to isolate variables regarding any relationship to body condition and related reproductive parameters. These physiological characteristics of individuals and populations of marine mammals are subject to numerous dynamic variables in the marine environment.

5.1.4.1.3. Potential Behavioral Effects

Behavioral response may take the form of startle, avoidance, attraction, flight, alteration of calling rate and frequency, alteration of orientation, alteration of pre-exposure activity, alteration of diving and breathing frequency, alteration of swim speed, and no reaction. Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary depending on the type, duration, and frequency of exposure of sound.

Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given situation, to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound. Because of this, our conclusions about potential affects and impacts are based on the most sensitive members of a population. In addition, we make assumptions that sound will travel the maximums observed elsewhere, rather than minimums. This assumption may overestimate potential effects in many cases.

5.1.4.1.4. Masking

When noise interferes with sounds used by the marine mammals (e.g., interferes with their communication or echolocation), it is said to "mask" the sound (a call to another whale might be masked by an icebreaker operating at a certain distance away). Masking (sometimes referred to as auditory interference) generally occurs when sounds in the environment are louder than and of a similar frequency to, auditory signals an animal is trying to receive. Noises can cause the masking of sounds that marine mammals need to hear to function (Erbe et al., 1999). The presence of the masking noise can make it so that the animal cannot discern sounds of a given frequency and at a given level that it would be able to in the absence of the masking noise. If sounds used by the marine

mammals are masked to the point where they cannot provide the individual with needed information, they can cause harm (Erbe and Farmer, 1998). In the presence of the masking sounds, the sounds the animal needs to hear must be of greater intensity for it to be able to detect and to discern the information in the sound.

Whales: Some whales can adapt their vocalizations to background noise (Erbe and Farmer, 1998). Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals. Parks et al. (2010) documented that right whales respond to periods of increased noise by increasing the amplitude of their calls. McDonald, Hildebrand, and Mesnick (2009) indicated that worldwide decline in tonal frequencies of blue whales could not be fully explained by interference from increasing ocean noise, but rather population increase may be more plausible.

Erbe and Farmer (1998:1386) summarized that in "...the human and dolphin ear, low frequencies are more effective at masking high frequencies than vice versa; masking is maximized if the characteristic frequencies of the masker are similar to those of the signal..." They proposed that the factor most important for determining the masking effect of the noises was their temporal structure. The noise that was the most continuous with respect to frequency and time masked the beluga vocalization most effectively, whereas sounds (e.g., natural icebreaking noise) that occurred in sharp pulses that left quiet bands in between and left gaps through which the beluga could detect pieces of the call. In a given environment, then, the impact of a noise on cetacean detection of signals likely would be influenced by both the frequency and the temporal characteristics of the noise, its signal-to-noise ratio, and by the same characteristics of other sounds occurring in the same vicinity (for example, a sound could be intermittent but contribute to masking if many intermittent noises were occurring).

Ice Seals: Masking of biologically important sounds by anthropogenic noise could be considered a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individual marine mammals. There are few situations or circumstances where low frequency sounds could mask biologically important signals. While seismic surveys can contain sounds up to 1 kHz, most of the emitted sound is <200 Hz. Seismic surveys generate periodic sounds that have little potential to mask sounds important to seals. Continuous sounds from drilling operations have some potential to mask sounds important to ice seals if they voluntarily approached within very close proximity to an operating drilling unit, depending on the specific sound characteristics of the unit.

5.1.4.1.5. Sound Exposure Level Criteria

Southall et al. (2007) recommend criteria for injury (PTS) from exposure to a single pulse, expressed in terms of peak sound pressure level (SPL), are TTS onset levels plus 6 dB of additional exposure. Expressed in terms of sound-exposure level (SEL), the recommended criteria are TTS-onset levels plus 15 dB of additional exposure. They proposed injury criteria expressed both as SPL and SEL for individual low-frequency cetaceans, including humpback, fin, and bowhead whales, exposed to "discrete" noise events (either single or multiple exposures within a 24-hour period) and multiple pulses. The proposed injury-criteria levels for pulses are SPL of 230 dB re 1 μ Pa (rms) (peak) (flat) and SEL of 198 dB re 1 μ Pa (rms). Proposed injury criteria for nonpulses are based on recommended SEL criteria for injury (PTS-onset are M weighted exposures 20 dB higher than those required for TTS-onset. For all cetaceans exposed to nonpulses, the recommended SPL for injury is 230 dB 1 μ Pa (rms) (peak) (flat) and SEL of 215 dB re 1 μ Pa (rms).

Southall et al. (2007) notes that, for non-pulsed noise, the combined information generally indicates no (or very limited) responses at received levels of 90–120 dB re 1 μ Pa (rms) and an increasing probability of avoidance and other behavioral effects in the 120–160 dB re 1 μ Pa (rms) range. However, these data indicated considerable variability in received levels associated with behavioral

responses. Contextual variables (e.g., source proximity, novelty, operational features) appear to have been at least as important as exposure level in predicting response type and magnitude. The Southall et al. (2007) criteria differ from those used by NMFS under the MMPA. NMFS uses two levels of acoustic thresholds to evaluate potential effects to marine mammals. The Level B criterion for continuous noise in the water is 120 SPL x dB re 1 μ Pa (rms) and 160 SPL x dB re 1 μ Pa (rms) for impulse noise. For airborne sounds, the NMFS Level B threshold is 100 SPL x dB re 1 μ Pa (rms) for pinnipeds. The Level A criterion is 180 SPL x dB re 1 μ Pa (rms) for cetaceans and 190 SPL x dB re 1 μ Pa (rms) for pinnipeds.

Results from several experimental studies have been published regarding sound-exposure metrics incorporating sound-pressure level and exposure duration. Investigators have also examined noise-induced TTS in some odontocetes and pinnipeds exposed to moderate levels of underwater noise of various band widths and durations (Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002).

Available evidence indicates reactions to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, habituation, type of activity engaged in at the time or, in some cases group size (Schusterman, 1981; Richardson, 1995a; Richardson, 1995b). For example, reaction to sound may vary, depending on whether females have calves accompanying them or whether individuals are feeding or migrating. It may depend on whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates the ability, in a given situation, to predict the impacts of sound on a species or on classes of individuals within a species. Because of this, we focus on the potential effects on the most sensitive members of a population.

5.1.4.1.6. Potential Long-term Effects

Little data are available about how, over the long term, most marine mammal species (especially large cetaceans) respond either behaviorally or physically to intense sound and exposure to long-term increases in ambient noise levels. Large cetaceans cannot be easily monitored or examined after exposure to a particular sound source.

The bowhead whale population, however, is approaching, or has reached, its pre exploitation population size and has been documented to be increasing at a roughly constant rate for over 20 years, which indicates the impacts of oil and gas industry on individual survival and reproduction in the past have likely been minor (Allen and Angliss, 2014). Available data indicates that noise and disturbance from oil and gas exploration and development activities since the mid-1970's have had localized, short-term adverse effects, but no lasting population-level adverse effect on bowhead whales.

5.2. Potential Effects of the Proposed Action

The following subsections detail the potential effects of the Proposed Action to NMFS-managed, ESA-listed species that may occur in the Action Area.

5.2.1. Potential Effects of First Incremental Step Activities

As mentioned in previous sections, activities associated with oil and gas exploration during the First Incremental Step in the Action Area have the potential to disturb listed whales and ice seals. Sound associated with seismic surveys, geohazard and geotechnical surveys; operation of exploration MODUs; and marine vessel and aircraft traffic may affect marine mammals. Exploratory drilling may also discharge materials into the marine environment, which could affect marine mammals in the area. In this section BOEM describes the potential pathways through which listed whales and ice seals could be impacted by oil and gas exploration activities in the Action Area during the First Incremental Step, including potential adverse affects from:

- Vessel traffic
- Aircraft traffic
- Seismic, geohazard, and geotechnical surveys
- Onshore facilities construction
- Exploratory drilling operations
- Discharges.

5.2.1.1. Potential Effects of Vessel Traffic

There are a number of variables that help determine whether marine mammals are likely to be disturbed by vessels, including the number of vessels, the distance between a vessel and a marine mammal, vessel speed and direction, vessel noise, vessel type and/or size, and the behavior/activity of the marine mammal prior to its awareness of the vessel(s)' presence.

Under the Proposed Action vessel operations would occur throughout the Action Area during the First Incremental Step in conjunction with (1) seismic and other ancillary surveys, (2) exploratory drilling, and (3) onshore construction. Vessels would operate primarily during open-water and early winter periods. During the First Incremental Step of the Proposed Action, one to three support vessel trips are possible per seismic or ancillary survey. The frequency of vessel trips during exploratory drilling would be higher (up to three trips per week) due to the need for re-supply or crew transfers. Onshore construction activities would require one to two barge trips per season over the course of one or two open-water seasons to transport construction equipment and supplies to the shorebase construction site. Additional details regarding vessel traffic during the First Incremental Step of the Proposed Action are presented in Section 2.2.1.1.6 of this BA. Vessels and their operations produce effects through a visual presence; traffic frequency and speed; and operating noise of on-board equipment, engines, and, in the case of icebreakers, engine and ice breakage noise. Listed species could be exposed to vessels when the species' seasonal distribution and habitat selection overlaps in time and space with proposed exploration vessel activities. Noise from seismic sources will be considered separately.

In general for OCS oil and gas exploration operations, vessels provide the primary means for various open water season and in-ice (late fall/early winter during seasonal ice formation) seismic surveys and secondary support for these surveys such as monitoring, crew transfer; fuel, and equipment and supplies delivery. Vessels also provide similar support functions for the transport, placement, and operation of MODUs. In-ice seismic surveys and some late fall/early winter drilling activities require icebreaker operations for ice management.

5.2.1.1.1. Vessel Presence

Whales

Bisson et al. (2013) reported a total of 581 whales observed during vessel-based monitoring of exploratory drilling activities by Shell in the Chukchi Sea during the 2012 open-water season. This total includes animals sighted outside of the Leased Area during transits to and from the drill site. The majority of whales (approximately 44%) showed no observable movement or neutral movement relative to moving vessels. Approximately 47% of whales sighted from stationary vessels had either no observed movement or neutral movement relative to the vessel. Swimming away from the moving or stationary vessel was the next most common behavior observed, with approximately 18% and 16% of whales (respectively) swimming away. In vessel disturbance experiments conducted in the Beaufort Sea, a similar environment to the Chukchi, bowhead whales began to orient away from an oncoming vessel at a range of 2–4 km (1.2–2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (Richardson and Malme, 1993). Vessel disturbance during these

experimental conditions temporarily disrupted activities and sometimes disrupted social groups, when pods of whales scattered as a vessel approached. Reactions to slow-moving vessels, especially if they do not approach directly, are much less dramatic. Bowhead whales often are more tolerant of vessels moving slowly or in directions other than toward the whales. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. After some disturbance incidents, at least some bowhead whales returned to their original locations (Richardson and Malme, 1993).

As a result of vessel presence and operations associated with the Proposed Action, some whales encountering vessels could exhibit subtle changes in their surfacing and blow cycles, while others could appear to be unaffected.

Ice Seals

The presence and movements of ships in the vicinity of some seals can affect their normal behavior (Jansen et al., 2010) and may cause ringed seals to abandon their preferred breeding habitats in areas with high traffic (Smiley and Milne, 1979; Mansfield, 1983).

Adult ringed and bearded seals are agile and easily avoid vessels in open water conditions. Ringed seal pups are less adept than are adults, and those that are in their dens or resting on ice may enter the water with little provocation. Since ringed seal pups are much smaller than adults, they likely have a greater potential for heat loss. Because of their greater potential for heat loss, they are also more sensitive to energetic losses incurred from swimming in Arctic waters. If a vessel disturbs young ringed seals, some might subsequently become energetically and behaviorally stressed, leading to lower overall fitness of those individuals.

The noise in a ringed seal den is buffered by snow (Holliday, Cummings, and Bonnett, 1983) and tolerances to vessel presence and sounds could be higher for ringed seal pups in their winter dens. However, for such an incident to occur, vessel activity would have to occur March and early June when the pups are maturing (Cameron et al., 2010).

Bearded seal pups are precocial, often making foraging attempts during their first week of life (Watanabe et al., 2009; Lydersen et al., 2002), with successful foraging noted after the 1st or 2nd week of swimming slightly before natural abandonment by the mother (Burns, 1981). Smiley and Milne (1979) speculated that the risk of ship traffic causing a mother bearded seal to abandon her pup may be lower than with some other ice seals such as ringed seals, since bearded seals mothers and young separate naturally at such an early age.

Surveys and studies in the Arctic have observed mixed reactions of seals to vessels at different times of the year. Disturbances from vessels may motivate seals to leave haulout locations and enter the water (Richardson, 1995c). Due to the relationship between ice seals and sea ice, the reactions of seals to vessels activity are likely to vary seasonally with seals hauled out on ice reacting more strongly to vessels than seals during open water conditions in the Chukchi Sea.

Bruggeman et al. (1992) observed ringed seals on ice pans entering the water in short-term escape reactions, when vessels approached within 250–500 m (820–1640 ft), and Calambokidis, Steiger, and Healey (1983) noted harbor seals were displaced from ice when vessels approached to within 100–300 m (984 ft). However other studies (Bonner, 1982; Johnson et al., 1989) concluded habituation is possible when higher levels of vessel traffic occur or when certain boats visit an area regularly. Such variations in seal responses may be explained as the result of the risk assessment, and conclusions made by individual seals on a case by case basis.

During open water surveys in the Beaufort and Chukchi Seas (Harris, Miller, and Richardson, 2001; Blees et al., 2010; and Funk et al., 2010) ringed and bearded seals showed slight aversions to vessels activity. Funk et al. (2010) noted among vessels operating in the Chukchi Sea where received sound levels were <120 dB, 40% of observed seals showed no response to a vessel's presence, slightly more

than 40% swam away from the vessel, 5% swam towards the vessel, and the movements of 13% of the seals were unidentifiable. In the same Chukchi Sea surveys 60% of the observed seals “...exhibited no reaction to vessels...”, and 27% simply looked at the vessels. Funk et al. (2010) concluded that bearded seals were more likely to occur near the pack ice margin than in open water, and that it is likely some individuals near the seismic survey were displaced to some limited extent. Brueggeman (2010) noted that in 2008 and 2009 ringed seal behavior was dominated by swimming (49%), diving (20%), and looking (18%) at the survey vessels.

Blees et al. (2010) reported a total of 16 ringed seals and 69 bearded seals was observed by monitoring vessels where the received noise levels were <120 dB during Statoil’s 2010 seismic surveys in the Chukchi Sea. Of those observations the seals responded mainly by looking at the vessel (56.7%) or showed no reaction at all (32.8%). Blees et al. (2010) reported seals responded to the vessel by looking (37.5%) or simply did not respond to the vessels presence (62.5%) when the M/V *Geo Celtic* was performing non-seismic activities. Summarily the majority of seals encountered by Statoil’s monitoring vessels reacted by looking at the vessel (51%) or by showing no obvious reaction (39%). Consequently ringed seals did not appear to be affected by vessel traffic with background noises below 120 dB in the 2006–2008 (Funk et al., 2010) or the 2010 (Blees et al., 2010) surveys when they were in open water conditions and not hauled out on ice. However in Blees et al. (2010) ringed, bearded, ribbon, and spotted seals were collectively grouped together in the analyses. Blees et al. (2010) noted seal observations by individual species; however their analysis for sighting rates used the cumulative number of ice seal observations as a collective group rather than by individual species, which would have been much lower.

More recently, Bisson et al. (2013) reported a total of 938 seals observed during vessel-based monitoring of exploratory drilling activities by Shell in the Chukchi Sea during the 2012 open-water season. This total includes animals sighted outside of the Leased Area during transits to and from the drill site. The majority of seals (42%) responded to moving vessels by looking at the vessel, while the second most behavior was no observable reaction (38%). The majority of seals (58%) showed no reaction to stationary vessels, while looking at the vessel was the second most common behavioral response (38%). Other common reactions to both moving and stationary vessels included splashing and changing direction.

The loudest noise from normal ship operation comes from propeller cavitation, which adds 10–15 dB to the noise level of regular operations (Greene and Moore, 1995). Otherwise the level of noise produced by vessels is a function of ship size, speed, and the weight of cargo. Increases in ambient noise, however temporary, have the potential to mask communication between mammals (Richardson and Malme, 1995) and some marine mammals have been known to alter their own signals to compensate for increased ambient noise levels (Evans, 1982; Au et al., 1974; Di Lorio and Clark, 2010; Parks et al., 2011). Noise from shipping may also disturb ringed seals and disrupt their activities, possibly leading to abandonment of quality habitat (Reeves, 1998). Richardson (1995c) found vessel noise does not seem to strongly affect pinnipeds in the water, explaining that seals on haulouts often respond more strongly to the presence of vessel, suggesting seals may have a high tolerance to vessels and their associated noise. Moreover, the isolated and inaccessible habitat of ringed seals in interior and shorefast ice has provided some protection from the effects of vessel traffic.

Evidence suggests that a greater rate of mortality and serious injury to marine mammals correlates with greater vessel speed at the time of a ship strike (Laist et al., 2001; Vanderlaan and Taggart, 2007; as cited in Aerts and Richardson, 2008). Most lethal and severe injuries resulting from ship strikes have occurred from vessels travelling at 14 kn or greater (Laist et al., 2001). Vanderlain and Taggart (2007), using a logistic regression modeling approach based on vessel strike records, found that for vessel speeds greater than 15 kn, the probability of a collision will result in mortality or severe injury approaches 100%. The probability that a collision will result in a lethal injury declined to approximately 20% at speeds of 8.6 kn and less than 5% at 4 kn (Vanderlain and Taggart, 2007). In

the case of seismic survey vessels (which typically operate from 4.5 to 5 kn), the risk of lethal injury from vessel strike would be limited.

There is a possibility that vessels associated with First Incremental Step activities of the Proposed Action could strike a small number of seals in open water conditions. Seals that closely approach larger vessels also have some potential to be drawn into bow-thrusters or ducted propellers. In recent years gray and harbor seal carcasses have been found on beaches in eastern North America and Europe with injuries indicating the seals may have been drawn through ducted propellers. To date no similar incidents such as these have been recorded in Alaska, though Sternfield (2004) documented a single spotted seal (*Phoca largha*) stranding in Bristol Bay, Alaska, that may have resulted from a propeller strike.

During First Incremental Step activities of the Proposed Action, vessels would produce sound that may elicit behavioral changes in ice seals, mask their underwater communications, mask received noises, and cause them to avoid noisy areas. Richardson (1995c) found vessel noise does not seem to strongly affect pinnipeds that are already in the water, explaining that hauled out seals often respond more strongly to the presence of vessels.

5.2.1.1.2. Vessel Collisions

Large vessels employed for oil and gas exploration activities range from 75 m to 110+ m in length. Speeds range from 4.5 kn when towing seismic gear up to 16.5 kn when transiting. Operations historically were confined to the open water period; however, recently technology to conduct in-ice seismic surveys during the late-fall/early winter period, when new ice is forming, but not exceeding 1.6 m in thickness is now feasible. Vessel activity occurs 24 hours a day including periods of poor visibility due to darkness and weather conditions. Vessels that perform as MODUs may be considered large vessels as well.

Laist et al. (2001) noted 89% of all collision accounts pertained to whales that were killed or severely injured from vessels moving at 14 kn or faster. None of these collisions occurred at speeds of less than 10 knots. Also, collision records first appear late in the 1800s when the fastest vessels began attaining speeds of 14 kn, and then increased sharply in the 1950s–1970s when the average speed of most merchant ships began to exceed about 15 kn. Large vessels in the Arctic Region typically operate at less than 10 kn when traveling from location to location, such as when positioning at a drill site. These large vessels when traveling cannot perform abrupt turns and cannot slow speeds over short distances to react to encounters with marine mammals. Effects upon large whales is dependent upon the dynamics of visual presence, the timing, duration, and frequency of trips to work locations, routing, seasonal and concurrent numbers of large vessels (and support vessels) operating in the area, and spatial/temporal overlap with the seasonal distribution including critical life function habitats (breeding, calving, nursing, feeding, migrating, resting areas, etc.) of large whales.

During the First Incremental Step of the Proposed Action, medium and small vessels would be used to support for refueling operations and equipment/personnel transport. These vessels would be <75 m long and have the ability to slow down in relatively short distances and make rapid turns to avoid collisions with marine mammals. These vessels may operate at speeds greater than 10 kn during supply missions and operate in periods of darkness and poor visibility. Collisions with listed species could occur under such conditions.

5.2.1.1.3. Ice Management Vessels

Under the First Incremental Step of the Proposed Action, some exploration activities would require ice management support. When an ice-management vessel (e.g., icebreaker) is transiting open-water, the sound generated is less than when the vessel is managing or breaking ice. Icebreaker support can introduce loud noise episodes into the marine environment when actively engaged in ice management or breaking due to cavitation of the propellers when higher power levels are required to move ice or

ram/run up on ice for breakage. The greatest sound generated during ice-breaking operations is produced by cavitations of the propeller as opposed to the engines or the ice on the hull (Richardson et al., 1995a). Davis and Malme (1997) noted cavitation occurs during ice breaking if a ship has to reverse and ram thick ice. Short (~5 sec) bursts of cavitation noise (197–205 dB) is created when the propeller is switched from astern (reverse) to full forward power, producing higher noise levels than continuous forward progress through the ice. Based on measurements in Greene (1987), sounds produced by an icebreaker, the *Robert Lamonte*, actively managing ice were estimated to fall below 160 dB rms at <100 m from the vessel and to fall below 120 dB rms at ~8 km from the vessel.

During vessel-based marine mammal monitoring of Shell's 2012 exploratory drilling in the Chukchi Sea (Bisson et al. 2013), a total of 15 whales were observed during ice management activities. No whale exhibited a discernable reaction to ice management activities.

There are wide-ranging responses recorded for the reaction of seals to ice management activity. Reeves (1998) noted that some ringed seals have been killed by ice-breakers moving through fast-ice breeding areas and that the passing ice-breakers could have far reaching effects on the stability of large areas of sea ice however these mortalities are associated with actual icebreaking movements and not the associated noise. There are no similar reports indicating icebreakers have killed bearded seals.

Overall, the noise generated from ice breaking that occurred during the First Incremental Step of the Proposed Action could have a similar masking effect on seals as ambient noise such as proximity to a vocalizing marine mammal or noise from strong wind and rain or ice movement (Gales, 1982).

Fay and Kelly (1982) reported ice seals hauling out onto the ice when approached by an icebreaker. Other reports have ice seals diving into the water when an icebreaker is 0.93 km away (Brueggeman et al., 1992) but remaining on the ice when the icebreaker was 1–2 km away (Kanik et al., 1980). Because of their habitat preferences in polynyas, and the ice front, icebreakers could elicit a brief startle or escape reactions by a proportion of bearded seals encountered on ice.

Icebreakers are unlikely to be a threat to bearded seals because of their habitat preferences and the fast growth and development of their pups. Bearded seal pups are not likely to be at risk of abandonment by their mothers as a result of disturbance by icebreakers because of the very brief period of maternal care, and because unlike ringed seals, bearded seals rest on top of the ice where they would be visible to approaching icebreakers. Reeves (1998) noted that some ringed seal pups have been crushed by ice-breakers operating in areas that contain breeding lairs.

Creating new channels in the ice by icebreaking may further affect ringed seals by altering ice dynamics, which could benefit or harm ringed seals (Smith, 1987; Smiley and Milne, 1979, Mansfield, 1983). A Canadian Department of Fisheries and Oceans (DFO) study suggested ringed seals tend to remain on the ice or in their breathing holes just a few tens of meters away from vessels moving through pack ice. After a ship had passed, the seals generally moved into the ship's track, treating the track as a natural opening in the ice (Strandberg et al., 1984).

To address the potential for icebreaking to adversely affect the ice habitat itself or alter the mechanical behavior of the surrounding ice, a literature review and analysis was conducted by subject matter experts with an emphasis on the Arctic (Mahoney, 2010). This review and analysis suggested that icebreaker activity in fall/winter, when temperatures are cold and the ice is forming quickly, have very little impact on the availability of ice as habitat. Icebreaker track lines refreeze very quickly, within a matter of several hours in many cases. Icebreaker effects are overshadowed by the natural variation in land fast ice, which involves constant re-breaking, and even more so in pack ice. In spring when the ice is melting and retreating further north the effects would be more prolonged and widespread. Any icebreaking activity in spring/summer could open new leads which could remain open and expand as the open water absorbed more light and further melting occurred.

Icebreaker noise associated with activities of the First Incremental Step may affect ice seals. In the Davis and Malme (1997) study, noise levels from the M/V *Arctic* were 5–10 dB higher for ice

breaking astern compared to ice breaking ahead. Even though there is a rapid attenuation of noise under heavy sea ice, the noise caused by ice breaking may be detected by ringed seals at ranges of 20–25 km at a water depth of 50 m and at about 25–35 km in water 100 m deep. The study also determined avoidance behavior would be displayed by seals 500–700m from such an activity, and so hearing damage was unlikely.

Mansfield (1983) reasoned that an icebreaker approaching a ringed seal at full power while breaking ice could be heard by ringed seals from 40 km (about 25 mi) away in Lancaster Sound, Canada. Ringed seals pups may also be at risk of abandonment by their mothers as a result of disturbance by icebreakers (Smiley and Milne, 1979).

During one study in the Northwest Territories (Alliston, 1980), and another in Lake Melville, Labrador (Alliston, 1981), the abundance of ringed seals was not adversely affected by icebreakers and it was assumed that ringed seal mortalities from icebreakers would only occur if the seal had no avenues of escape.

Some seals are known to approach vessels out of apparent curiosity, including noisy vessels such as those operating seismic airgun arrays (Moulton and Lawson, 2000). In contrast, seals hauled out on land often are quite responsive to nearby vessels. Terhune (1985) reported that Northwest Atlantic harbor seals were extremely vigilant when hauled out, and were wary of approaching (but less so passing) boats. Suryan and Harvey (1999) reported that Pacific harbor seals commonly left the shore when powerboat operators approached to observe the seals. Those seals detected a powerboat at a mean distance of 264 m, and seals left the haul-out site when boats approached to within 144 m.

Jansen et al. (2006) reported that harbor seals approached by ships at 100 m were 25 times more likely to enter the water than were seals approached at 500 m. However, they also reported that seal abundance in Disenchantment Bay, Alaska steadily increased during the summer in concert with increasing ship traffic (i.e., no short term avoidance of areas used by ships), suggesting that changes in overall abundance were influenced by other factors. Harbor seals in their study area did aggregate more closely with increasing ship presence, similar to studies of other marine mammals that show denser aggregations during periods of disturbance.

During vessel-based marine mammal monitoring of Shell's 2012 exploratory drilling in the Chukchi Sea (Bisson et al., 2013), a total of 34 seals were observed during ice management activities. The majority of the seals responded to ice management activities in the manner described previously for vessel traffic, displaying either no observable response or looking at the vessel.

Research suggests that bearded seals may exhibit fidelity to distinct areas and habitats during the March to June breeding season (Van Parijs and Clark, 2006). Any vessel traffic occurring as part of the First Incremental Step that were to occur during this period could disturb bearded seals in the pack ice; however vessels without icebreaker support are expected to avoid these areas by a large margin due to the risks associated with navigating large amounts of sea ice.

5.2.1.2. Potential Effects of Aircraft Traffic

Aircraft traffic associated with First Incremental Step activities of the Proposed Action could affect listed species due to presence and airborne noise. Two types of aircraft are anticipated to be used during proposed activities of the First Incremental Step: fixed-wing and helicopter. Little aircraft traffic is anticipated in association with marine surveys during the First Incremental Step. During exploratory drilling and onshore construction, up to six round-trip flights (primarily using helicopters) could occur each day, primarily to transport crew, small equipment, and supplies from Wainwright or Barrow to operation sites. Additional details regarding aircraft traffic during the First Incremental Step of the Proposed Action are presented in Section 2.2.1.1.6 of this BA. The potential impacts of these aircraft types to listed marine mammals are evaluated in the following sections.

5.2.1.2.1. Fixed-Wing Aircraft

Under the First Incremental Step of the Proposed Action, exploration surveys and drilling operations could be supported by fixed-wing aircraft. Fixed-wing operations are typically used to monitor and assess marine mammal habitat use, distribution, movement, behavior before, during, and after seismic surveys and drilling operations occur. Monitoring surveys are typically conducted with aircraft flying above 1,500 ft AGL/ASL unless safety due to weather or other factors becomes an issue. Greene and Moore (1995:102–105) explained fixed wing aircraft typically used in offshore activities were capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB re 1 μ Pa-m at the source.

Fixed-wing aircraft flying at low altitude often cause bowhead whales to make hasty dives (Richardson and Malme, 1993). Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowhead whales sometimes caused abrupt turns and hasty dives.

Aircraft on a direct course usually produce audible noise for only tens of seconds, and the whales are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowhead whales (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60–460 m. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowhead whales occurred when the Twin Otter was at altitudes of 182 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowhead whales when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

Individual whale responses appear to vary depending on flight altitude and received sound levels. For example, Shallenberger (1978) reported some humpback whales were disturbed by overflights at 1,000 ft (305 m), whereas others showed no response at 500 ft (152 m).

Fixed-wing aircraft flying at altitudes below 60–120 m at times cause panic among adult harbor seals and mortality of young at beach haulouts (Johnson, 1977; Bowles and Stewart, 1980; Osborn, 1985). However, seals habituated to aircraft may show little or no reaction (Johnson et al., 1989; Richardson, 1995c).

Born et al. (1999) reported ringed seals showed a 21% probability of fleeing from fixed wing aircraft at 100 m from the aircraft, 6% between 100 and 300 m from the flight track, and 2% between 300 and 500 m from the flight track. The study also noted that the variables most likely to influence the probability of escaping were time of day, and temperature, while wind speed, wind exposure, ice category, and cloud cover did not improve the explanatory power of the model.

5.2.1.2.2. Helicopters

Under the First Incremental Step of the Proposed Action, drilling operations could be supported by helicopters engaged in crew and equipment transport. Most helicopter use in the Action Area would be for ferrying personnel and equipment to offshore operations and would involve turbine helicopters. Surveys and drilling operations could involve variable numbers of trips daily or weekly depending on the specific operation. The more surveys and drilling operations being conducted simultaneously the more aircraft effort and distribution of overflights would occur. Helicopter operations would be conducted 1,000 to 1,500 feet AGL/ASL unless safety due to weather or other factors becomes an issue. Greene and Moore (1995:102–110) explained helicopters commonly used in offshore activities radiate more sound forward than backwards, and are capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 151 dB re 1 μ Pa-m at the source. By radiating more noise

forward of the helicopter, noise levels will be audible at greater distances ahead of the aircraft than to the aircrafts rear.

Patenaude et al. (1997) found that most reactions by bowhead whales to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 m or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. However, the majority of bowhead whales showed no obvious reaction to single passes, even at those distances. The helicopter sounds measured underwater at depths of 3 and 18 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m ranged from 117–120 dB re 1 μ Pa in the 10–500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112–116 dB re 1 μ Pa in the 10–500-Hz band. Observations of bowhead whales exposed to helicopter overflights indicate that most bowhead whales exhibited no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowhead whales probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). Helicopter noise is generally audible for only tens of seconds. If the aircraft remains on a direct course, the whales should resume their normal activities within minutes.

Individual whale responses appear to vary depending on flight altitude and received sound levels. Humpback whales in large groups showed little or no response, but some adult-only groups exhibited avoidance (Herman et al., 1980).

Several reports document the responses of seals to low-flying aircraft. The effect is more pronounced in areas where air traffic is uncommon and with helicopters vs. fixed wing aircraft. Various responses have been elicited by aircraft on ringed seals (Kelly et al., 1986) and aircraft noise may directly affect seals which are hauled out on ice during molting or pupping, although subnivean dens may buffer some aircraft noise (Holliday, Cummings, and Bonnett, 1983; Cummings and Holliday, 1983; Kelly et al., 1986). Richardson, 1995c) noted pinnipeds hauled out for pupping or molting are the most responsive to aircraft and other authors (Burns and Harbo, 1972; Burns and Frost, 1979; Alliston, 1981) noted ringed seals often slipping into the water when approached by aircraft but not always (Burns et al., 1982).

Born et al. (1999) indicated that the disturbance of hauled out ringed seals can be substantially reduced if a small helicopter does not approach ringed seals closer than 1,500 m. There are reports of seals habituating to frequent over flights to the point where there was no reaction (Richardson, 1995c) and Hoover (1988) did not attribute seal pup mortality to low-flying aircraft, noting a temporary avoidance behavior reaction of flights over 76 m away. A greater number of ringed seals responded to helicopter presence than to fixed-wing aircraft presence, and at greater distances up to 2.3 km from the aircraft, suggesting sound stimuli trigger escape responses in ringed seal (Born et al., 1999; Smith and Hamill, 1981; Johnson, 1977). Kelly et al. (1986) also reported ringed seals leaving the ice when a helicopter was within 2 km, flying below 305 m altitude. However escape responses are not elicited consistently (Richardson, 1995c). Bearded seals hauled out on ice often dove when approached by low flying aircraft or helicopters (Burns and Harbo, 1972; Burns and Frost, 1979; and Alliston, 1981, as reported in Greene and Moore, 1995:102–110), but do not in all instances (e.g., Burns et al., 1982).

Born et al. (1999) reported that the probability of hauled out ringed seals responding to aircraft over-flights with escape responses was greatest at lateral distances of <200 m and overhead distances <150 m. Over-flights at low altitudes have caused some animals to dive (Richardson, 1995c).

Individual bearded seals have been documented exhibiting escape reactions when approached by aircraft (Richardson, 1995c; Burns and Harbo, 1972).

5.2.1.3. Potential Effects of Seismic Surveys

Results from different studies indicate that whale responses to oil and gas related noises are varied. Airguns can be of different sizes and can be combined into different array configurations. The reactions of whales and ice seals to seismic surveys have primarily been reported within the context of assessing responses to the underwater noise produced by the airgun(s) so we will focus the effects analysis on the responses to airguns.

During the First Incremental Step of the Proposed Action, seismic survey operations using airguns could be conducted 24 hrs a day. Action operation would depend on weather, sea state, ice and operational considerations. To improve operational efficiency, seismic surveys typically stay active as many days as possible. Because of delays due to weather, equipment, and other reasons, not all seismic surveys may be operated continuously, but rather may have periods when the airguns are silent or only the mitigation gun is active. Under the Proposed Action, each 3D or 2D seismic survey could last a maximum of 90 days. The First Incremental Step of the Proposed Action estimates that one marine 3D or 2D seismic survey would occur during the open-water season (July–November) and one in-ice survey would occur between October and late December (Section 2.2.1.1.1). Up to five geohazard surveys (which can involve smaller airgun arrays or other sound sources; Section 2.2.1.1.1) and up to five geotechnical surveys could occur during the First Incremental Step, with no more than one geohazard survey and one geotechnical survey occurring in any given year.

In the following subsections we describe potential effects of seismic airguns on whales and ice seals. We make a distinction between typical seismic surveys and those surveys that are sufficiently different to require a separate analysis. The categories are open-water seismic surveys and in-ice seismic surveys. This analysis addresses the potential level of effect from each type of seismic activity and does not include factors described under other sections of this document, including vessel presence and noise, aircraft presence and noise, and discharges.

5.2.1.3.1. Potential Effects of Seismic Airguns on Whales

Baleen whales are known to avoid operating airguns at variable distances. Whales often reportedly show no overt reactions to airgun pulses at distances of a few kilometers even though the airgun pulses remain well above ambient noise levels at much greater distances. However, baleen whales exposed to strong noise pulses often react by deviating from normal migration and/or feeding by moving away.

Several summaries related to the potential effects of seismic surveys have been written (e.g., Richardson, 1995c; McCauley et al., 2000; Gordon et al., 1998, 2004). Gordon et al. (1998: Section 6.4.3.1) summarized that “Given the current state of knowledge, it is not possible to reach firm conclusions on the potential for seismic pulses to cause...hearing damage in marine mammals.” Later in this review, they reach the same conclusion about the state of knowledge about the potential to cause adverse effects from masking. “This review has certainly emphasized the paucity of knowledge and the high level of uncertainty surrounding so many aspects of the effects of sound on marine mammals” (Gordon et al., 1998: Section 6.12).

The results of studies on the effects of seismic survey noise on bowhead whales have varied, in some cases considerably (Gordon et al., 2004; Miller et al., 2005; Moulton and Miller, 2005; Stone and Tasker, 2006; Gailey et al., 2007; Yazenko et al., 2007a, b). Unfortunately, the variables used between studies were not consistent and studies are not directly comparable. These differences included the type of seismic survey (2D versus 3D), the location of the study, and the year in which the study was conducted. Ice and other weather-related factors and use of total available habitat by bowhead whales varied among years. Some of the studies employed different methodologies, some of which have been criticized by peer reviewers and others of which are more widely adopted.

Multiple factors may be important in a whale's response (McCauley et al., 2000a). In some studies, these factors have been shown to include the physical characteristics of the location into which the sound is released and the physical characteristics of the location where the whale is located at the time the sound is released; group composition; whale behavior (e.g., migrating or feeding); specific characteristics of the sound (e.g., frequency, duration, etc.), and, perhaps, previous exposure to seismic noise.

During the 1980s, the behavior of bowhead whales exposed to noise pulses from seismic surveys was observed during the summer in the Canadian Beaufort Sea and during the fall migration across the U.S. Beaufort Sea. The majority of seismic surveys conducted during the 1980s were 2D seismic surveys that covered fairly large areas in nearshore, relatively shallow waters to deeper waters. Reeves, Ljungblad, and Clarke (1983) conducted aerial surveys to observe bowhead whale behavior in the presence of active seismic vessels. Whales were observed as close as 3 km (1.86 mi) and as far away as 135 km (83.9 mi) from active seismic vessels. A pair of whales observed at a distance of 3 km (1.83 mi) were not moving while at the surface although the two whales' heads were in contact. This pair of whales was closer to a shooting seismic vessel than any other whales observed during the study. No obvious response was apparent, but the observation time was brief. The received level of low-frequency underwater sound from an underwater source is generally lower by 1–7 dB re 1 μ Pa (rms) near the surface (depth of 3 m) than at deeper (greater than 9 m) depths (Greene and Moore, 1995:142).

For the group of 20 whales at a distance of approximately 135 km (83.9 mi), the blow frequency per surfacing and time at the surface was greater during the period immediately after the seismic vessel began shooting than before it began shooting. The authors stated that no substantial changes in whale behavior (such as flight reactions) were observed that could unequivocally be interpreted as responses to seismic noise. They noted a possible exception of "huddling behavior", which they thought may have been caused by the onset of seismic sounds. The authors concluded that although their results suggest some changes in behavior related to seismic sounds, the possibility that unquantified factors could be correlative dictates caution in attempting to establish causative explanations from these findings.

Ljungblad et al. (1985) also reported findings from early tests of bowhead reactions to active seismic vessels in the Beaufort Sea. However, methodological problems with this early study preclude us from drawing conclusions about probable bowhead reactions based on its findings. A subcommittee of the Scientific Committee of the IWC previously reviewed the data from this study and some members were critical of the methodology and analysis of the results. Comments included reference to: the small sample size; inconsistencies between the data and conclusions; lack of documentation of calibration of sound monitoring; and possible interference from other active seismic vessels in the vicinity. The subcommittee acknowledged the difficulty of performing experiments of this kind, particularly in the absence of a control environment free of industrial noise.

NMFS (2001:20) noted that early tests of bowhead reactions to active seismic vessels by Ljungblad et al. (1985):

...were not conducted under controlled conditions (i.e., other noise sources were operating at the time), and approaches at greater ranges were not conducted, so results cannot be used to determine the range at which the whales first begin to respond to seismic activity.

In Fraker et al. (1985), an active seismic vessel traveled toward a group of bowhead whales from a distance of 19 km (11.8 mi) to a distance of 13 km (8.18 mi). The whales did not appear to alter their general activities. Most whales surfaced and dove repeatedly and appeared to be feeding in the water column. During their repeated surfacing and dives, they moved slowly to the southeast (in the same direction as seismic vessel travel) and then to the northwest (in the opposite direction of seismic

vessel travel). The study first stated that a weak avoidance reaction may have occurred but then stated there is no proof that the whales were avoiding the vessel. The net movement was about 3 km (1.86 mi). The study found no evidence of differences in behavior in the presence and absence of seismic noise, but noted that observations were limited.

In another study (Richardson, Wells, and Würsig, 1985) involving a full-scale seismic vessel with a 47-L airgun array (estimated source level 245–252 dB re 1 μ Pa), bowhead whales began to orient away from the approaching ship when its airguns began to fire from 7.5 km (4.7 mi) away. This airgun array had about 30 airguns, each with a volume of 80–125 cu. The *Mariner* had been shooting seismic about 10 km to the west of a group of six whales. Prior to the start of the experimental seismic period, the whales were surfacing and diving and moving at slow to medium speed while at the surface. The vessel ceased shooting and moved within 7.5 km of the whales and began firing the airgun array while approaching the whales. The study reported no conspicuous change in behavior when the *Mariner* resumed shooting at 7.5 km away. The bowhead whales continued to surface and dive, moving at slow to medium speeds. The received level was estimated at 134–138 dB at 7 km (4.35 mi). Some near-bottom feeding (evidenced by mud being brought to the surface) continued until the vessel was 3 km (1.86 mi) away.

The closest point of approach to any whale was approximately 1.5 km (0.93 mi), with the received level probably well over 160 dB. When the seismic vessel was within 1.5 km of whales at the original location, at least two of the whales were observed to have moved about 2 km to the south of the original location. The movements of the whales, at least while they were at the surface, were at the usual slow to moderate speeds. The study reported no conspicuous changes in behavior when the *Mariner* ceased shooting at 6 km beyond the whales. The bowhead whales were still surfacing and diving and moving at slow to medium speed. The most notable change in behavior apparently involved the cessation of feeding when the vessel was 3 km away. The whales began feeding again about 40 min after the seismic noise ceased. As this information pertains to whales in general, however, these distances are similar to those observed by Richardson and Malme (1993) during vessel-disturbance experiments in the Canadian Beaufort Sea. In those experiments, bowhead whales began to orient away from an oncoming vessel (non-seismic) at a range of 2–4 km (1.2–2.5 mi).

Based on early data, Richardson and Malme (1993) concluded that collectively, scientific studies have shown that most bowhead whales usually show strong avoidance response when an operating seismic vessel approaches within 6–8 km (3.8–5.0 mi). Strong avoidance occurs when received levels of seismic noise are 150–180 dB re 1 μ Pa (Richardson and Malme, 1993). Strong pulses of seismic noise often are detectable 25–50 km (15.5–31 mi) from seismic vessels, but in early studies, bowhead whales exposed to seismic sounds from vessels more than about 7.5 km (4.7 mi) away rarely showed avoidance. Seismic pulses can be detectable 100 km (62.2 mi) or more away. Bowhead whales may also show specific behavioral changes, such as reduced surfacing; reduced dive durations; changes in respiration rates, including fewer blows per surfacing, and longer intervals between successive blows; and they may temporarily change their individual swimming paths. The authors noted that surfacing, respiration, and dive cycles may be altered in the same manner as those of whales closer to the vessels. Bowhead surface-respiration-dive characteristics appeared to recover to pre-exposure levels within 30–60 min following the cessation of the seismic activity. However, we emphasize that 3D seismic may occur within an evaluation area, or within a more specific areas for the entire open water period. If bowhead whales, especially females with calves, avoided areas where they wanted to rest or feed because seismic surveys were occurring, there could be a small effect if whales moved to other nearby resting or feeding areas.

Based on 1996–1998 data, there was little or no evidence that bowhead headings, general activities, or swimming speeds were affected by seismic exploration. Bowhead whales approaching from the northeast and east showed similar headings at times with and without seismic operations. Miller et al. (1999) stated that the lack of any statistically significant differences in headings should be interpreted cautiously. Changes in headings must have occurred given the avoidance by most bowhead whales of

the area within 20 or even 30 km of active seismic operations. Miller et al. (1999) noted that the distance at which deflection began cannot be determined precisely, but they stated that considering times with operations on offshore patches, deflection may have begun about 35 km to the east. However, some bowhead whales approached within 19–21 km of the airguns when they were operating on the offshore patches. It appears that in 1998, the offshore deflection might have persisted for at least 40–50 km west of the area of seismic operations. In contrast, during 1996–1997, there were several sightings in areas 25–40 km west of the most recent shotpoint, indicating the deflection in 1996–1997, may not have persisted as far to the west.

Miller et al. (1997) reported on a marine mammal monitoring program for a seismic survey near the Northstar Development Project in 1996. The marine mammal monitoring program was continued for subsequent seismic surveys in nearshore waters of the Beaufort Sea in 1997 and 1998 (Miller, Elliot, and Richardson, 1998; Miller et al., 1999). These studies indicated that the bowhead whale-migration corridor in the central U.S. Beaufort Sea during 1998 was similar to the corridor in many prior years, although not 1997. In 1997, nearly all bowhead whales sighted were in relatively nearshore waters. The results of the 1996–1998 studies indicated a tendency for the general bowhead whale-migration corridor to be farther offshore on days with seismic airguns operating compared to days without seismic airguns operating, although the distances of bowhead whales from shore during airgun operations overlapped with those in the absence of airgun operations. Aerial-survey results indicated that bowhead whales tended to avoid the area around the operating source, perhaps to a radius of about 20–30 km.

Sighting rates within a radius of 20 km of seismic operations were lower during seismic operations than when no seismic operations were happening. Within 12–24 hrs after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km. There was little or no evidence of differences in headings, general activities, and swimming speeds of bowhead whales with and without seismic operations. Overall, the 1996–1998 results show that most bowhead whales avoided the area within about 20–30 km of the operating airguns. Within 12–24 hrs after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km. The observed 20–30 km area of avoidance is a larger avoidance radius than documented by previous scientific studies in the 1980s and smaller than the 30 mi suggested by subsistence whalers, based on their experience with the types of seismic operations that occurred in the Beaufort Sea before 1996 (Richardson, 2000).

Based on recordings of bowhead whale calls made during these same studies, Greene et al. (1999), summarized that results for the 3 years of study indicated that: (1) bowhead whales call frequently during the autumn migration through the study area; (2) calling continued at times when whales were exposed to airgun pulses; and (3) call-detection rates at some locations differed significantly when airguns were detectable versus not detectable. However, there was no significant tendency for the call-detection rate to change in a consistent way at times when airguns started or stopped. Several explanations have been offered to explain possible changes whale vocalizations in the vicinity of airgun operations; including whale orientation/movements or the potential for whales to be quieter in order to better listen to received sounds. Airgun sounds are unlikely to result in masking effects because of the silent periods between seismic pulses.

Richardson (1997) provided a brief comparison between observations from seismic studies conducted in the 1980s and the 1996 seismic survey at the Arctic Seismic Synthesis Workshop in Barrow (USDOI, MMS, 1997). Observations from earlier seismic studies during the summer and early autumn show that most bowhead whales interrupt their previous activities and swim strongly away when a seismic ship approaches within about 7.5–8 km. At the distances where this strong avoidance occurs, received levels of seismic pulses typically are high, about 150–180 dB re 1 μ Pa (rms). The surfacing, respiration, and dive cycles of bowhead whales engaged in strong avoidance also change in a consistent pattern involving unusually short surfacing and diving and unusually few blows per surfacing. These avoidance and behavioral effects among bowhead whales close to seismic vessels

are strong, reasonably consistent, and relatively easy to document. Less consistent and weaker disturbance effects probably extend to longer distances and lower received sound levels at least some of the time. Bowhead whales often tolerate much seismic noise and, at least in summer, continue to use areas where seismic exploration is common.

However, at least one case of strong avoidance has been reported as far as 24 km from an approaching seismic boat (Koski and Johnson, 1987) and, as noted above, the aerial survey data (Miller et al., 1999) indicated that bowhead whales tended to avoid the area around the operating source, perhaps to a radius of about 20–30 km.

Richardson (1997) noted that many of the observations involved bowhead whales that were not actively migrating. Actively migrating bowhead whales may react somewhat differently than bowhead whales engaged in feeding or socializing. Migrating bowhead whales, for instance, may react by deflecting their migration corridor away from the seismic vessel. Monitoring of the bowhead whale migration past a nearshore seismic operation in September 1996 provided evidence consistent with the possibility that the closest whales may have been displaced several miles seaward during periods with seismic activity.

A study in Canada provides information on the behavioral response of bowhead whales in feeding areas to seismic surveys (Miller and Davis, 2002). During the late summer and autumn of 2001, Anderson Resources Ltd. conducted an open-water seismic exploration program offshore of the Mackenzie Delta in the Canadian Beaufort Sea. The program consisted of streamer seismic surveys and associated bathymetric surveys conducted off the Mackenzie Delta. The bathymetric surveys were conducted by two medium-sized vessels equipped with side-scan sonar and single-beam echo sounders. The seismic vessel was the *Geco Snapper*. The acoustic sources used in the seismic operations were two 2,250 cui arrays of 24 sleeve-type airguns. Each 2,250 cui airgun array was comprised of 24 airguns with volumes ranging from 40–150 cui. The two airgun arrays fired alternately every 8 sec along the survey lines. The airgun arrays were operated at a depth of 5 m below the water surface. Water depths within the surveyed areas ranged from 6–31 m and averaged 13 m (Miller, 2002). Because marine seismic projects using airgun arrays emit strong sounds into the water and have the potential to affect marine mammals, there was concern about the acoustic disturbance of marine mammals. A monitoring program consisted of three primary components: acoustic measurements, vessel-based observations, and aerial surveys. Estimates of sound-propagation loss from the airgun array were used to determine the designated 1,000-m safety radius for whales (the estimated zone within which received levels of seismic noise were 180 dB re 1 μ Pa (rms) or higher).

Aerial and vessel-based surveys confirmed the presence of substantial numbers of bowhead whales offshore of the Mackenzie Delta from late August until mid-September. The distribution of bowhead whales in the study area was typical of patterns observed in other years and suggests that there were good feeding opportunities for bowhead whales in these waters during that period.

A total of 262 bowhead whales were observed from the seismic vessel *Geco Snapper* (Moulton, Miller, and Serrano, 2002). Sighting rates during daylight hours were higher when no airguns were operating than during periods with airguns operating. During the period when bowhead whales were most abundant in the study area (August 23–September 19), the bowhead sighting rate during periods with no seismic (0.85 bowhead whales/hr) was about twice as high as that recorded during periods with seismic (0.40 bowhead whales/hr) or all seismic operations combined (0.44 bowhead whales/h). Average sighting distances from the vessel were significantly lower during no airguns (a mean radial distance of 1,368 m) versus line-seismic periods (a mean radial distance of 1,957 m). The observed difference in sighting rates and the significant difference in sighting distances suggest that bowhead whales did avoid close approach to the area of seismic operations. However, the still substantial number of sightings during seismic periods and the relatively short (600 m) but significant difference in sighting distances suggests that the avoidance may have been localized and relatively small in

nature. At a minimum, the distance by which bowhead whales avoided seismic operations was on the order of 600 m greater than the average distance by which they avoided general vessel operations. The lower sighting rates recorded during seismic operations suggest that some bowhead whales avoided the seismic operations by larger distances and stayed out of visual range of the PSOs on the *Geco Snapper*.

Holst et al. (2002) reported a total of 275 bowhead whale sightings were recorded during aerial transects with good lighting conditions. Bowhead whales were sighted at similar rates with and without seismic, although the no feeding-seismic sample was too small for meaningful comparisons. Bowhead whales were seen regularly within 20 km of the operations area at times influenced by airgun pulses. Of 169 transect sightings in good conditions, 30 sightings were seen within 20 km of the airgun operations at distances of 5.3–19.9 km. The aerial surveys were unable to document bowhead avoidance of the seismic operations area. The area of avoidance around the seismic operations area was apparently too small to be evident from the aerial surveys that were flown, especially considering the small amount of surveying done when seismic was not being conducted. General activities of bowhead whales during times when seismic operations were conducted were similar to times without seismic.

The bowhead whales that surfaced closest to the vessel (323–614 m) would have been exposed to sound levels of about 180 dB re 1 μ Pa rms before the immediate shutdown of the array (Miller et al., 2002). There were seven shutdowns of the airgun array in response to sightings of bowhead whales within 1 km of the seismic vessel. Bowhead whales at the average vessel-based sighting distance (1,957 m) during line seismic would have been exposed to sound levels of about 170 dB re 1 μ Pa (rms). The many aerial sightings of bowhead whales at distances from the vessel ranging from 5.3–19.9 km would have been exposed to sound levels ranging from approximately 150–130 dB re 1 μ Pa (rms), respectively.

The results from the study in summer 2001 are markedly different from those obtained during similar studies during the autumn migration of bowhead whales through the U.S. Beaufort Sea (Miller et al., 2002). For example, during the Alaskan studies only 1 bowhead whale was observed from the seismic vessel(s) during six seasons (1996–2001) of vessel-based observations compared with 262 seen from the *Geco Snapper* in 2001. The zone of avoidance for bowhead whales around the airgun operations in 2001 was clearly much smaller (~2 km) than that observed for migrating bowhead whales in recent autumn studies in Alaskan waters (up to 20–30 km). Davis (1987) concluded that migrating bowhead whales during the fall migration may be more sensitive to industrial disturbance than bowhead whales on their summering grounds, where they may be engaged in feeding activities. Densities of feeding whales are greater in the Canadian Beaufort Sea during summer.

There are also data on the effect of seismic surveys on other species that are useful in interpretation of effects on baleen whales. McCauley et al. (2000a, b) studied the responses of humpback whales to seismic surveys in Australia. McCauley et al. (2000a, b) reported that pods of humpback whales containing cows involved in resting behavior in sheltered bays and island groups (considered by McCauley et al. (2000a, b) to be key habitats) could be more sensitive to airgun noise than males and than pods of migrating humpback whales. In 16 approach trials carried out in Exmouth Gulf, off Australia, McCauley et al. (2000a, b) reported that pods of humpback whales with resting females consistently avoided a single (20 in³) operating airgun at an average range of 1.3 km. Standoff ranges were 1.22–4.4 km. McCauley et al. (2000a, b) also reported a single a startle response. As this information pertains to whales in general, however, these distances are similar to those observed by Richardson and Malme (1993) during vessel-disturbance experiments in the Canadian Beaufort Sea. In those experiments, bowhead whales began to orient away from an oncoming vessel at a range of 2–4 km (1.2–2.5 mi).

Females and females with calves in key habitats were believed to show increased sensitivity to a single airgun. McCauley et al. (2000a, b) used an algorithm to scale the noise from the single airgun

to a larger array and calculated the mean airgun level at which they predicted whale avoidance could occur was 140 dB re 1 μ Pa (rms), the mean standoff range could be 143 dB re 1 μ Pa (rms), and the startle response could be at 112 dB re 1 μ Pa (rms) for groups of female humpback whales in these protected areas. The estimated noise levels at which a response were calculated to occur were considerably less than those published for gray and for bowhead whales. They were also less than those observed by McCauley et al. (2000a, b) in observations made from the seismic vessel operating outside of the resting habitats, where whales were migrating and not resting.

McCauley et al. (2000a, b) also found that adult male humpback whales were less sensitive to airgun noise than were females. At times, males closely approached the seismic vessel. McCauley et al. (2000a, b) suggested males that did so may have been attracted by airgun sounds because of similarities between those sounds and the sounds of breaching male humpback whales. McCauley et al. (2000a, b) stressed that this conclusion was speculative.

Fin and minke whales have regularly been reported in areas of the North Atlantic ensonified by airgun pulses. Sightings by observers on seismic vessels (201 surveys) of the United Kingdom from 1997–2000 suggest that at times of good sight-ability, numbers of large baleen whales were similar when airguns were active and inactive (Stone and Tasker, 2006). Although the available data for individual species did not show significant displacement in relation to seismic surveys, when data from all baleen whales was combined, median distances (Closest Point of Approach= CPA) from airguns were found to be significantly larger (approximately 1,600 meters vs. 1,000 meters; see Figure 4, Stone and Tasker, 2006) and whales tended to head away from the vessel during seismic versus non-seismic periods (Stone and Tasker, 2006). Ship-based monitoring studies of baleen whales (blue, fin, sei, and minke) off shore Newfoundland found no more than small differences in sighting rates and swim directions during seismic vs. non-seismic periods (Moulton et al., 2005). The CPA of baleen whales sighted from seismic vessels in the Orphan Basin during 2004 was, on average, significantly closer during non-seismic period compared to seismic periods (means 1,526 m versus 2,316 m, respectively), but did not differ significantly in the Orphan Basin or the Laurentian Basin during 2005. These studies concluded that, based on observations from the seismic vessel, some Mysticetes exhibited localized avoidance of seismic operations (Moulton et al., 2005).

The IWC (2004a, b) discussed the potential displacement of western Pacific gray whales from a feeding area off of Sakhalin Island by seismic surveys and agreed that there was compelling evidence of increasing sound levels, including sound from ships and seismic activities.

Weir (2008) noted that encounter rates (sightings/hour) of humpback whales did not differ significantly according to airgun (array volumes of either 5,085 cui or 3,147 cui) operational status. The mean distance to humpback whales was greater during full-array operations but the difference was not significant.

Weller et al. (2004) tested the hypothesis that the distribution of feeding western gray whales would shift away from seismic surveys by comparing the number of feeding western gray whales and the number of pods sighted during systematic scans conducted before, during, and after 3D seismic surveys. These authors found that both the number of whales and the number of pods sighted were significantly different during 3D seismic surveys than before and after the surveys concluded that “Disruption of feeding in preferred areas is a biologically significant event that could have major negative effects on individual whales, their reproductive success, and thus the population as a whole.”

Seismic activity should have little effect on zooplankton. Bowhead whales feed on concentrations of zooplankton. Zooplankton that is very close to the seismic source may react to the shock wave, but little or no mortality is expected (LGL Ltd., 2001). A reaction by zooplankton to a seismic impulse would be relevant only if it caused a concentration of zooplankton to scatter. Pressure changes of sufficient magnitude to cause zooplankton to scatter probably would occur only if they were very close to the source. LGL Ltd. (2001) predicted impacts of seismic surveys on zooplankton behavior are negligible and are not likely to adversely affect feeding bowhead whales.

5.2.1.3.2. Potential Effect of Seismic Airguns on Ice Seals

The pulsed sounds associated with seismic exploration have higher peak levels than most other industrial sounds to which ice seals are routinely exposed. Most ice seals spend greater than 80% of their time submerged in the water (Gordon et al., 2003); consequently, some could be exposed to sounds from seismic surveys that occur in their vicinity. Underwater audiograms for ice seals suggest that they have very low hearing sensitivity below 1 kHz, though they can hear underwater sounds at frequencies up to 60 kHz, making calls between 90 Hz and 16 kHz (Thomson and Richardson, 1995; Richardson et al., 1995a). The auditory bandwidth for pinnipeds in water is approximately 75 Hz to 75 kHz (Southall et al., 2007), and while seismic surveys can contain sound up to 1 kHz, most of the emitted sound is less than 200 Hz. Gordon et al. (2003) suggested that phocids may be susceptible to the masking of biologically important signals by low frequency sounds, such as those from seismic surveys, and while brief, small scale masking episodes might have few long term consequences.

Reported seal responses to seismic surveys have been variable and often contradictory, although they suggest ice seals often remain within a few hundred meters of operating airgun arrays (Brueggeman et al., 1991, Harris, Miller, and Richardson, 2001, Miller and Davis, 2002). Brueggeman et al. (1991) reported that 96% of the seals they encountered during seismic operations in the Beaufort Sea were encountered during non-data acquisition activities, suggesting avoidance of active data acquisition operations, and Miller et al. (2002) reported that on average seals in the Beaufort Sea were spotted at 150 m from vessels when seismic surveys were inactive as opposed to 210 m when seismic surveys were being conducted, with sound levels of 190 dB re 1 μ Pa (rms) extended out to 210 m. Harris, Miller, and Richardson (2001) observed sighting rates of ringed seals from a seismic vessel in the Beaufort Sea showed no difference between periods using the full airgun array, a partial array, or no airguns, although the mean distances to seals increased during full array operations, indicating some local avoidance at 190–200 dB re 1 μ Pa (rms) noise levels. 2001 tagging studies (Cott et al., 2003) reported seismic surveys in the Beaufort Sea had no obvious effect on the timing or route of ringed seals migrating in the fall. These observations provide limited support to the TTS and PTS injury criteria as outlined in Southall et al. (2007) and localized avoidance by ringed seals (Harris, Miller, and Richardson, 2001). In contrast, telemetry work by Thompson, Duck, and McConnell (1998) (as cited in Gordon et al., 2004) suggests that avoidance and behavioral reactions to small airgun sources could be more pronounced than ocular observations indicate.

Funk et al. (2009) reported the highest PSO effort was required where noise levels were <120 dB re 1 μ Pa during 2006–2008 Beaufort and Chukchi Sea seismic survey activities. In the same report pinniped sighting rates from monitoring vessels in the Beaufort and Chukchi Seas were higher than those from seismic vessels, with the highest rates occurring in the <120 dB re 1 μ Pa zone, suggesting localized avoidance of active seismic vessels.

During a 2010 seismic survey in the Chukchi Sea, PSOs from the seismic vessel had the highest sighting rate in the ≥ 160 dB re 1 μ Pa zone, while PSOs on the monitoring vessels had their highest sighting rates in the 159–120 dB re 1 μ Pa (rms) (Blees et al., 2010). PSOs on both vessels observed roughly similar sighting rates of 12.5/1,000 km (seismic vessel) and 11.8/1,000 km (monitoring vessels) during periods of non-seismic activity or when dB levels were <120 dB re 1 μ Pa (rms). Results from Blees et al. (2010) conflict with the position that seismic surveys would likely displace ringed seals from an area where received noise levels are in excess of 159 dB re 1 μ Pa (rms) since monitoring vessels enjoyed their highest seal sighting rates from monitoring vessels in the 159–120 dB re 1 μ Pa (rms) zone (18.8/1,000 km) as opposed to the seismic vessel where the highest seal sighting rate was in the ≥ 160 dB re 1 μ Pa (rms) zone (31.5/1,000 km). Although 146 seals were observed from the seismic vessel during airgun operations only ten were detected in the ≥ 190 dB re 1 μ Pa (rms) zone, while 154 seals were observed by monitoring vessels where there was no ≥ 190 dB re 1 μ Pa (rms) zone.

Ultimately Blees et al. (2010) estimated 416 ringed seals may have been exposed to approximately 21 airgun pulses each with pulses ≥ 160 dB re 1 μ Pa (rms), based on the assumption that approximately 19.1% (416 of 2180) of the seals observed were ringed seals. By applying this 19.1% estimate to the number of seals observed in the ≥ 190 dB re 1 μ Pa zone (rms) (652), a rough estimate ($0.191 \times 652 = 124.5 \approx 125$ seals) can be derived suggesting 125 ringed seals were exposed to noise levels ≥ 190 dB re 1 μ Pa (rms) for approximately 2 times each if there was no avoidance of the sound source. Caution should be used in interpreting this calculation since Blees et al. (2010) did not specify the ringed seals estimate for the ≥ 190 dB re 1 μ Pa zone, because the estimate of 652 exposed seals is much higher than the 10 seals that were actually witnessed in the zone, and because the author states that the actual numbers of seals exposed to RSL ≥ 190 dB re 1 μ Pa (rms) was likely greater than the ten observations but lower than the estimate of 652 seal exposures.

Similarly, Blees et al. (2010) estimated 1,681 bearded seals may have been exposed to approximately 21 airgun pulses, each with pulses ≥ 160 dB re 1 μ Pa (rms), based on the assumption that $\sim 77\%$ of the seals observed were bearded seals. By applying the 77.1% estimate to the number of seals observed in the ≥ 190 dB re 1 μ Pa zone (652), a rough estimate ($0.771 \times 652 = 502.75 \approx 503$ bearded seals) can be derived, suggesting 503 bearded seals were exposed to noise levels ≥ 190 dB re 1 μ Pa (rms) approximately two times each if there was no avoidance of the sound source. Caution should be used in interpreting this calculation since Blees et al. (2010) did not specify the bearded seals estimate for the ≥ 190 dB re 1 μ Pa zone, because the estimate of 652 exposed seals is much higher than the ten seals that were actually witnessed in the zone, and because the author states that the actual numbers of seals exposed to RSL ≥ 190 dB re 1 μ Pa (rms) was likely greater than the ten observations but lower than the estimate of 652 seal exposures.

Seismic surveying has limited potential to affect fishes and some invertebrate species that make up the ringed seal diet (USDOI, MMS, 2006). The primary prey species for ringed seals from the late fall into the spring is Arctic cod. Potential effects to some prey species (i.e., some teleost fishes) may include displacement from foraging, staging, or spawning areas. For some species the displacement may last for days, weeks, or longer. If seismic surveys cause prey items to become scarce, either because they move out of an area or become more difficult to catch, seal distributions and feeding rates could be affected, especially newly weaned ringed seal pups (Gordon et al., 2004). The opposite potentially could occur because damaged or disoriented prey could attract ice seals to seismic-survey areas, providing robust short-term feeding opportunities (Gordon et al., 2004).

Southall et al. (2007) proposed that PTS could occur to pinnipeds exposed to single sound pulses at 218 dB re: 1 μ Pa (rms) in water, however, injury from seismic surveys may occur only if animals entered the zone immediately surrounding the sound source since noise loss occurs rapidly with distance from operating airguns.

5.2.1.3.3. Potential Effects of In-Ice Seismic Surveys on Marine Mammals

Under the Proposed Action, one in-ice survey would occur during the First Incremental Step (Section 2.2.1.1.1). In-ice seismic surveys were developed largely to decrease the potential for adverse effects to certain marine mammals that are present during the open-water season, particularly the bowhead whale (an important subsistence species). In the Arctic Region, the location and timing of operations are planned to avoid the highest bowhead whale concentrations and subsistence hunting activities from coastal villages. While there may be somewhat different aspects of particular in-ice projects as future technology evolves, to date only one in-ice survey has occurred recently in the Chukchi Sea: a project conducted by ION in 2012 (Beland et al., 2013). The potential effects of in-ice surveys evaluated below are primarily based this survey record. Many impacts of in-ice surveys would be expected to be similar to and include the impacts of ice-breakers conducting ice management (see Section 5.2.1.1, Potential Effects of Vessel Traffic: Icebreaker Activities). Potential noise effects from in-ice survey seismic sources are anticipated to be the same as those for open-water surveys; as a

result, typical mitigation procedures (seismic array ramp ups, delayed ramp ups, power downs, and shut downs), and monitoring measures would be expected to be similar.

For the 2012 ION in-ice project, the seismic survey vessel (M/V *Geo Arctic*) used a 26-airgun configuration (4380 cui total airgun volume) for seismic data acquisition and a single 70 cui airgun for mitigation purposes. The single 70 in³ airgun was used during turns and brief periods between full airgun array operations to discourage marine mammals from approaching and being exposed to higher-level sounds from the 4380 in³ array when it was ramped up. This is similar to open-water operations. The M/V *Geo Arctic* was escorted by the medium class (100A) icebreaker M/V *Polar Prince* during some survey operations in open-water and during most (~97%; 360 km or 224 mi) survey operations when ice was present and in heavily (≥80%) ice-covered waters. PSOs aboard the *Geo Arctic* and the *Polar Prince* collected data during the operations.

The survey commenced on October 20th with the initiation of SSV; all SSV was completed in the Beaufort Sea. Distances from the airgun sources to rms sound pressure level thresholds between 190 and 120 dB re 1 μ Pa (rms) in 10-dB steps were determined in shallow (approximately 50 m depth) and deep (approximately 500 m depth) water. Underwater sound propagation was substantially different between the shallow and deep sites; sound generally propagated further at the shallow site than at the deep site. SSV was used to define exclusion zones that were implemented in the field by PSOs onboard the survey vessels (see Beland et al., 2013; Table 3.18). These differed from the exclusion zones modeled for the IHA (see Beland et al., 2013; Table 3.15) which had overestimated distances to lower level thresholds. Therefore, after the SSV, marine mammal safety zone distances were reduced. They were further refined after the field season and after modeling, and were used to estimate the number of marine mammals potentially exposed to various sound levels. The final ≥190-dB and ≥180-dB safety radii for the 4,380 cui array gun for marine mammals in shallow water was 0.3 km and 2.3 km respectively (Beland et al., 2013; Table 4.1). The final ≥190 dB and ≥180 dB safety radii for the full array in deep waters was 0.4 km and 1.3 km, respectively (Beland et al., 2013; Table 4.1).

No cetaceans observed during ION's seismic survey exhibited a discernible reaction to the vessel (Beland et al., 2013). Most of the initial seals (81%) observed were seals looking or resting (i.e., showing no disturbance response); however, in the Chukchi Sea there were a significantly higher number of seal sightings resting than in the Beaufort Sea. This difference is likely because the majority of the survey operations occurred later in the season in the Chukchi Sea, when there were higher concentrations of ice on which seals could haul out (Beland et al., 2013). Most of the remaining behaviors of seals sighted from both vessels were swimming, surface-active, or diving. Seals were most often recorded as having no reaction (89%), while the second-most observed seal reaction to both vessels was looking at the vessel (Beland et al., 2013).

Sound source level verification was conducted during ION's 2012 in-ice for all vessels. Sound levels from transiting vessels were calculated using data from periods when the airguns were not operating or from periods between airgun pulses. The calculated distances to the 120-dB threshold for the M/V *Geo Arctic* and M/V *Polar Prince* transiting at the shallow site were 1,420 and 943 m, respectively. The M/V *Polar Prince* did not conduct icebreaking activities during the SSV.

The SSV measurements were completed on 23 October and seismic data collection began on October 24th. Survey activities continued in the Beaufort Sea until November 9th, at which time the seismic equipment was recovered and the vessels transited to the Chukchi Sea. One seismic line in the Chukchi Sea was surveyed on November 14th and 15th before the vessels began transiting out of the area. ION collected 1,844 km (1,146 mi) of seismic data in the Beaufort and Chukchi seas in 2012. Periods of full array firing including periods of lead-in, lead-out, seismic testing, and ramp-up occurred along 2,408 km (1,496 mi) of trackline. During turns from one seismic line to the next, during testing of a single airgun, and during power-down periods for marine mammals observed within the safety radii of the full airgun array, the single mitigation gun was operated along 583 km

(362 mi) of vessel trackline. Thus, one or more airguns were operated along 2991 km (1,858 mi) of total trackline in the Beaufort and Chukchi seas in 2012.

No power-downs or shut-downs of the airguns occurred for any marine mammals as all sighting were outside the safety zones established at the time of survey. However, there would have been seven power-downs if the safety radii established after the field season had been used. Based on direct observations, 64 bowhead whales and two seals (species unknown) were likely exposed to airgun sounds above the 160-dB (rms) disturbance threshold. However, based on the final analysis of the SSV measurements, it was estimated that seven bowhead whales and one bearded seal were likely exposed to airgun sounds above the 180-dB (rms) disturbance threshold. Based on densities calculated from observational data collected during the survey, around 3,000 bowhead and 1,000–4,500 seals (species unknown) may have been present during survey activities.

Whales: The in-ice survey anticipated during the First Incremental Step of the Proposed Action would use an icebreaker to break newly formed ice ahead of the seismic source vessel. The source vessel would tow an underwater airgun array. Depending on the timing and location of an in-ice survey, some whales could be disturbed by noise from both the ice breaking and airgun sound sources if they are in the vicinity of newly forming ice. Only whales associated with early-season ice have some potential to be affected and these whales would be among the last cetaceans migrating out of the Action Area for winter. As was the case with reactions to icebreakers and seismic sounds, these migrants could alter their migration path slightly to avoid survey operations.

Ice Seals: During the First Incremental Step of the Proposed Action, operation of the icebreaker and seismic vessel could disturb ringed seals and bearded seals, causing them to temporarily leave the in-ice survey area. This disturbance could result in the energetic cost of moving away from the seismic operations. As with other seismic surveys, short-term impacts to Arctic cod from in-ice surveys could lead to short term localized impacts on ice seal prey availability.

Conversely, some ice-seals may be drawn to the open water created by the icebreakers and may remain within the area in spite of the seismic activity. This could lead to an increase in masking or TTS. The 190-dB received sound level typically varies from 215 m to 670 m depending upon water depth. The modeled NMFS Level A harassment radius (190-dB zone for seals) would be vacated in 5.4 min.

5.2.1.4. Potential Effects from Onshore Base Construction

The First Incremental Step of the Proposed Action includes construction of up to three shorebases at a location likely near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would likely occur during the winter months when listed whales are largely absent from the area. All construction is limited to land so effects will be minimal to listed marine mammals. Construction would produce low energy localized noise from equipment operation, generators, etc. Noise from on-land pile driving (no marine) would be the loudest source of noise. Excavation and construction are slow moving operations and a relatively stationary sound source around a small noise footprint. The onshore activities described under the First Incremental Step of the Proposed Action (Section 2.2.1.1.5) represent BOEM and BSEE's best estimate as to the location, timing and types of activities that would be part of onshore construction. The specific location, timing and activities would be decided during the exploration process and specific impacts to listed species from onshore activities would be discussed at that time in coordination between the lessee, the land managing entity or entities, and appropriate Federal agencies to ensure impacts to species don't violate the ESA. Because onshore activities occur outside of BOEM and BSEE's jurisdiction, lessees would have to work with landowners (i.e. BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permits and authorizations for onshore development and comply with any stipulations, BMPs, and/or other mitigation measures set forth by landowners and other involved agencies (e.g., U.S. Army Corps of Engineers (USACE)).

Under the Proposed Action, vessel (during the open-water season) and aircraft traffic (year-round) would occur in association with the construction of an on-shore base. The potential effects from these sources have been addressed above in Sections 5.2.1.1 and 5.2.1.2 (*Potential Effects of Vessel Traffic* and *Potential Effects of Aircraft Traffic*, respectively).

The loudest noise associated with construction during the First Incremental Step would be pile-driving on land and Greene et al. (1995) described marine pile-driving noise levels of 131–135 dB re 1 μ Pa (rms) (40 – 100 Hz) at 1 km from the source. On-shore levels are expected to be less. The audibility range for phocid seals occurs in a 50 Hz – 80 kHz band (Ciminello et al., 2012), overlapping the 100 Hz – 2 kHz frequency noise range produced by marine pile driving. Though there is overlap in the noise frequencies produced by pile-driving and the noise frequencies used by bearded seals, the overlap occurs at the bottom of the audibility spectrum for seals. Furthermore, it is generally assumed that seals would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. With audible noise levels within a kilometer of pile-driving activity only slightly above those of ambient noise, the effects of pile-driving would likely include only behavioral responses such as slight avoidance and nothing more is expected. No PTS, TTS, or other physiological responses are anticipated to occur because of pile-driving or other construction activities.

Whales: Listed whales would be expected to display variable responses to construction activity (ranging from no response to avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Bowhead whales do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary lasting from minutes (e.g., vessels and aircraft) to possibly hours (e.g., seismic surveys). Similarly, if whales saw or smelled emissions from a construction activity, they could exhibit the same behavior and move away from it.

Construction of an onshore base during the First Incremental Step would be a temporary activity, likely taking place primarily in the winter (see Section 2.2.2.1.1.5) when listed whales are largely absent from the Action Area. Individual and groups of bowhead whales engaged in migration during the fall-early winter period would be expected to defer migration route up to several kilometers in an avoidance response to encountering sufficient levels of construction noise.

Ice-seals: Noise and disturbance from on-shore base construction may affect nearby ringed and bearded seals. Ringed seals near Northstar production facility in 2000 and 2001 established lairs and breathing holes in the landfast ice within a few meters of Northstar, before and during the onset of winter oil activity. Seal use of the habitat continued despite low-frequency noise and vibration, construction, and use of an ice road (Williams et al., 2006). Blackwell et al. (2003) determined ringed seal densities were significantly higher around offshore industrial facilities. Another study by Frost and Lowry (1988) found ringed seal densities between 1985 and 1986 were higher in industrialized areas than in the controls in the Central Beaufort Sea. Onshore activities associated with the First Incremental Step of the Proposed Action would not be expected to affect food availability for these species as construction is all onshore.

5.2.1.5. Potential Effects from Drilling Operations

Exploration drilling in the Action Area would be conducted using MODUs. A maximum of two MODUs would drill up to 28 exploration and delineation wells during the First Incremental Step of the Proposed Action, with a maximum of four wells drilled and plugged during each open-water season. First Incremental Step drilling activities are detailed in Section 2.2.1.1.4 of this BA. The type of unit chosen would be based on the characteristics of the well site physical environment, well site water depth; expected drilling depth and the mobility required based on well site weather and ice conditions. These drilling units would be mobile and are either towed or self-propelled from one site to another and travel at less than 10 kn. Anchor placement is not considered construction, but there

could be a small, temporary seafloor footprint. The area of the leases in the Action Area is suitable for these types of platforms and are appropriate for water depths up to 500 ft. MODUs can be sources of noise and disturbance to listed species. Potential adverse effects from exploratory drilling include displacing listed species from the vicinity of drill sites. Drill sites could be located in feeding areas or migration paths. Drilling operations would generate underwater sounds that are quite different from seismic surveys because the sounds are of a continuous nature and tend to be from a stationary source whereas seismic surveys tend to be impulsive sounds from a constantly moving source.

5.2.1.5.1. Sound Source Levels from Drilling Operations

Exploration drilling in the Action Area would likely be conducted from a MODU (see Section 2.2.1.1.5). The level of sound propagation would depend upon a combination of factors including the precise drilling unit used, the water depth, and location. Underwater sound propagation results from the use of generators, anchor placement, drilling machinery, and the rig itself. Sound levels during operations may fluctuate depending on the specific type of activity or specific equipment in use at a given time. Lower sound levels have been reported during well logging than during actual drilling operations (Greene, 1987) and underwater sound appeared to be lower at the bow and stern aspect compared to the beam (Greene, 1987).

Most sounds generated from vessel-based drilling operations occur at relatively low frequencies, below 600 Hz although tones up to 1,850 Hz were recorded by Greene (1987) during exploration drilling operations in the Beaufort Sea. At a range of 0.11 mi (0.17 km) the 20–1,000 Hz band level was 122–125 dB re 1 μ Pa (rms) for the drilling ship *Explorer I*. Underwater sound levels were slightly higher (134 dB) during drilling activity from the *Explorer II* at a range of 0.12 mi (0.20 km) although tones were only recorded below 600 Hz. Underwater sound measurements from the *Kulluk*, an ice-strengthened specialized MODU designed for Arctic waters, at 0.61 mi (0.98 km) were higher (143 dB re 1 μ Pa (rms)) than from the other two drillships. Shell Gulf of Mexico, Inc. measured the sounds produced by the *Discoverer* while drilling on the Burger Prospect (within the Leased Area) in 2012. A broadband (10 Hz – 32 kHz) source level of 182 dB was calculated for the *Discoverer* based on the measurements recorded when drilling the 26-inch hole interval (Shell, 2014). These estimates are considered representative of a typical industry-standard, ice-reinforced drillship that would be used for exploration drilling in the Arctic OCS.

Shell's measurements showed source levels from drilling would fall below 160 dB (rms) within 10-m from the drillship. The 2012 measurement of the distance to the 120-dB (rms) threshold for normal drilling activity by the *Discoverer* was 0.93 mi (1.5 km) while the distance of the ≥ 120 dB (rms) radius during mudline cellar (MLC) construction was 5.1 mi (8.2 km) (Shell, 2014). These near-continuous, non-pulse source sound levels were expected to cause some temporary avoidance of the immediate area by marine mammals but no physical damage to marine mammal hearing.

Anchor laying at the Sivulliq Prospect in the Beaufort produced noise levels of 160 dB re 1 μ Pa rms SPL out to 63-120 m (Shell Off Shore, Inc, 2013), which indicates anchoring is louder than drilling. Shell Off Shore, (2013) also noted that anchor hook-up produced some of the highest recorded levels. However, these activities are short-term sound sources (2 to 5 days, Shell Off Shore, 2013).

Sounds emanating from the drilling unit may enter the water at levels greater than the NMFS level B harassment threshold. While PSOs would typically monitor this zone, the drilling unit does not have the ability to power- or shut-down if a marine mammal enters this zone. Because this would be a continuous source of underwater noise, marine mammals would have to voluntarily enter the level B zone from an area of lower sound. This type of behavior would not be likely because, as stated above, marine mammals would be expected to avoid the area.

5.2.1.5.2. Potential Effects of Drilling Noise on Whales

Underwater sound propagation is affected by numerous factors including bathymetry, seafloor substrate, and water depth (Malme, 1995:59). Underwater sound propagation is reduced in locations where water is shallow compared to deepwater locations. Underwater drilling noise could be audible up to 10 km during unusually calm periods (Greene and Moore, 1995). Blackwell, Greene, and Richardson (2004) indicated underwater broadband sound levels from drilling on Northstar island reached background levels about 9.4 km from the island. McDonald et al. (2006) reported subtle offshore displacement of the southern edge of the bowhead whale migratory corridor offshore from the island. Work performed by Shell, most recently in 2012 in the Beaufort and Chukchi Seas, support this statement. Most whales deflected around drilling operations at around 20 km (12 nmi). However, under certain circumstances such as during feeding bouts, the whales may approach drillships much more closely. (Bisson, et al., 2013; Shell Off Shore, 2013).

Bowhead reaction to drillship-operation noise is variable. Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by bowhead whales than do moving sources, particularly ships. It also appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. Most observations of bowhead whales tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Other cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with a harmful event, and this may suggest that bowhead whales will habituate to certain noises that they learn are nonthreatening. Additionally, it is not known what components of the population were observed around the drillship (e.g., adult or juvenile males, adult females, etc.).

Bowhead whales whose behavior appeared normal have been observed on several occasions within 10–20 km (6.2–12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2–5 km (0.12–3 mi) from drillships (Richardson et al., 1985; Richardson and Malme, 1993). On several occasions, whales were well within the zone where drillship noise should be clearly detectable by them. In other cases, bowhead whales may avoid drillships and their support vessels at 20–30 km (see below and NMFS, 2003). Without specific behavioral data and the contextual circumstances surrounding such observations, it cannot be assumed that bowhead whales are not affected or exhibiting tolerance and sex/age-differential responses (such as avoidance of cows with calves from feeding areas and tolerance of bowhead during intensive feeding bouts) rather than no effects from drillship activity and presence. The presence of actively operating icebreakers in support of drilling operations introduces greater noise into the marine environment and, thus, responses of whales.

The distance at which bowhead whales may react to drillships is difficult to gauge, because some bowhead whales would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23–27 km (14.3–16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowhead whales within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The principal finding of this study was that migrating bowhead whales appeared to avoid the offshore drilling operation in Fall 1986. Thus, some bowhead whales may avoid noise from drillships at 20 km (12.4 mi) or more.

In other studies, Richardson, Wells, and Würsig (1985) observed three bowhead whales 4 km (2.48 mi) from operating drillships, well within the zones ensounded by drillship noise. The whales were not heading away from the drillship but were socializing, even though exposed to strong drillship

noise. Eleven additional whales on three other occasions were observed at distances of 10–20 km (6.2–12.4 mi) from operating drillships. On two of the occasions, drillship noise was not detectable by researchers at distances from 10–12 km (6.2–7.4 mi) and 18–19 km (11.2–11.8 mi), respectively. In none of the occasions were whales heading away from the drillship. Ward and Pessah (1988, as cited in Richardson and Malme, 1993) reported observations of bowhead whales within 0.2–5 km (0.1–3 mi) from drillships.

The *Kulluk* was used for drilling operations at the Kuvlum drilling site in western Camden Bay in 1992 and 1993. Data from the *Kulluk* indicated broadband source levels (10–10,000 Hz) during drilling and tripping were estimated to be 191 and 179 dB re μPa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (Greene and Moore, 1995:134). The *Kulluk* was also used for drilling operations at the Sivulli drilling site in the Beaufort Sea in 2012. Data from the *Kulluk* in 2012 indicated a broadband (10 Hz–32 kHz) source level of 172 dB based on the measurements for drilling of the pilot hole (Bisson et al. 2013). There was a strong decay of the high frequency tones (> 1 kHz) due to absorption in the water column (Bisson et al. 2013).

Hall et al. (1994) conducted a site-specific monitoring program around the Kuvlum drilling site in the western portion of Camden Bay during the 1993 fall bowhead whale migration. Results of their analysis indicated that bowhead whales were moving through Camden Bay in a significantly nonrandom pattern, but they became more randomly distributed as they left Camden Bay and moved to the west. The results also indicated that whales were distributed farther offshore in the proximal survey grid (near the drill site) than in the distant survey grid (an area east of the drill site), which is similar to results from previous studies in this general area. The authors noted that information from previous studies indicated that bowhead whales routinely were present nearshore to the east of Barter Island and were less evident close to shore from Camden Bay to Harrison Bay (Hall et al., 1994). The authors believed that industrial variables such as received level were insufficient as a single predictor variable to explain the 1993 offshore distribution of bowhead whales, and they suggested that water depth was the only variable that accounted for a significant portion of the variance in the model. They concluded that for 1993, water depth, received level, and longitude accounted for 85% of the variance in the offshore distribution of the whales. Based on their analyses, the authors concluded that the 1993 bowhead whale distribution fell within the parameters of previously recorded fall-migration distributions.

Davies (1997) used the Hall et al. (1994) data in a Geographic Information System to model the distribution of fall-migrating bowhead whales in relation to an active drilling operation. He also concluded that the whales were not randomly distributed in the study area, and that they avoided the region surrounding the drill site at a range of approximately 20 km (12.4 mi). He noted that the whales were located significantly farther offshore and in deeper water in the area of the drilling rig. As noted by Hall et al. (1994), the distribution of whales observed in the Camden Bay area is consistent with previous studies (Moore and Reeves, 1993), where whales were observed farther offshore in this portion of the Beaufort Sea than they were to the east of Barter Island. Davies (1997) and Hall et al. (1994) concluded it was difficult to separate the effect of the drilling operation from other independent variables. The model identified distance from the drill rig and water depth as the two environmental factors that were most strongly associated with the observed distribution of bowhead whales in the study area. Davies (1997) failed to note that surface observers (Hall et al., 1994) observed whales much closer to the drilling unit and support vessels than did aerial observers. In one instance, a whale was observed approximately 400 m (1308 ft) from the drill rig. Hall et al. (1994) suggested that bowhead whales, on several occasions, were closer to industrial activity than would be suggested by an examination of only aerial survey data.

Schick and Urban (2000) also analyzed the Hall et al. (1994) data and tested the correlation between bowhead whale distribution and variables such as water depth, distance to shore, and distance to the drilling rig. The distribution of bowhead whales around the active drilling rig in 1993 was analyzed, and the results indicated that whales were distributed farther from the drilling rig than they would be

under a random scenario. The area of avoidance was localized and temporary (Schick and Urban, 2000). Schick and Urban (2000) could not conclude that noise from the drilling rig caused the low density near the rig, because they had no data on actual noise levels. They also noted that ice, an important variable, is missing from their model and that 1992 was a particularly heavy ice year. Because ice may be an important patterning variable for bowhead whales, Schick and Urban (2000) were precluded from drawing strong inference from the 1992 results with reference to the interaction between whales and the drilling rig. Schick and Urban (2000) proposed that migrating bowhead whales often are found farther offshore in heavy ice years because of an apparent lack of feeding opportunities and that ultimately, the pattern in the 1992 data may be explained by the presence of ice rather than by the presence of the drilling rig.

In playback experiments, some bowhead whales showed a weak tendency to move away from the sound source at a level of drillship noise comparable to what would be present several kilometers from an actual drillship (Richardson and Malme, 1993). In one study, sounds recorded 130 m (426 ft) from the actual Karluk drill rig were used as the stimulus during disturbance test playbacks (Richardson et al., 1991). For the overall 20–1,000-Hz band, the average source level was 166 dB re 1 μ Pa (rms) in 1990 and 165 dB re 1 μ Pa in 1989. Bowhead whales continued to pass the projector while normal Karluk drilling sounds were projected. During the playback tests, the source level of sound was 166 dB re 1 μ Pa (rms). One whale came within 110 m (360 ft) of the projector. Many whales came within 160–195 m (525–640 ft), where the received broadband (20–1,000 Hz) sound levels were about 135 dB re 1 μ Pa. That level was about 46 dB above the background ambient level in the 20–1,000-Hz band on that day. Bowhead movement patterns were strongly affected when they approached the operating projector. When bowhead whales still were several hundred meters away, most began to move to the far side of the lead from the projector, which did not happen during control periods while the projector was silent.

In a subsequent phase of this study, Richardson et al. (1995c) concluded:

...migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 kilometer (0.54 nmile). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector.

Richardson (1995c) reported that bowhead whale avoidance behavior has been observed in half of the animals when exposed to 115 dB re 1 μ Pa (rms) broadband drillship noises. However, reactions vary depending on the whale activity, noise characteristics, and the physical situation (Richardson, 1995c).

Some migrating bowhead whales diverted their course enough to remain a few hundred meters to the side of a projected sound source (playback of recorded sounds). Surfacing, respiration behavior, and the occurrence of turns during surfacing, were strongly affected out to 1 km (0.62 mi). Turns were unusually frequent out to 2 km (1.25 mi), and there was evidence of subtle behavioral effects at distances up to 2–4 km (1.25–2.5 mi). Richardson et al. (1995c) concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior of individual whales were insignificant.

Richardson et al. (1995c) stated that one of the main limitations during every year of this four year study was the inability of a practical sound projector to reproduce the low-frequency components of recorded industrial sounds. Both the Karluk rig and the icebreaker Robert Lemeur emitted strong sounds down to approximately 10–20 Hz. The authors believed the projector adequately reproduced the overall 20–1,000-Hz level at distances beyond 100 m (109 yd), even though components below 80 Hz were under-represented (Richardson et al., 1991). If bowhead whales are no more responsive to

sound components at 20–80 Hz than to those above 80 Hz, then the playbacks provided a reasonable test of the responsiveness to components of Karluk sound above 20 Hz.

Richardson et al. (1995c) also stated that the study was not designed to test the potential reactions of whales to non-acoustic stimuli detected via sight, olfaction, etc. At least in summer/autumn, responses of bowhead whales to actual dredges and drillships seem consistent with reactions to playbacks of recorded sounds from those same sites. Additional limitations of the playbacks identified by the authors included low sample sizes and the fact that responses were only evident if they could be seen or inferred based on surface observations. The numbers of bowhead whales observed during both playback and control conditions were low percentages of the total Beaufort Sea population. Also, differences between whale activities and behavior during playback versus control periods represent the incremental reactions when playbacks are added to a background of other activities associated with the research. Thus, playback results may somewhat understate the differences between truly undisturbed whales versus those exposed to playbacks.

In Canada, bowhead whale use of the main area of oil-industry operations within the bowhead whale range was low after the first few years of intensive offshore oil exploration in 1976 (Richardson, Wells, and Würsig, 1985), suggesting perhaps that cumulative effects from repeated disturbance may have caused the whales to leave the area. In the absence of systematic data on bowhead whale summer distribution until several years after intensive industry operations began, it is arguable whether the changes in distribution in the early 1980s were greater than natural annual variations in distribution, such as responding to changes in the location of food sources. Ward and Pessah (1988) concluded that the available information from 1976–1985 and the historical whaling information do not support the suggestion of a trend that use of the industrial zone by bowhead whales decreased as a result of oil and gas exploration activities.

Within the Leased Area PSOs recorded a total of 107 cetaceans (65 different sightings) during 2012 while Shell was conducting drilling operations. All but two of these individual cetaceans (unidentified mysticetes), however, were recorded from distant support vessels in areas where RSLs from drilling activities were <120 dB re 1 μ Pa (rms). The two whales were approximately 1.6 km (1.0 mi) from the *Discoverer* at the time of the initial detection. The whales were detected a second time nearly 40 min after the initial sighting at a distance of 2 km (1.2 mi). No whales, including the two individuals sighted within the 120-dB radius, exhibited observable behavioral responses to drilling activities (Bisson et al., 2013).

5.2.1.5.3. Potential Effects of Drilling Noise on Ice Seals

Although this BA analyzes the impacts of oil and gas activities in the Chukchi Sea, exploration and development has already been occurring in the eastern Beaufort Sea for decades (in predominantly State waters) and serves as a good proxy for the Chukchi as the activities, species and conditions are similar and activities in the Chukchi have been limited to date. As such BOEM and BSEE uses information from both the Beaufort and the Chukchi, when available. The effects of offshore drilling on ice seals in the Beaufort Sea have been investigated in the past (Frost and Lowry, 1988; Moulton et al., 2003). Frost and Lowry (1988) concluded that local seal populations were less dense within a 2 nmi buffer from offshore wells that were being constructed in 1985–1987 and Moulton et al. (2003) found seal densities on the same locations to be higher in years 2000 and 2001 after a habituation period. Thus ringed seals were briefly disturbed by drilling activities, until the drilling and post-construction activity was concluded; then they adjusted to the environmental changes for the remainder of the activity. Seals may be disturbed by drilling activities temporarily until the drilling and post-construction activity has been completed.

Moulton et al. (2005) reported no indication drilling activities at the BP's Northstar oil development affected ringed seal numbers and distribution; however, drilling and production sounds from Northstar could have been audible to ringed seals, out to about 1.5 km in water and 5 km in air

(Blackwell et al., 2004). Richardson and Williams (2004) found underwater noise from drilling reached background values at 2–4 km and underwater sound from vessels were sometimes detectable out to 30 km offshore. They concluded that the low-frequency industrial sounds emanating from the Northstar facility during the open-water season resulted in brief, minor localized effects on ringed seals with no consequences to ice seal populations. Adult ringed seals seem to habituate to long-term effects of drilling activities. Brewer et al. (1993) noted ringed seals were the most common marine mammal sighted and did not seem to be disturbed by drilling operations at the Kuvlum #1 project in the Beaufort Sea.

A total of 123 seals (80 different sightings) were observed by PSOs aboard eight different project vessels during periods when the *Kulluk* was conducting drilling activities in the Beaufort Sea during the 2012 open water season at the Sivulliq site (Bisson et al. 2013). This total includes seal sightings from both moving and stationary vessels that were operating in the Sivulliq area. Numerous seals from this total, however, were confirmed to be resightings of the same individuals recorded on multiple days across the drilling period. *Kulluk* PSOs catalogued the distinct markings on the pelages of at least six different seals (four ringed and two bearded seals) that were observed in the vicinity of the drill rig over the period of multiple days. The total of 123 seals observed during drilling periods undoubtedly is greater than the actual number of distinct individuals observed due to double counting.

The majority of these 123 seals, 103 or 84%, were recorded during periods when the pilot hole was being drilled. The remaining 20 seals were observed during excavation of the mudline cellar. The estimated radius to RSLs ≥ 120 dB (rms) during excavation of the mudline cellar was 6.15 km (3.82 mi) compared to only 660 m (2165 ft) during other drilling activities (e.g., pilot hole drilling). The differences in these radii were considered when analyzing the estimated RSL to each seal to capture the specific acoustic footprint likely to have been present in the water at the time and location of each sighting. Not all of the 123 seals recorded during drilling activities in the Beaufort Sea in 2012 were observed in areas where RSLs were estimated to be ≥ 120 dB (rms).

Eighty one of the 123 seals observed during drilling activities in the Beaufort Sea in 2012 were observed at distances where RSLs were estimated to be ≥ 120 dB (rms; Table 6.48). Sixty nine of these 81 seals were observed while the pilot hole was being drilled and the remaining 12 were recorded during excavation of the mudline cellar. The 81 seals observed in areas where RSLs from drilling activities were ≥ 120 dB (rms) consisted of 58 ringed, 12 bearded, one spotted, and 10 unidentified seals.

The vast majority of the 81 seals observed in areas where continuous sounds from drilling activities were ≥ 120 dB (rms) were recorded by PSOs aboard the *Kulluk* ($n=68$ or 84%). Of these 68 seals, 41 were observed in areas where RSLs were estimated to be ≥ 160 dB (rms) and the remaining 27 seals were observed at distances from the drill rig where RSLs were estimated to be between 120 and 160 dB (rms). No seals were observed from any of the support vessels during drilling activities in areas where RSLs were estimated to be ≥ 160 dB (rms).

Harwood et al. (2007; 2010) evaluated the potential impacts of offshore exploratory drilling on ringed seals in the near shore Canadian Beaufort Sea, during February to June 2003–2006. The first 3 years of the study (2003–2005) were conducted prior to industry activity in the area, while a fourth year of study (2006) was conducted during the latter part of a single exploratory drilling season. Seal presence was not significantly different in distance from industrial activities during the non-industry (2003 and 2004) and industry (2006) years. Further, the movements, behavior, and home range size of ten seals tagged in 2006 also did not vary statistically between the 19 days when industry was active (20 March to 8 April) and the following 19 days when industry operations were completed. The density of basking seals was not significantly different among the different study years and was comparable to densities found in this same area during surveys conducted in 1974–1979, and no detectable effect on ringed seals was observed during the single season of drilling in the study area (Harwood, Smith, and Melling, 2007). The effects of longer exposures to industrial activity, or

exposure to multiple industrial sources are more ambiguous, however Harwood et al. (2010) observed that densities of seal lairs were attributable to ice features, not to the presence/absence or distance of drilling activity at the Paktoa drill site.

A total of 396 seals (73 different sightings) were observed by PSOs aboard 10 different project vessels during periods when the *Discoverer* was conducting exploratory drilling activities in the Chukchi during the 2012 open water season (Bisson et al. 2013). This total includes seal sightings from both moving and stationary vessels that were operating in the Burger area. The total of 396 seals observed during drilling periods likely is greater than the actual number of distinct individuals observed due to double counting. The majority of these 396 seals, 369 or 93%, were recorded during periods when the pilot hole was being drilled (Bisson et al. 2013). The remaining 26 seals were observed during excavation of the mudline cellar. The estimated radius to RSLs ≥ 120 dB (rms) during excavation of the mudline cellar was 8.1 km (5.0 mi) compared to only 1.5 km (0.9 mi) during other drilling activities (e.g., pilot hole drilling;). The differences in these radii were considered when analyzing the estimated RSL to each seal to capture the specific acoustic footprint likely to have been present in the water at the time and location of each sighting. The vast majority of the 396 seals recorded during drilling activities in the Chukchi Sea in 2012, 386 or 97%, were observed in areas away from the drill site where they would not have been exposed to RSLs ≥ 120 dB (rms).

Only ten of the 396 seals observed during drilling activities in the Chukchi Sea in 2012 were observed at distances where RSLs were estimated to be ≥ 120 dB (rms) (Bisson et al. 2013). Six of these 10 seals were observed while the pilot hole was being drilled and the remaining 4 were recorded during excavation of the mudline cellar. The 10 seals observed in areas where RSLs from drilling activities were ≥ 120 dB (rms) consisted of three ringed, two bearded, one spotted, and four unidentified seals.

Nine the 10 seals observed in areas where continuous sounds from drilling activities were ≥ 120 dB (rms) were recorded by PSOs aboard the *Discoverer* (Bisson et al. 2013). Of these nine seals, two were observed in areas where RSLs were estimated to be ≥ 160 dB (rms) and the remaining 7 seals were observed at distances from the drill rig where RSLs were estimated to be between 120 and 160 dB (rms). No seals were observed from any of the support vessels during drilling activities in areas where RSLs were estimated to be ≥ 160 dB (rms).

The majority of seals observed during drilling activities either looked at the vessel or exhibited no discernible response. A few individuals splashed (4), increased traveling speed (4). Or changed direction (2) (Bisson et al. 2013).

These data suggest that, in general, seals did not show overt reaction to the 2012 drilling programs in the Chukchi or the Beaufort seas. Reactions were typical of seals when they encounter vessels operating in these areas. Seals often approached the drilling vessels while they were stationary and remained in the general vicinity of the drilling operations for days. Some individuals were seen each day for weeks at a time (Bisson et al., 2013).

Detection distances of seals observed from the drilling vessels were rarely greater than 300 m (984ft) and often were substantially less (LGL and Jasco, 2013). Sound measurements of the drillship *Discoverer* on site in the Chukchi Sea placed the 120 dB (rms) radius for continuous sound at ~1.5 km (0.93 mi) during drilling of the pilot hole and 8.1 km (5.0 mi) for drilling of the mud-line cellar (Bisson et al., 2013). In the Beaufort Sea, the distance to the 120 dB (rms) radius was ~0.66 km (0.41 mi) for drilling of the pilot hole and ~6.2 km (3.9 mi) for the mud-line cellar (Bisson et al., 2013). These measurements indicate that seals were often seen within the behavioral disturbance zone for non-impulsive sounds recognized by NMFS. Seals approached, entered and often remained in areas ensonified to these levels for extended periods of time. Seals often swim near the surface and due to pressure release effects of sound near the surface of the water may be exposed to lower sound levels while at the surface than occur deeper in the water column (Richardson et al. 1995). There are no measurements of the dive patterns of the seals that frequented the drilling rigs in 2012, but it is likely

that they were exposed to levels of continuous sound above 120 dB (rms) for at least part of the time they were in the vicinity of the rigs, and multiple times during the drilling program.

Data collected onboard the drilling vessels in both the Chukchi and Beaufort seas in 2012 suggest that seals routinely approached the vessels while they were stationary and remained in the general vicinity of drilling throughout the operational period (Bisson et al., 2013). Some individual seals were seen daily for weeks at a time while the *Kulluk* was moored at the drill site in the Beaufort Sea. Seals were seen around the rigs during periods when drilling was active and during periods when other types of operations were occurring other than drilling (Bisson et al., 2013). In general, there was little difference between active drilling periods and non-drilling periods in the closest point of approach of seals, the length of time that they remained around the rigs, or the behavior of seals observed near the rigs (Bisson et al., 2013). Seals showed no overt reactions or behavioral changes associated with the exploration activities regardless of the specific activities that were occurring (Bisson et al., 2013).

5.2.1.6. Potential Effects from Discharges

5.2.1.6.1. Authorized Discharges

The principal regulatory method for controlling pollutant discharges from vessels (grey water, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Action Area is the CWA of 1972. Section 402 establishes the NPDES. The EPA issued an NPDES Vessel General Permit (VGP) for “Discharges Incidental to the Normal Operation of a Vessel” for Alaska, which was finalized in 2013 (EPA, 2013a). The final VGP applies to owners and operators of non-recreational vessels that are 24 m (79 ft) and greater in length, as well as to owners and operators of commercial vessels of less than 79 ft which discharge ballast water.

The EPA Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. This includes permit limits on the discharges such that it would tend to reduce the potential for impacts to the environment and species. The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012).

Potential Effects of Authorized Discharges to Whales

Under the First Incremental Step of the Proposed Action, authorized discharges would occur from offshore vessels and exploratory drilling activities. Adverse effects to bowhead whales from discharges are directly related to whether any harmful substances reach the marine environment and if they become bio-available (i.e., they bio-accumulate). The rate and level of bioaccumulation depends on the trophic level at which a marine mammal feeds. Bowhead whales forage primarily on zooplankton, which are secondary producers. Filter-feeding whales are less likely to accumulate higher concentrations of contaminants than species such as higher-order predators such as killer whales. At present levels, these contaminants do not appear to pose a serious threat to Arctic whales (Allen and Angliss, 2014).

While there is “concern” that “Increasing oil and gas development in the Arctic [including Russia and Canada] has led to an increased potential for various forms of pollution to bowhead whale habitat, including oil spills, other pollutants, and nontoxic waste” (Allen and Angliss, 2014), there is little or no evidence that contaminants are an immediate threat to bowhead, fin, or humpback whales in the Action Area. EPA regulation of discharges appears effective in avoiding degradation to the marine environment, including effects to listed whales.

Potential Effects of Authorized Discharges to Ice Seals

Bearded and ringed seals are high-level predators in the marine food web and contaminants might accumulate in the body tissues of individuals over time. Contaminants over time can pollute ocean systems, resulting in adverse effects to species such as ringed and bearded seals. Contaminants such as PCBs, DDT, chlordane, toxaphene, and numerous heavy metals have been found in ringed seals in the Beaufort and Chukchi seas (Becker, 1995; Becker et al., 1995). Woshner (2000) analyzed the accumulations of selenium, mercury, silver, cadmium, and other potentially toxic metals in ringed seals from the Beaufort Sea and other areas. The levels of contaminants detected in Beaufort and Chukchi sea seals were similar to or less than levels found in ringed seal populations elsewhere (Becker, 1995; Becker et al. 1995).

Ringed and bearded seals likely ingest metals (Wagemann and Stewart, 1994) through contaminated prey or by unintentional swallowing of contaminated sediments. Consumption of metal-contaminated food or sediment could result in the liberation of metal ions by acids in the stomach and in a free ionic form may be digested. Heavy metals in seals most likely were a product of accumulation over the age of the seal and the geology of an area, which is supported by other studies (Dietz et al., 1998).

The rate and level of bioaccumulation depends on the trophic level at which a marine mammal feeds. Bearded seals forage on benthic and epibenthic organisms, many of which are filter feeders. The filter feeders are likely to bioaccumulate concentrations of heavy metals from the water column. Bearded seals would be more likely to accumulate higher concentrations of contaminants than species such as the ringed seal. However, at present levels these contaminants do not appear to pose a serious threat to individual seals or ringed or bearded seal stocks (Allen and Angliss, 2014).

There is little or no evidence that contaminants are an immediate threat to ringed or bearded seals in the Action Area. The existing guidelines and stipulations of the current NPDES permit would minimize the potential for marine mammal exposure to authorized discharges produced during the First Incremental Step of the Proposed Action.

5.2.1.6.2. Unauthorized Discharges

Oil spills are unauthorized events and spill prevention, and oil spill response plans including in-place equipment, personnel and infrastructure are required for all operations. Nevertheless, the risk of an oil spill cannot be completely eliminated and is therefore considered in this analysis. Section 2.2.1.1.4 presents the types, numbers, and volumes of oil spills that could be reasonably certain to occur during the First Incremental Step of the Proposed Action. Depending on the location, timing, duration, sea and climatic conditions and response to a spill event, listed species could be affected. As discussed in Section 2.2.1.1.4, only small spills (<1,000 bbl) of refined oil would be reasonably likely to occur during the First Incremental Step because no production of crude oil would occur prior to submittal and approval of a DPP. While a VLOS from an exploration well blowout is possible, it is an extremely low-probability event of the Proposed Action as it is not reasonably certain to occur (see Section 2.2.1.1.4 for additional details regarding VLOS analysis).

Potential Effects of Direct Contact

Whales

Several investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales. It remains unclear if marine mammals actually can observe spilled oil and avoid it. Typically, the whales did not avoid slicks but swam through them, apparently showing no reaction to the oil. For example, during the spill of Bunker C and No. 2 fuel oil from the *Regal Sword*, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). Whales and white-sided dolphins also were observed

swimming, playing, and feeding in and near the slicks, and no difference in behavior was observed between cetaceans within the slick and those beyond it. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities. This section describes situations where marine mammals are in close association with spilled oil after aromatic vapors have dissipated. In a later section, the potential effects from inhalation of toxic vapors are described.

If whales cannot detect spilled oil or detect it but still choose to proceed through it, there are limited situations where oil could contact and remain on parts of the whale body. Albert (1981) suggested that oil could adhere to the skin's rough surfaces (eroded areas on the skin's surface, tactile hairs, and depressions around the tactile hairs), and that eroded skin may provide a point of entry into the bloodstream for pathogenic bacteria, if the skin becomes more damaged.

Geraci and St. Aubin (1990) also investigated how oil might affect healing of superficial wounds in a bottlenose dolphin's skin, and concluded that dead tissue protects underlying tissues from gasoline in the same way it repels osmotic attack by seawater. The authors further concluded that in natural conditions, contact with oil would be less harmful to cetaceans than they and others had proposed.

It is not clear how long crude oil would remain on the skin. It is hypothetically conceivable that oil will wash off the skin and body surface shortly after contact with whale skin; however, oil might adhere to the skin and other surface features (such as sensory hairs) longer if whales remained in or left the oiled area. Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect, and they concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum.

Harvey and Dahlheim (1994) observed 80 Dall's porpoises, 18 killer whales, and two harbor porpoises in oil on the water's surface from the EVOS, and they confirmed that 12 animals in light sheen or moderate-to-heavy oil did not have oil on their skin. None of the observed cetaceans appeared to alter their behaviors when in oiled areas, and the authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present. Bratton et al. (1993) synthesized studies on the potential effects of oil contamination on bowhead whales. Bratton et al. (1993) concluded that no published data proved oil fouling of the skin of any free-living whales and that bowhead whales contacting fresh or weathered petroleum are unlikely to suffer harm.

Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions, to seals can cause temporary or permanent damage of the mucous membranes and eyes (Davis, Schafer, and Bell, 1960) or epidermis (Hansbrough et al., 1985; St. Aubin, 1988; Walsh et al., 1974). Contact with crude oil can damage eyes (Davis, Schafer, and Bell, 1960), resulting in corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes, as were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976a, b).

Ice Seals

The effects of an oil spill on ringed or bearded seals will depend largely on the season and location of the spill. If a spill were to occur during the ice free, open water season, seals may be exposed to oil through direct contact, or perhaps through contaminated food items. However it is believed that with their keen sense of smell and good vision, ringed and bearded seals could detect and avoid most oil spills in the open water season (St. Aubin, 1990).

Immersion studies by Smith and Geraci (1975) found ringed seals may develop mild liver injury, kidney lesions, and eye injury from immersion in crude oil. The eye damage was often severe, suggesting permanent eye damage might occur with longer periods of exposure to crude oil, and the overall severity of the injuries was most likely associated with the exposure duration to crude oil. Geraci and Smith (1976a) concluded the direct effects of an oil blow-out or spill may result in transient eye damage to healthy seals in open water.

However if breathing holes, polynyas, or leads become fouled with oil, permanent damage may occur. Geraci and Smith (1976a) noted their findings pointed to stress as instrumental in their convulsive behavior and subsequent death when exposed to crude oil, suggesting exposure to crude oil was additive to pre-existing stress levels in ringed seals in their experiment where all of the test animals died. Geraci and Smith (1976b) also found ringed seals exposed to a slick of light crude oil showed no impairment in locomotion or breathing.

Ringed seal pups could be particularly vulnerable to the cold if they become oiled and they have not yet established adequate fat reserves. Unlike other ice seal species, bearded seal pups might not be particularly vulnerable to the effects of oiling. Watanabe et al. (2009) and Lydersen et al. (2002) found bearded seal pups begin swimming and diving early, sometimes as newborns during their first week of life, and one must conclude that such behavior would be impractical with insufficient blubber reserves. Therefore, bearded seal pups should not be especially vulnerable to the cold if they become oiled unless they have not yet established adequate fat reserves.

Reports of the effects of oil spills have shown that some mortality of seals may have occurred as a result of oil fouling; however, large-scale mortality has never been observed (St. Aubin, 1990). Some researchers have suggested that ice seal pups may be particularly vulnerable to fouling because of their dense lanugo coat (Johnson, 1983; St. Aubin, 1990; Jenssen, 1996). Newborn seal pups that come in contact with oil may compromise the thermo-insulation capabilities of their lanugo coats, and eventually die from hypothermia or may have their scent obscured such that their mothers would fail to recognize them and abandon them (Geraci and St. Aubin, 1988). Bearded seals, however, only nurse for about three weeks before natural abandonment by their mothers (Lydersen and Kovacs, 1999 as reported in Cameron et al., 2010) and consequently the effects of abandonment might not be as severe if it occurred during the latter stages of nursing. Adults, juveniles, and weaned young of the year rely on blubber for insulation, so effects on their thermoregulation would be minimal (Jenssen, 1996), although energetic costs would be compounded if mothers and pups spend more time in the water by swimming out of the affected area.

Flippers of young harp and gray seal pups were impeded by a heavy oil coating (Davis and Anderson, 1976; Sergeant, 1991) leading to the drowning of the gray seal pups. Oiling of both mother and pups does not appear to interfere with nursing (Lowry, Frost, and Pitcher, 1994) although disturbances associated with oil spill response and clean-up may do so (Geraci and St. Aubin, 1988). Jenssen (1996) reported that approximately 50% of gray seal pups at Norway's largest breeding rookery are fouled each year by chronic low-level pollution from coastal ship traffic and offshore petroleum activity. In these areas, oil has produced few visible effects to gray seal behavior and there has been little mortality.

Potential Effects from Ingestion

Listed species could ingest surface oil while feeding from oil at the surface or from prey items. Ingestion of petroleum hydrocarbons can lead to organ damage or to rapid death (Khan et al., 1987). In at least some marine mammals, digestion and behavior is affected with decreased food assimilation of eaten prey (St. Aubin, 1988), increased gastrointestinal motility, and decreased sleep (Geraci and Smith, 1976a, b; Engelhardt, 1985, 1987).

Bio-accumulation is a process by which certain substances are taken up by consumption of prey items and become more concentrated in higher trophic levels of the food chain. Whales that feed lower in the food chain (i.e., on plankton) would have lower potential to bio-accumulate harmful substances from their prey compared to other whales or ice seals that feed higher in the food chain (i.e., on benthic invertebrates or fish).

Whales

Albert (1981) suggested that whales could take in tarballs or large "blobs" of oil with prey. He also said that swallowed baleen "hairs" mix with the oil and mat together into small balls. These balls

could block the narrow tube connecting the stomach's fundic and pyloric chambers (the second and fourth chambers of the stomach) (Tarpley et al., 1987). Hansen (1992) suggested that cetaceans can metabolize ingested oil, because they have cytochrome p-4501A (CYP1A) in their livers. The hepatic biotransformation enzyme CYP1A in fish and other vertebrates is specifically induced by organic contaminants such as aromatic hydrocarbons, polychloride biphenyls (PCBs), and dioxins, and is used as a biomarker of exposure to organic pollution. The presence of cytochrome p-450 (a protein involved in the enzyme system associated with the metabolism and detoxification of a wide variety of foreign compounds, including components of crude oil) suggests that cetaceans should be able to detoxify oil (Geraci and St. Aubin, 1982, as cited in Hansen, 1992). Hansen also suggests that digestion may break down any oil that adheres to baleen filaments and causes clumping (Hansen, 1985). Observations and stranding records do not reveal whether cetaceans would feed around a fresh oil spill long enough to accumulate a large dose of oil. More information is needed on cytochrome p4501A induction in bowhead whales. The opportunity for such study has not been available.

Tissue studies by Geraci and St. Aubin (1990) revealed low levels of naphthalene in the livers and blubber of baleen whales. This result suggests that bowhead whale prey have low concentrations in their tissues, or that baleen whales may be able to metabolize and rapidly excrete certain petroleum hydrocarbons.

While it appears likely that whales can breakdown and eliminate small amounts of hydrocarbons they may encounter in the marine environment (i.e., from natural seeps or from their prey), larger doses of ingested compounds, such as those produced during a large or very large oil spill, are more likely to result in greater adverse physiological effects.

Bowhead whales may swallow some oil-contaminated prey (see section on Potential Effects to Prey Populations below) and could be exposed to some hydrocarbons through their food. Zooplankton may engulf petroleum droplets when in direct contact and retain metabolized and unmetabolized petroleum for 7–10 days (Geraci and St. Aubin, 1990). Copepods may passively accumulate polyaromatic compounds (PACs) from water and could serve as a conduit for the transfer of PACs to higher trophic-level consumers. Duesterloh, Short, and Barron (2002) concluded that subarctic marine copepods may passively accumulate aqueous polyaromatic compounds and may transfer them to higher trophic-level consumers. Bioaccumulation factors were ~2,000 for *Metridia okhotensis* and ~8,000 for *Calanus marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher bioaccumulation than many other species of copepods because of their characteristically high lipid content.

To the extent that ingestion of crude oil affected the weight or condition of the mother, her dependent young could also be affected. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

Ice Seals

St. Aubin (1990) found ingestion of hydrocarbons can irritate and destroy epithelial cells in the stomach and intestine, affecting motility, digestion, and absorption, which may result in death or reproductive failure. Harbor seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker, Lowry, and Frost, 1994).

Subsequent studies (Engelhardt, Geraci, and Smith, 1977; Engelhardt, 1982) indicate that ringed seals may accumulate compounds from hydrocarbons in their tissues, but that they are rapidly excreted via renal pathways. Engelhardt (1983) further states that exposure studies in ringed seals revealed they have a great capability to excrete accumulated hydrocarbons via renal and biliary excretion mechanisms, clearing blood and most other tissues of the residues. Engelhardt (1978, 1982, 1985), found that contaminated animals can depurate this internal oil after being returned to clean water over a 7-day period. Ringed seals probably have the ability to purge their bodies of some harmful oil

residues, depending on the duration and quantity of exposure. Based on morphological similarities, the physiological impacts in bearded seals are expected to be similar to those of ringed seals.

Similar to whales, it appears that ice seals can breakdown and eliminate small amounts of hydrocarbons they may encounter in the marine environment (i.e., from natural seeps or from their prey), with the physiological impacts of ingestion being dosage-dependent.

Investigations into the effects of crude oil ingestion and exposure on ringed seals (Smith and Geraci, 1975) indicate the probability of ringed seals accidentally ingesting large amounts of oil by way of contaminated food items is very low. Zooplankton may engulf petroleum droplets when in direct contact and retain metabolized and unmetabolized petroleum for 7–10 days (Geraci and St. Aubin, 1990). Bivalve molluscs however, tend to bio-accumulate hydrocarbons from prolonged or repeated exposure, posing a threat to benthic-feeding seals. Similarly, oil can be transferred through the food web from invertebrates to larger fish (Koyama, Uno, and Kohno, 2004, Elmgren et al., 1983).

Ingestion of small quantities of oil through feeding is not harmful to some marine mammals such as bearded or ringed seals that can metabolize hydrocarbons (Payne, 1992). Direct ingestion of larger amounts of oil or ingestion of contaminated prey transfers toxins to body fluids and tissues causing effects that may lead to death, as suspected in dead gray and harbor seals found with oil in their stomachs (Engelhardt et al., Geraci, and Smith, 1977; Engelhardt, 1982; St. Aubin, 1990; Frost et al., 1994b; Lowry et al., Frost, and Pitcher, 1994; Spraker, Lowry, and Frost, 1994; Jenssen, 1996).

Potential Effects from Baleen Fouling

If a baleen whale encountered spilled oil, baleen filaments might be fouled, which would reduce a whale's filtration efficiency during feeding. Early studies on baleen fouling were summarized by Geraci (1990) who noted that while there was a great deal of interest in the possibility that residues of oil may adhere to baleen plates so as to block the flow of water and interfere with feeding, the concerns are largely speculative. He also noted that effects may be imperceptible and concluded that a safe assumption is that any substance in seawater that alters the characteristics of the plates, the integrity of the hairs, or the porosity of the sieve may jeopardize the nutritional well-being of the animal. Braithwaite (1983, as cited in Bratton et al., 1993) used a simple system to show a 5–10% decrease in filtration efficiency of bowhead baleen after fouling, which lasted for up to 30 days.

Geraci (1990) summarized studies by Geraci and St. Aubin (1982, 1985) where the effects of contamination by different kinds of oil on humpback, sei, fin, and gray whale baleen were tested in saltwater ranging from 0–20°C. In these studies, resistance to flow was increased more than 100% in some humpback baleen, and <75% in gray and sei whale baleen; gray whale samples were “relatively unaffected” (Geraci, 1990:186). Resistance to water flow through baleen was increased the greatest with contamination by Bunker C oil at the coldest temperatures. Geraci (1990) summarized that oil of medium weight had little effect on resistance to water flow at any temperature. Fraker (1984) noted that there was a reduction in filtering efficiency in all cases, but only when the baleen was fouled with 10 mm of oil was the change statistically different.

In the study in which baleen from fin, sei, humpback, and gray whales was oiled, Geraci and St. Aubin (1985) found that 70% of the oil adhering to baleen plates was lost within 30 min (Geraci, 1990) and in 8 of 11 trials, more than 95% of the oil was cleared after 24 hours. The study could not detect any change in resistance to water flowing through baleen after 24 hours. The baleen from bowhead whales is longer than from the studied species and has many hair like filaments that could foul more easily or remain fouled longer.

Lighter oil and condensate should result in less interference with feeding efficiency. Lambertsen et al. (2005:350) concluded that results of their studies indicate that Geraci's analysis of physiologic effects of oiling on mysticete baleen “considered baleen function to be powered solely by hydraulic pressure,” a perspective they characterized as a “gross oversimplification of the relevant physiology.” Lambertsen et al. (2005) concluded that the current state of knowledge of how oil would affect the

function of the mouth of right whales and bowhead whales can be considered poor, despite considerable past research on the effects of oil on cetaceans. Lambertsen et al. (2005) believe that the resistance of the baleen is increased by oil fouling, and that the most likely adverse effect would be a reduction in capture of larger, more actively mobile species (e.g., euphausiids) with possible reductions in capture of copepods and other prey.

In a laboratory experiment, Braithwaite, Aley, and Slater (1983:42) reported that Prudhoe Bay crude oil appeared to cause abnormal spacing of baleen filaments which allowed an increase in the numbers of zooplankton to escape capture during feeding. The filtration efficiency of bowhead whale baleen was reduced by 5–10%. Extended or repeated baleen fouling might reduce net food intake and blubber deposition of whales, which could have an adverse effect on the body condition and health of affected whales.

Potential Effects from Inhalation of Vapors

Listed species in the immediate vicinity of a spill could inhale volatile compounds present in fresh crude oil. Geraci and St. Aubin (1982) calculated the concentrations of hydrocarbons associated with a theoretical spill of a typical light crude oil. They calculated the concentrations of the more volatile fractions of crude oil in air. The results showed that vapor concentrations could reach critical levels for the first few hours after a spill. Natural gas and condensates would also disperse rapidly and not persist at the sea surface.

Both listed whales and ice seals are believed to smell and should be well aware of hydrocarbon vapors. As listed whales and ice seals should be able to use their sense of smell to detect the direct of the smell, they should be able to move in a direction away from it if it bothered them.

If a whale or seal were unable to leave the immediate area of a spill, it could inhale some vapors, perhaps enough to cause damage. This hypothetical situation would most likely arise only if fresh oil was spilled directly into a lead where a marine mammal was trapped. In this case, Bratton et al. (1993) theorized the marine mammal could inhale oil vapor that would irritate their mucous membranes or respiratory tract or they also could absorb volatile hydrocarbons into the bloodstream. Within hours after the spill, vapors could harm the lungs. It appears highly unlikely, however, that any individuals of a listed species would be in a “trapped situation” or willingly remain in a vaporous area.

Whales

Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), and have anesthetic effects (Neff, 1990). Fraker (1984) stated that a whale surfacing in an oil spill will inhale vapors of the lighter petroleum fractions, and many of these can be harmful in high concentrations. Calves could be more vulnerable than adults to vapors from a spill, because they take more breaths than do their mothers and spend more time at the surface. Marine mammals away from the immediate area or that are exposed to weathered oils would not be expected to be affected by inhalation of vapors.

The potential for there to be long-term sublethal effects (e.g., reduced body condition, poorer health, reduced immune function, reduced reproduction, or longer dependency periods) from an oil spill are difficult to predict because there have been few observations of whales interfacing with spilled oil and sublethal effects would most likely occur away from the spill site at a later time. Furthermore, it has not been demonstrated that potential adverse effects on a small number of individual whales translate into adverse effects on the entire population.

Ice Seals

NRC (2003) states that contact with crude oil could harm ice seals; however, the effects of a crude oil spill on seals would largely be a function of the amount of oil released into the water and the

composition of the oil. The more volatile compounds in an oil slick, particularly aromatic volatiles, usually are the most toxic components. In situ, cold-water measurements (Payne et al., 1984) demonstrated that individual compounds in a slick decrease significantly in concentration in hours to tens of days.

In contrast to open water conditions, ice cover restricts oil dispersion, limiting the area affected to one degree or another. Oil tends to concentrate in ice leads, polynyas, and in breathing holes, and will be held closer to the surface against ice edges where seals may travel (Engelhardt, 1987). Floating sea ice reduces wave action and surface exchange which may delay weathering and dispersion of oil, prolonging the extent and duration of exposure for bearded seals and the risk of permanent damage to their eyes and other organs. Low temperatures also makes oil more viscous, increasing the hazards associated with the fouling of animals, and also reducing evaporation rates of volatile hydrocarbons, lessening the acute levels of toxins in the air but lengthening the period of exposure (Engelhardt, 1987). Consequently oil dispersing from a spill site may retain high levels of toxic aromatic compounds, depending on temperature and whether the oil becomes frozen into ice (St. Aubin, 1990).

Potential Effects to Prey Populations

Fish constitute a substantial portion of the diets of fin whales, humpback whales, ringed seals, and bearded seals. Oil spills have been observed to have a range of effects on fish. Oil spills can have acute, sub-lethal, and long-term impacts on fish resources. Oil spills can:

- cause mortality to eggs and immature stages from exposure in spawning or nursery areas;
- impede access to spawning habitat or displace individuals from preferred habitat;
- constrain or eliminate prey populations;
- impair feeding, growth, or reproduction, reducing individual fitness and survival;

- contaminate organs and tissues and cause physiological responses, including stress; and/or
- modify community structure.

There are two general ways that oil spills adversely affect the abundance of a forage fish (e.g., herring, cod, and capelin) population: (1) through direct mortality or (2) through indirect impacts on reproduction and survival (Hilborn, 1996). The specific effect depends on the concentration of petroleum present; the time of exposure; and the stage of fish development involved.

Evidence indicates that free-swimming fish are generally not injured by oil spills in the open sea because they are able to avoid the area (Patin, 1999). However, concentrations of petroleum hydrocarbons are acutely toxic to fishes a short distance from and a short time after a spill event (Malins, 1977; Kinney, Button, and Schell, 1969). Although the majority of adult fish are able to leave or avoid areas of heavy pollution to avoid acute effects, the death of adult fish has occurred almost immediately following some oil spills (the Florida and Amoco Cadiz; Hampson and Sanders, 1969; Teal and Howarth, 1984). Oil spills may kill or injure demersal fish in shallow coastal waters with limited water exchange.

Eggs, larvae, and juveniles are more sensitive than adults and effects to these stages may pose more threat to populations than effects on adults (e.g., Teal and Howarth, 1984). Floating eggs and juvenile stages of many species can be killed when contacted by oil (Patin, 1999). Sublethal responses to fish include a wide range of compensational changes (Patin, 1999). These start at the subcellular level. If sublethal concentrations are encountered over a sufficient duration, effects could include changes in growth, feeding, fecundity, survival, and temporary displacement. Rice et al. (2000) reported that: (1) PAHs are released from oil films and droplets at progressively slower rates with increasing molecular weight leading to greater persistence of larger PAHs; (2) eggs from demersally spawning fish species accumulate dissolved PAHs released from oiled substrates, even when the oil is heavily weathered; and (3) PAHs accumulated from aqueous concentrations of <1 ppb can lead to adverse sequelae (i.e., a secondary result of disease or injury) appearing at random over an exposed individual's lifespan. These adverse effects likely result from genetic damage in response to PAHs. These can affect the population abundance and, subsequently, community structure as well as availability and contamination of those species consumed by whales and ice seals.

Whales

An oil spill probably would not permanently affect zooplankton populations and most adverse effects would likely only occur near shore (Richardson et al., 1987, as cited in Bratton et al., 1993). A small fuel spill would be localized and would not permanently affect zooplankton populations and higher trophic-level consumers that are bowhead or humpback prey. The amount of zooplankton and other prey lost in such a spill likely would be undetectable compared to what is available on the whales' summer feeding grounds. The amount of zooplankton lost, even in a large or very large oil spill, would be very small compared to what is available (Bratton et al., 1993). However, long-term and chronic effects could be most evident in populations of benthic and pelagic animals. Even with the advection of zooplankton through the currents of surrounding waters and the reproductive capacity of resident populations of benthic and pelagic invertebrates, the recovery of invertebrate populations may take 1–2 years if the impacting factors discussed in earlier sections should culminate in causing population-level effects to this diverse group of organisms."

Duesterloh, Short, and Barron (2002) concluded that phototoxic effects on copepods could conceivably cause ecosystem disruptions that have not been accounted for in traditional oil-spill-damage assessments. Particularly in nearshore habitats, where vertical migration of copepods is inhibited due to shallow depths and geographical enclosure, phototoxicity could cause mass mortality in the local plankton population.

Ice Seals

Oil spills could also have deleterious effects on the quality and availability of seal prey species (as described previously). In some cases, spilled oil has caused major disruptions to benthic communities by failed spawning and significantly lower densities (Elmgren et al., 1983).

Potential Effects from Oil Spill Response and Cleanup Activities

As Arctic sea ice continues to contract and thin, energy exploration and transportation activities will be increasing in the region, escalating the risk of oil spills and accidents. As a result, NOAA, BSEE, the Oil Spill Recovery Institute, and the University of New Hampshire's Coastal Response Research Center and its partners have developed an Environmental Response Management Application (ERMA) for the Arctic region (NOAA 2014). ERMA is a web-based GIS tool that assists both emergency responders and environmental resource managers in dealing with incidents that may harm the environment.

ERMA integrates and synthesizes data—some of which happens in real time—into a single interactive map, providing a quick visualization of the situation and improving communication and coordination among responders and environmental stakeholders.

Arctic ERMA brings together all of the available information needed for an effective emergency response in the Arctic's distinctive conditions, such as the extent and concentration of sea ice, locations of ports and pipelines, and vulnerable environmental resources.

Listed species could be affected by any spill response and cleanup activities that would occur during the First Incremental Step of the Proposed Action; however, only small spills are reasonably likely to occur during the First Incremental Step (see Section 2.2.1.1.4) and these would be quickly contained and cleaned up, minimizing potential exposure of listed species to spilled oil. Whales and seals could be temporarily affected by cleanup activities; however, this behavior response would have a short-term, temporary impact. Effects of cleanup activities from small spills would be expected to be similar to those described for vessel traffic (Section 5.2.1.1). Additional discussion of the impacts of spill response and cleanup activities to ESA-listed species (with a focus on impacts from response and cleanup of large spills) is presented in species-specific analysis.

5.2.2. Effects Analysis by Species-First Incremental Step

The following sections evaluate the direct and indirect effects of the Proposed Action on bowhead whales, fin whales, humpback whales, bearded seals, ringed seals and ringed seal proposed critical habitat. We conclude each species section with BOEM and BSEEs' potential effects.

5.2.2.1. Potential Effects of the First Incremental Step on the Bowhead Whale

Direct and indirect effects to bowhead whales during the First Incremental Step of the Proposed Action could arise from vessel and aircraft traffic, seismic surveys, geohazard and geotechnical surveys, onshore facility construction, and exploratory drilling operations.

Marine seismic surveys should affect very few bowhead whales in the Action Area until mid to late September when large migration pulses of bowheads begin leaving the Beaufort Sea, traveling through the Action Area to feeding grounds off the northern coast of Chukotka. Seismic operations during this timeframe have the potential to affect much of the bowhead whale population within the Western Arctic Stock by eliciting avoidance reactions in whales. A small number of whales in the Action Area during summer months would avoid areas of active airgun arrays by a margin of several miles, depending on airgun array size, source levels, sound propagation characteristics, and the activity that whales are engaged in at the time they perceive airgun noise. Migrating bowhead whales would briefly divert around active seismic surveys before resuming travel on their migration route.

Two marine seismic surveys, and five geohazard and five geotechnical surveys are to be expected in the First Incremental Step. The small number and scale of the geohazard and geotechnical surveys, the equipment used, and the few marine seismic surveys would not interact to produce anything beyond temporary, brief avoidance behavior by bowhead whales.

One to three shorebases are planned during the First Incremental Step at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months when bowheads are largely absent from the Action Area. All construction activity will be on land. Activities associated with this construction (e.g., vessel traffic) would be subject to typical mitigation measures that would help avoid adverse effects on bowhead whales.

Exploratory drilling would occur during the First Incremental Step, during the open water period when MODUs could be brought to the drill site. Such operations could affect bowhead whales since broadband source levels from the drillship *Noble Discoverer* ranged from 177 to 185 dB re 1 μ Pa (rms) during Chukchi Sea exploration drilling activities in 2012 (Shell, 2012), and jack-up rigs are assumed to produce lower noise levels than drillships (NMFS, 2013a, b). Koski and Johnson (1987) concluded the area of effects for exploratory drilling noise would radiate approximately 12.4+ mi (20+ km) from an operating drillship. The limited number of exploration wells, 4 per year, would affect very few bowhead whales before the fall migration. During the fall bowhead whale migration exploratory drilling would likely cause whales to divert around areas where drilling was occurring with avoidance distances of at least 12.4 mi which represents the potential area of effects (Koski and Johnson, 1987).

Small refined oil spills may occur during the First Incremental Step. The estimated total and annual number and volume of small refined spills during the First Incremental Step are shown in Table 2–2. Small refined oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual bowhead whales could be exposed to small spills, which would have minimal effects on their health, due to small spill sizes, weathering, and rapid spill dispersal.

There are no large spills reasonably foreseeable during the First Incremental Step; though two spills could be reasonably foreseeable for Future Incremental Steps and are discussed in Section 5.3 and Section 5.4. A very large oil spill (VLOS) is not reasonably certain to occur at any stage and is therefore not considered an effect of the proposed action.

5.2.2.1.1. Potential Effects from Vessel Traffic

Vessels can affect bowhead whales by disturbing them with underwater noise. Some high-speed vessels have the potential to strike bowhead whales.

Vessels

These vessels primarily represent a risk to bowhead whales as result of noise and disturbance. Bowhead whales react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowhead whales begin to swim rapidly away when vessels approach them rapidly and directly. Avoidance usually begins when a rapidly approaching vessel is 1–4 km (0.6–2.5 mi) away. A few whales may react at distances from 5–7 km (3–4 mi), and a few whales may not react until the vessel is less than 1 km (0.6 mi) away. Received noise levels as low as 84 dB re 1 μ Pa (rms) or 6 dB above ambient may elicit a strong avoidance response to an approaching vessel at a distance of 4 km (2.5 mi) (Richardson and Malme, 1993). This reaction may be related to the fact that bowhead whales were commercially hunted within the lifetimes of some older individuals (although there are fewer and fewer each year) and members of the current population are hunted for subsistence throughout many parts of their range.

The encounter rate of bowhead whales with vessels associated with activities during the First Incremental Step will be low because of the limited number of surveys and exploratory drilling operations planned (see Section 2.2.1.1.6). Bowhead whales could encounter noise and disturbance from seismic and support vessels as they migrate through and feed in the Action Area. The response to vessel encounters depends on the area in which the whales and vessels are transiting, the total number of vessels and whales in the area, the behavior of individual whales, and monitoring and mitigation measures to minimize adverse effects. Vessels moving from one site to another would be more disturbing to bowhead whales than vessels idling or maintaining their position. In either case, bowhead whales probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels and probably would move away from vessels that approached within a few kilometers. Overall, vessel activities associated with exploration are not expected to disrupt the bowhead migration.

However, it is theoretically conceivable that if exploration seismic pulses cause TTS or PTS in marine mammals, this could lead to reductions in the ability of bowhead whales to detect and avoid approaching vessels (Aerts and Richardson, 2008), but typical mitigation measures (see Section 2.3) are specifically designed to reduce the potential for TTS and PSOs monitor for the presence of whales near vessels and airgun arrays. No threshold shifts or injuries to bowhead whales are anticipated.

Ships can injure whales near the surface (Silber et al., 2010; Laist et al., 2001). Vessels transiting at speeds >10 knots present the greatest potential hazard of collisions (Jenson and Silber, 2003; Silber, Bettridge, and Cottingham, 2009). Vessels engaged in active seismic surveying operate at speeds of 4.0 to 6.0 knots. These slower speeds present a low risk of collision as whales have adequate warning and respond to avoid the vessels. Seismic vessels have some potential to strike bowhead whales during periods of low visibility due to darkness or weather conditions when observer capabilities are limited. Seismic vessels typically are required to have on-board PSOs to require vessels to reduce speed or take evasive action to avoid collisions with whales. See Section 2.3 for more detail on mitigation measures that avoid or minimize vessel-whale collisions.

Medium and small vessels typically operate at greater speeds than large vessels but have greater maneuverability that could enable them to avoid marine mammals. Collisions could occur during darkness and poor visibility; however, vessel operators try to avoid objects in their path. No threshold shifts or injuries to bowhead whales are anticipated.

Ice Management Vessels

Bowhead whale response distances to ice management vessels (e.g., icebreakers) are expected to vary, depending on icebreaker activities and sound-propagation conditions. Miles, Malme, and Richardson (1987) modeled icebreaker noise and predicted that roughly half of the bowhead whales would show an avoidance response to an icebreaker underway in open water at a range of 2–12 km (1.2–7.5 mi) when the sound-to-noise ratio is 30 dB.

Icebreakers can generate considerable underwater noise when actively breaking ice. Zones of responsiveness for intermittent sounds, such as an icebreaker pushing ice have not been studied. There are no observations of bowhead whale reactions to icebreakers breaking ice. Based on models, bowhead whales likely would respond to the sound of an icebreaker at distances of 2–25 km (1.2–15.5 mi) (Miles, Malme, and Richardson, 1987). The study also predicted that roughly half of the bowhead whales would show avoidance response to an icebreaker pushing ice at a range of 4.6–20 km (2.8–12.4 mi) when the sound-to-noise ratio is 30 dB.

Richardson, Koski, and Patenaude (1995) found that bowhead whales migrating in nearshore leads often tolerated exposure to projected icebreaker sounds at received levels up to 20 dB or more above the natural ambient noise levels at corresponding frequencies. The source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in this study (median difference 34 dB over the frequency range 40–6,300 Hz). Over the two-season period (1991 and

1994) when icebreaker playbacks were attempted, an estimated 93 bowhead whales (80 groups) were seen near the ice camp when the projectors were transmitting icebreaker sounds into the water, and an estimated 158 bowhead whales (116 groups) were seen near there during quiet periods. Some bowhead whales diverted from their course when exposed to levels of projected icebreaker sound greater than 20 dB above the natural ambient noise level in the one-third octave band of the strongest icebreaker noise. However, not all bowhead whales diverted at that sound-to-noise ratio, and a minority of whales apparently diverted at a lower sound-to-noise ratio. The study concluded that exposure to a single playback of variable icebreaker sounds can affect movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow, but these effects are temporary and minor. The study also indicated the predicted response distances for bowhead whales around an actual icebreaker would be highly variable; however, for typical traveling bowhead whales, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10–30 km (6.2–18.6 mi).

Effects of an actual icebreaker on migrating bowhead whales, especially mothers and calves, could result in adverse effects if it caused aggregations to leave resting or feeding areas. It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. The predicted typical radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least 10 dB around the typical threshold, with commensurate variability in predicted reaction radius.

Concerns have been raised regarding the effects of noise from OCS exploration and production operations in the winter and spring near the ice edge and the potential for this noise to delay or block the bowhead spring migration or displace bowhead whales from key habitats. We conclude that icebreaker activity, should it occur, in the spring could potentially disturb bowhead whales during calving, breeding and migrating activities in and adjacent to the spring polynya system in the Chukchi Sea if present when icebreaker activity occurred. Bowhead whales could occur in the area and these individuals could be affected by icebreaker activity and respond by avoidance, displacement from habitat, or alter migratory or other movements.

Summary of Potential Effects from Vessel Traffic

Vessel operations and typical mitigation measures would help avoid adverse effects on and collisions with bowhead whales (see Section 2.3). As noted in Chapter 4, Environmental Baseline, available information indicates that vessel strikes of whales in the area are low and there is no indication that strikes will become an important source of injury or mortality in the evaluation area. Icebreakers actively engaged in ice management/breaking activities could cause alterations in localized migration routes and spatial distribution. Local alterations to migration route and spatial distribution are likely and would be temporary, nonlethal to bowhead whales experiencing icebreaker activity.

5.2.2.1.2. Potential Effects from Aircraft Traffic

Aircraft operations include fixed-wing and helicopter support to MODUs or, less often, seismic survey vessels. Data on reactions of bowhead whales to helicopters are limited. Underwater sounds from aircraft are transient. According to Greene and Moore (1995:103) the angle at which a line from the aircraft to the receiver intersects the water's surface is important. At angles greater than 13 degrees from the vertical, much of the incident sound is reflected and does not penetrate into the water. Therefore, strong underwater sounds are detectable while the aircraft is within a 26-degree cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period it passes overhead and is heard underwater.

Fixed-wing Aircraft

Fixed-wing aircraft flying at low altitude often cause bowhead whales to make hasty dives (Richardson and Malme, 1993). Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowhead whales sometimes caused abrupt turns and hasty dives.

Aircraft on a direct course usually produce audible noise for only tens of seconds, and the whales are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowhead whales (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60–460 m. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowhead whales occurred when the Twin Otter was at altitudes of 182 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowhead whales when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

Helicopters

Most helicopter use in the Action Area would be for ferrying personnel and equipment to OCS operations and involves turbine helicopters. Patenaude et al. (1997) found that most reactions by bowhead whales to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 m or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. However, the majority of bowhead whales showed no obvious reaction to single passes, even at those distances. The helicopter sounds measured underwater at depths of 3 and 18 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m ranged from 117–120 dB re 1 μ Pa in the 10–500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112–116 dB re 1 μ Pa in the 10–500-Hz band. Observations of bowhead whales exposed to helicopter overflights indicate that most bowhead whales exhibited no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowhead whales probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). Helicopter noise is generally audible for only tens of seconds. If the aircraft remains on a direct course, the whales should resume their normal activities within minutes.

Summary of Potential Effects from Aircraft Traffic

Most bowhead whales are unlikely to react substantially to occasional single passes by helicopters; however, typical mitigation measures associated with aircraft operations (Section 2.3) would help avoid adverse effects to bowhead whales. While the obvious behavioral reaction of a bowhead to a single low-flying helicopter or fixed-winged aircraft flying overhead is probably temporary, chronic “fleeing” reactions could unnecessarily stress bowhead whales. These effects are not anticipated because frequent close-approaches to whales by aircraft are prohibited.

5.2.2.1.3. Potential Effects from Marine Seismic and Other Ancillary Surveys

The bowhead whale is the most commonly encountered large whale in the Action Area. Most seismic surveys use airguns of various sizes and array designs. Bowhead whales conceivably could be disturbed or harmed by seismic survey noise in certain situations. Mitigation measures are designed to avoid these situations. In this section we consider the level of seismic activity and the mitigation measures typically required under an Incidental Harassment Authorization issued under the Marine Mammal Protection Act (MMPA) by the NMFS (Section 2.3.1.3). This analysis addresses the

potential level of effect from both in-ice and open-water seismic surveys and does not include vessel presence and noise, aircraft presence and noise, discharges, etc.

Potential Effects from Seismic Surveys using Airguns

The Proposed Action considers that no more than one deep penetration survey (marine seismic survey) may occur annually during the First Incremental Step. Bowhead whales may avoid operating airguns, but avoidance radii are quite variable. Some migrating bowhead whales may avoid an active seismic source at 20–30 km, but others may respond from even further (35 km), depending on the individual whale and other circumstances. Avoidance distances can exceed the distance at which boat-based observers can see whales, which indicates 1) that the whales may respond to lower sounds at greater distances and 2) that these whales were outside sounds levels for TTS and PTS. Slight changes in swim path do not constitute “take” and are not considered biologically important.

The Proposed Action also considers that no more than two ancillary seismic or other site clearance survey may occur annually during the First Incremental Step. High-resolution ancillary seismic surveys are of shorter duration and have a smaller zone of influence than deep penetration seismic surveys. These activities use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys. Bowhead whales appear to continue normal behavior at closer distances to high-resolution seismic surveys than to 2D/3D seismic surveys. These activities are less likely to affect bowhead whales. Bowhead whales sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3–5 km (1.86–3.1 mi) away (received noise levels at least 118–133 dB re 1 μ Pa(rms)). Some bowhead whales oriented away during an experiment at a range of 2–4.5 km (1.2–2.8 mi) and another experiment at a range of 0.2–1.2 km (0.12–0.75 mi) (received noise levels at least 124–131 and 124–134 dB, respectively). Frequencies of turns, predive flexes, and fluke-out dives were similar with and without airgun noise; and surfacing and respiration variables and call rates did not change significantly during the experiments. The primary concern with high resolution surveys is the potential for these activities to add to noise and disturbance from 2D/3D seismic or drilling activities, and to cause local impacts in a specific area if concentrations of bowhead whales are present or may be prevented from using an important area.

Mitigation measures associated with seismic surveys using airguns include implementation of power-down and shut-downs to avoid exposure of bowhead whales to TTS-level sounds, active monitoring to avoid collisions, and regular recording of observations whether actively conducting seismic surveys or not. Furthermore, in the Beaufort Sea, airplane surveys are used to relay updated monitoring information to seismic survey operators to minimize effects upon bowhead whales. Data from routine survey and weekly industry reports is used by an inter-agency team to assess the potential for overlapping or interacting activities on the Action Area to further minimize effects on bowhead whales. Implementation of typical mitigation measures for active seismic operations decreases the potential for adverse effects.

In-Ice Seismic Surveys. In-ice geophysical deep penetration 2D/3D surveys would have similar effects as open water 2D/3D deep penetration surveys with some important differences. When continuous ice cover occurs, the long range propagation of broadband seismic pulses can shift by as much as 200 km compared to open water propagation (Thode et al., 2010). Active ice-breaking by an icebreaker can also introduce an additional source of loud noise.

One of the primary motivations for developing an in-ice survey technique was to conduct surveys during a time that would to avoid impacts to most marine mammals. The in-ice surveys in the Action Area are designed to occur after most of the bowhead whale fall migration is complete. A few late migrants have the potential to temporally and spatially overlap with in-ice survey operations and these whales could experience noise exposure and exhibit avoidance responses, including adjusting their path. Overall, these effects would be temporary and non-lethal.

Potential Effects from Onshore Base Construction

The First Incremental Step includes construction of one on-shore base at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months when bowhead whales are largely expected to be absent from the Area. All construction during the First Incremental Step would be limited to land so effects to the marine environment would be minimal and there would be no impacts to bowhead prey base. Construction would produce low energy localized noise from land-based equipment operation, generators, etc. Noise from on-land pile driving (i.e., no marine construction) would be the loudest source of noise. Excavation and construction are slow moving operations, with a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as plans are submitted. Companies would have to work with landowners (i.e. BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permits.

Vessel (during the open-water season) and aircraft traffic would be associated with the construction of an on-shore base and potential effects from these sources have been addressed above.

It is generally expected that whales would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities. Whales likely would avoid activities that bothered them; the distances vary according to individual and site-specific conditions (activity type, duration, and timing, etc.).

Bowhead whales would be expected to display variable responses to construction activity (ranging from no response to avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Bowhead whales do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary lasting from minutes (for vessels and aircraft). Similarly, whales could exhibit the same behaviors if they saw or smelled emissions from a construction activity, and move away from it.

Individual and groups of bowhead whales engaged in migration during the fall-early winter period would be expected to defer migration route up to several kilometers in an avoidance response to encountering sufficient levels of construction noise.

5.2.2.1.4. Potential Effects from Exploratory Drilling Operations

The different types of MODUs that could be used in the Action Area are described in Section 2.2.1.1.4.

The MODUs that would be used for exploration in the Action Area require transport either by towing or are self-propelled for transfer from site to site. The physical presence of these MODUs in place may cause bowhead whales to avoid them. When on site for up to 60 days, exploratory drilling operations produce noise in the marine environment that is a stationary noise footprint that may slightly deter bowhead whales from feeding areas or migration path. The technological and logistical capabilities are not yet available to study exposure rates, response rates, and individual and population effects of numerous human activities on bowhead whales.

Some bowhead whales could experience noise exposure and adjust their path around active exploratory drilling operations. The degree of this alteration would depend on the timing and location of the drilling operation, noise levels, level of peripheral activities that are co-occurring with drilling, and feeding opportunities for bowheads. These small adjustments would be temporary, non-lethal.

5.2.2.1.5. Potential Effects from Discharges

Authorized Discharges

The EPA Arctic NPDES general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. This includes permit limits on the discharges such that it would tend to reduce the potential for impacts to the environment and species.

The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012).

There could be slight alterations in bowhead whale habitat as a result of exploration. Bowhead whales feed primarily on pelagic zooplankton and little on benthic invertebrates. Adverse effects to benthic invertebrates on-site would be negligible when compared to their availability in the surrounding areas.

Discharges from the First Incremental Step of the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or through affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, typical discharge criteria and other mitigation measures, authorized discharges from the First Incremental Step of the Proposed Action will have negligible impacts on bowhead whales.

Unauthorized Discharges

Oil spills are accidental or unlawful events that are evaluated according to two different size categories: small and large spills. Spills that are reasonably foreseeable during the First Incremental Step are expected to be small and limited to refined oils because crude and condensate oils would not be produced at this stage. Refined oil would be used in the drilling activity for the equipment and refueling. BOEM and BSEE estimate that about 20 spills occur during the First Incremental Step ranging in size from < 1 bbl up to 55 bbls per spill.

Small Oil Spills

Small oil spills are defined as being <1,000 bbl. Zero to six small spills in total (0–3 annually) could occur during geological and geophysical activities and 0–14 small spills total (0–2 annually) could occur during exploration and delineation drilling activities during the First Incremental Step for a total of 0–20 small spills (0–5 annually). Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers failure of spill prevention measures or rupture of fuel lines. There are no reported historical fuel spills from geological or geophysical operations in the Chukchi Sea OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum potential annual levels of geological and geophysical activities could range from 0 if no fuel spills occur to <13 bbl if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤ 55 bbl spill is estimated to occur during exploration drilling operations from refueling (USDOI, BOEM 2014).

A small fuel spill would be localized and would not permanently affect zooplankton populations that are bowhead whale prey. The amount of zooplankton and other prey lost in such a spill likely would be undetectable compared to what is available on the whales' summer feeding grounds.

Some small spills could be in or close to areas used by bowhead whales. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from bowhead whales and reduce the opportunity for whales to contact these spills.

Large Oil Spills

No large oil spills are estimated to occur from exploration activities during the First Incremental Step (see Section 2.1.1.1.1 and USDOI, BOEM, 2014). The analysis supporting this estimate is detailed in Section 2.2.1.1.4 of this BA. A hypothetical large oil spill scenario is evaluated under for Future Incremental Steps (Section 5.3).

Summary of Potential Oil Spill Effects to Bowhead Whales in the Action Area

Some small spills could be in or close to areas used by bowhead whales. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from bowhead whales and reduce the opportunity for whales to contact these spills.

5.2.2.1.6. Summary of Potential Effects during the First Incremental Step on Bowhead Whales

The interaction of marine seismic surveys, geohazard surveys, geotechnical surveys, drilling from MODUs, construction of shorebases and aircraft traffic may have short-term and localized impacts on bowheads during the First Incremental Step. Though the noise levels from airguns could produce short-term and localized effects on bowheads, mitigations typically required (see Section 2.3 of this BA and Appendix C of USDOI, BOEM, 2014) would reduce the impacts to bowhead whales. Small oil spills would have minimal effects on bowhead whales due to their small volume, rapid weathering, and rapid dispersal. Vessel traffic may result in impacts that could be long-lasting and widespread. However, considering the low levels of vessel traffic associated with the First Incremental Step, few mortalities would be likely during this phase however there could be some behavioral responses i.e. avoidance of traffic.

5.2.2.2. Potential Effects of the First Incremental Step on the Fin Whale

Direct and indirect effects to fin whales could arise during the First Incremental Step from vessel and aircraft traffic, seismic surveys, geohazard and geotechnical surveys, onshore base construction, and exploratory drilling operations associated with the Proposed Action. Individual and small groups of fin whales have been documented in portions of Action Area; however, no consistently used areas have been identified.

Fin whales may be found throughout the OCS of the Chukchi Sea during the open water season; however, the numbers of individuals detected have always been very low. Though fin whales differ from bowhead whales in many ways, their auditory abilities, sensitivities, behavior, and physiology are comparable to bowhead whales such that the effects analysis for bowhead whales is applicable to fin whales.

5.2.2.2.1. Potential Effects from Vessel Traffic

Vessel traffic could affect fin whales in the same ways as previously discussed for bowhead whales in this section on potential effects. Few individuals or groups of fin whales would be encountered by vessels in the Action Area. Fin whales are found in the Chukchi Sea during the open water period when ice management may be needed. However, icebreaker activity is unlikely to affect fin whales because there are relatively small numbers of fin whales in the Chukchi Sea planning area as compared to the overall population of North Pacific fin whales.

5.2.2.2.2. Potential Effects from Aircraft Traffic

Aircraft traffic could affect fin whales in the same ways as previously discussed for bowhead whales in this section on potential effects. Few individuals or groups of fin whales would be encountered by aircraft in the Action Area. There are relatively small numbers of fin whales in the Chukchi Sea planning area as compared to the overall population of North Pacific fin whales. Currently, 1,500 ft (456 m) is the current mitigation applied to industry-operational aircraft in the Chukchi Sea and Beaufort Sea Planning Areas to protect marine mammals, including the fin whale. With inclusion of the mitigation measures designed to avoid or minimize impacts, aircraft activity associated with the First Incremental Step of the Proposed Action, is likely to have no impact on fin whales.

5.2.2.2.3. Potential Effects from Seismic and Other Surveys

Seismic surveys could affect fin whales in the same ways as previously discussed for bowhead whales. Fin whales conceivably could be disturbed or harmed by seismic survey noise in certain situations. Mitigation measures are designed to avoid these situations.

In this section we consider the level of seismic activity and the mitigation measures typically required under an IHA issued under the MMPA by NMFS (Section 2.3). This analysis addresses the potential level of effect from both in-ice and open-water seismic surveys and does not include vessel presence and noise, aircraft presence and noise, discharges, etc.

5.2.2.2.4. Potential Effects from Seismic Surveys using Airguns

The Proposed Action considers that no more than one deep penetration survey may occur annually during the First Incremental Step. Fin whales may avoid operating airguns, but avoidance radii are likely quite variable. Some fin whales may avoid an active seismic source at 20–30 km, but others may respond from even further (35 km), depending on the individual whale and other circumstances. Avoidance distances can exceed the distance at which boat-based observers can see whales, which indicates 1) that the whales may respond to lower sounds at greater distances and 2) that these whales were outside sounds levels for TTS and PTS. Slight changes in swim path do not constitute “take” under the MMPA or ESA and are not considered biologically important.

The Proposed Action also considers that no more than two ancillary seismic or other site clearance surveys may occur annually during the First Incremental Step. High-resolution ancillary seismic surveys are of shorter duration and have a smaller zone of influence than deep penetration seismic surveys. These activities use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys. Fin whales are expected to continue normal behavior at closer distances to high-resolution seismic surveys than to 2D/3D seismic surveys. The primary concern with high resolution surveys is the potential for these activities to add to noise and disturbance from 2D/3D seismic or drilling activities, and to cause local impacts within a specific area; however, concentrations of fin whales are not expected in the Action Area and no important areas have been identified.

Mitigation measures associated with seismic surveys using airguns include implementation of power-down and shut-downs to avoid exposure of fin whales to TTS-level sounds, active monitoring to

avoid collisions, and regular recording of observations whether actively conducting seismic surveys or not. Furthermore, aircraft surveys are used to relay updated monitoring information to seismic survey operators to minimize effects upon fin whales. Data from routine survey and weekly industry reports is used by an inter-agency team to assess the potential for overlapping or interacting activities on the Action Area to further minimize effects on fin whales. Implementation of typical mitigation measures for active seismic operations decreases the potential for effects.

In-Ice Seismic Surveys

Because fin whales would likely not be present when the in-ice survey would be conducted the activity will have no impact on fin whales.

Summary of Potential Effects from Seismic Surveys

There are relatively small numbers of fin whales in the Chukchi Sea as compared to the overall population of North Pacific fin whales. Therefore, few individuals or groups of fin whales would be encountered by seismic survey activities in the Action Area.

5.2.2.2.5. Potential Effects from Onshore Facility Construction

The First Incremental Step includes construction of one on-shore base at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months when fin whales are absent from the Area. All construction is limited to land so effects will be minimal and there will be no impacts to fin whale prey base. Construction would produce low energy localized noise from land-based equipment operation, generators, etc. Noise from on-land pile driving (no marine) would be the loudest source of noise. Excavation and construction are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as plans are submitted. Companies would have to work with landowners (i.e. BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permits.

Vessel (during the open-water season) and aircraft traffic would be associated with the construction of an on-shore facility and potential effects from these sources have been addressed above.

It is generally expected that whales would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should be limited to behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities, dredging, or pipeline construction. Whales likely would avoid activities that bothered them; the distances vary according to individual and site-specific conditions (e.g., activity type, duration, and timing).

Fin whales would be expected to display variable responses to construction activity (ranging from no response to avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Similarly, whales could exhibit the same behaviors if they saw or smelled emissions from a construction activity, and move away from it.

5.2.2.2.6. Potential Effects from Exploratory Drilling Operations

Exploration drilling operations generate continuous type underwater sounds that could affect fin whales in the same ways as previously discussed for bowhead whales in this section on potential effects. Fin whales may avoid areas around an active drill site. As the whales encounter the continuous noise source, they would not be expected to proceed towards a noise source that was

bothering them. Given the small number of fin whales occurring in the Action Area, drilling operations will have minimal impacts on fin whales.

5.2.2.2.7. Potential Effects from Discharges

Authorized Discharges

The Arctic NPDES general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. This includes permit limits on the discharges such that it would tend to reduce the potential for impacts to the environment and species. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012).

Discharges from the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. Discharge of drilling muds and cuttings during the First Incremental Step is not expected to cause population-level effects, either directly through contact or through affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, typical discharge criteria, other mitigation measures, and the low number of fin whales are anticipated to occur in the Action Area, authorized discharges resulting from First Incremental Step activities of the Proposed Action are will have insignificant impacts on fin whales.

Unauthorized Discharges

Spills during the First Incremental Step of the Proposed Action are expected to be small and consist of refined oils because crude and condensate oils would not be produced at this stage. Refined oil would be used in the drilling activity for the equipment and refueling. BOEM and BSEE estimate that about 20 spills of refined oil occur during the First Incremental Step ranging in size from < 1bbl up to 55 bbls per spill (Section 2.2.1.1.4)

Small Oil Spills

Small oil spills are defined as being <1,000 bbl. Zero to six small spills in total (0–3 annually) could occur during geological and geophysical activities and 0–14 small spills total (0–2 annually) could occur during exploration and delineation drilling activities during the First Incremental Step for a total of 0–20 small spills (0–5 annually). Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers spill prevention measures fail or fuel lines rupture. There are no reported historical fuel spills from geological or geophysical operations in the Chukchi Sea OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum anticipated annual levels of geological and geophysical activities could range from 0 if no fuel spills occur to <13bbl if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. For the purposes of analysis in this BA, A ≤55 bbl spill is estimated to occur during exploration drilling operations from refueling (USDOI, BOEM, 2014).

Some small spills could be in or close to areas used by the few fin whales possibly occurring in the Action Area. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from fin whales and reduce the opportunity for whales to contact these spills. Because of their scarcity in the Chukchi Sea and the fact that existing observations show fin whales mostly in the southern Chukchi Sea, small oil, or natural gas releases during the First Incremental Step of the Proposed Action will have insignificant impacts on fin whales.

Large Oil Spill

No large oil spills are estimated to occur from exploration activities during the First Incremental Step (see Section 2.1.1.1.1 and USDOJ, BOEM, 2014). The justification for this assumption is detailed in Section 2.2.1.1.4 of this BA. A hypothetical large oil spill scenario is evaluated in Future Incremental Steps (Section 5.3.2).

Summary of Potential Oil Spill Effects on Fin Whales in the Action Area

The few fin whales that could be in the Action Area could experience similar types of adverse effects as bowhead whales but at a much reduced degree because they are much less abundant in the action area, they typically occur only during the open-water season, there are few calves (conceivably the most vulnerable component of a population), and have a more dispersed prey base. There are no hypothetical situations or scenarios where a large number of fin whales would be anticipated to experience adverse effects from a small spill during the First Incremental Step of the Proposed Action.

5.2.2.2.8. Summary of Potential Effects during the First Incremental Step

The effects to fin whales from IPFs in association with the First Incremental Step of the Proposed Action would be similar to those described for bowhead whales. However, because fin whales have limited range and low numbers in the Action Area any effects due to activities during the First Incremental Step are insignificant.

5.2.2.3. Potential Effects of the First Incremental Step on the Humpback Whale

Direct and indirect effects to humpback whales could arise during the First Incremental Step from vessel and aircraft traffic, seismic surveys, geohazard and geotechnical surveys, onshore base construction, and exploratory drilling operations associated with the Proposed Action. Individual and small groups of humpback whales have been documented in the Action Area; however, no consistently used areas have been identified because of the scarcity of this species in the Action Area.

Though humpback whales differ from bowhead and fin whales in many ways, their auditory abilities, sensitivities, behavior, and physiology are comparable to bowhead and fin whales such that the effects analysis for bowhead and fin whales is applicable to humpback whales.

5.2.2.3.1. Potential Effects from Vessel Traffic

Vessel traffic could affect humpback whales in the same ways as previously discussed for bowhead whales in this section on potential effects. However, few individuals or groups of humpback whales would be encountered by vessels in the Action Area. Humpback whales are found in the Chukchi Sea during the open water period when ice management may be needed; however, icebreaker activity is unlikely to affect humpback whales. There are relatively small numbers of humpback whales in the Action Area as compared to the overall population of humpback whales. Typical mitigation measures and approach regulations for vessel traffic are designed to avoid or minimize adverse impacts.

5.2.2.3.2. Potential Effects from Aircraft Traffic

Aircraft traffic could affect humpback whales in the same ways as previously discussed for bowhead whales in this section on potential effects. However, few individuals or groups of humpback whales would be encountered by aircraft in the Action Area. There are relatively small numbers of humpback whales in the Action Area as compared to the overall population of humpback whales. Currently, 1,500 ft (456 m) is the current mitigation applied to industry-operational aircraft in the Chukchi Sea to protect marine mammals, including the humpback whale. Typical mitigation measures (see Section 2.3) and approach regulations for aircraft traffic are designed to avoid or minimize adverse impacts.

5.2.2.3.3. Potential Effects from Seismic and Other Surveys

Seismic surveys during the First Incremental Step of the Proposed Action could affect humpback whales in the same ways as previously discussed for bowhead whales. Humpback whales could be disturbed or harmed by seismic survey noise in certain situations. Mitigation measures are designed to avoid these situations.

In this section we consider the level of seismic activity and the mitigation measures typically required under an Incidental Harassment Authorization issued under the Marine Mammal Protection Act (MMPA) by the NMFS (Section 2.3.1.3). This analysis addresses the potential level of effect from both in-ice and open-water seismic surveys and does not include vessel presence and noise, aircraft presence and noise, discharges, etc.

5.2.2.3.4. Potential Effects from Seismic Surveys using Airguns

The First Incremental Step of the Proposed Action considers that no more than one deep penetration survey may occur annually during the First Incremental Step. Seismic surveys could affect humpback whales in the same ways as previously discussed for bowhead whales in this section on potential effects. Humpback whales may avoid operating airguns, but avoidance radii are likely quite variable. Some humpback whales may avoid an active seismic source at 20–30 km, but others may respond from even further (35 km), depending on the individual whale and other circumstances. Avoidance distances can exceed the distance at which boat-based observers can see whales, which indicates: 1) that the whales may respond to lower sounds at greater distances; and 2) that these whales were outside sounds levels for TTS and PTS. Slight changes in swim path do not constitute “take” under the MMPA or ESA and are not considered biologically important.

The Proposed Action also considers that no more than two ancillary seismic or other site clearance surveys may occur annually during the First Incremental Step. High-resolution ancillary seismic surveys are of shorter duration and have a smaller zone of influence than deep penetration seismic surveys. These activities use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys. Humpback whales are expected to continue normal behavior at closer distances to high-resolution seismic surveys than to 2D/3D seismic surveys. The primary concern with high resolution surveys is the potential for these activities to add to noise and disturbance from 2D/3D seismic or drilling activities, and to cause local impacts within a specific area, however concentrations of humpback whales are not expected in the Action Area and no important areas have been identified.

Mitigation measures associated with seismic surveys using airguns include implementation of power-down and shut-downs to avoid exposure of humpback whales to TTS-level sounds, active monitoring to avoid collisions, and regular recording of observations whether actively conducting seismic surveys or not. Furthermore, airplane surveys are used to relay updated monitoring information to seismic survey operators to minimize effects upon humpback whales. Data from routine survey and weekly industry reports is used by an inter-agency team to assess the potential for overlapping or interacting activities on the Action Area to further minimize effects on humpback whales.

Implementation of typical mitigation measures for active seismic operations decreases the potential for adverse effects.

In-Ice Seismic Surveys. Humpback whales would not be expected to be present when in ice surveys would be conducted and thus will not be impacted.

Summary of Potential Effects from Seismic Surveys: Few individuals or groups of humpback whales would be expected to encounter seismic survey activities in the Action Area and there are relatively small numbers of humpback whales in the Action Area as compared to the overall population of humpback whales. Therefore seismic activity is expected to have insignificant impacts on humpback whales.

5.2.2.3.5. Potential Effects from Onshore Base Construction

The First Incremental Step of the Proposed Action includes construction of up to three shore bases at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months when humpback whales are absent from the Area. All construction is limited to land so effects will be minimal and there will be no impacts to humpback whale prey base. Construction would produce low energy localized noise from land-based equipment operation, generators, etc. Noise from on-land pile driving (no marine) would be the loudest source of noise. Excavation and construction are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as plans are submitted. Companies would have to work with landowners (i.e., BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permits.

Vessel (during the open-water season) and aircraft traffic would be associated with the construction of an on-shore facility and potential effects from these sources have been addressed above.

It is generally assumed that whales would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities, dredging, or pipeline construction. Whales likely would avoid activities that bothered them; the distances vary according to individual and site-specific conditions (activity type, duration, and timing, etc.).

Humpback whales would be expected to display variable responses to construction activity (ranging from no response to avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Similarly, whales could exhibit the same behaviors if they saw or smelled emissions from a construction activity, and move away from it.

5.2.2.3.6. Potential Effects from Exploratory Drilling Operations

Exploration drilling operations generate continuous type underwater sounds that could affect humpback whales in the same ways as previously discussed for bowhead whales in this section on potential effects. Humpback whales may avoid areas around an active drill site. As the whales encounter the continuous noise source, they would not be expected to proceed towards a noise source that was bothering them. Given the small number of humpback whales occurring in the Action Area, drilling operations that would occur during the First Incremental Step of the Proposed will have insignificant impacts on this species.

5.2.2.3.7. Potential Effects from Discharges

Authorized Discharges

The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. This includes permit limits on the discharges such that it would tend to reduce the potential for impacts to the environment and species. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

The current Arctic National Pollutant Discharge Elimination System (NPDES) General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012e).

Discharges from the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or through affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, typical discharge criteria, other typical mitigation measures, and the low number of humpback whales in the Action Area, authorized discharges associated with the First Incremental Step of the Proposed Action will have insignificant impacts on this species.

Unauthorized Discharges

Very low numbers of humpback whales have been observed in the Chukchi Sea during the open water season (i.e., Allen and Angliss, 2014; Clarke et al.; 2013; NMFS; 2013b) however some individuals could be vulnerable to contact from summer spill events. Oil spills are accidental or unlawful events that are evaluated according to two different size categories: small and large.

Small Oil Spills

Small oil spills are defined as being <1,000 bbl. Zero to six small spills in total (0–3 annually) could occur during geological and geophysical activities and 0–14 small spills total (0–2 annually) could occur during exploration and delineation drilling activities during the First Incremental Step for a total of 0–20 small spills (0–5 annually). Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers spill prevention measures fail or fuel lines rupture. There are no reported historical fuel spills from geological or geophysical operations on the Chukchi OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum potential annual levels of geological and geophysical activities could range from 0 if no fuel spills occur to <13 bbl if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤55 bbl spill was estimated to occur during exploration drilling operations from refueling (USDOI, BOEM, 2014).

Some small spills could be in or close to areas used by the few humpback whales possibly occurring in the Action Area. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from humpback whales and

reduce the opportunity for whales to contact these spills. Because of their scarcity in the Chukchi Sea and the fact that existing observations show fin whales mostly in the southern Chukchi Sea, small oil, or natural gas releases during the First Incremental Step of the Proposed Action will have little impact on this species.

Large Oil Spills

No large oil spills are estimated to occur from exploration activities during the First Incremental Step (see Section 2.1.1.1.1 and USDOJ, BOEM, 2014). The analysis supporting this estimate is detailed in Section 2.2.1.1.4 of this BA. A hypothetical large oil spill scenario is evaluated for Future Incremental Steps (Section 5.3.2).

Summary of Potential Oil Spill Effects on Humpback Whales in the Action Area

The few humpback whales that could be in the Action Area are anticipated to experience similar types of effects as bowhead whales but at a much reduced degree because they are much less abundant in the action area, they typically occur only during the open-water season, there are few calves (conceivably the most vulnerable component of a population), and have a more dispersed prey base. There are no hypothetical situations or scenarios where a large number of humpback whales would be likely to be affected by small spills from first increment step activities of the Proposed Action.

5.2.2.3.8. Summary of Potential Effects during the First Incremental Step on Humpback Whales

The effects to humpback whales in association with the First Incremental Step of the Proposed Action would be similar to those described for bowhead whales. However, because humpback whales have limited range and low numbers in the Action Area any effects due to activities during the First Incremental Step are insignificant.

5.2.2.4. Potential Effects of the First Incremental Step on the Bearded Seal

Direct and indirect effects to bearded seals could arise during the First Incremental Step of the Proposed Action from vessel and aircraft traffic, seismic surveys, geohazard and geotechnical surveys, onshore facility construction, and exploratory drilling operations associated with the Proposed Action.

5.2.2.4.1. Potential Effects from Vessel Traffic

Should they encounter vessel traffic related to the First Incremental Step of the Proposed Action, bearded seals would be expected to move away from the vessels. The effects of vessel presence on bearded seals in open water would likely be temporary and transient, affecting only a small number of the bearded seals in the region. Bearded seals resting on sea ice could move into the water when a vessel approached or passed them, but the seals would return to their normal activities once the vessel passed.

Icebreakers are designed to function outside the open-water season, operating in ice habitats. The pack ice habitat is most important to bearded seals during the pupping season. If icebreaking activities occur between mid-March and late-June, the likelihood of negative impacts (e.g., pup mortalities, disturbance, and sea ice alteration) could increase. The Proposed Action does not include vessels operating during the bearded seal pupping season. Icebreakers could disturb some bearded seals resting on the sea ice, but the seals are expected to return to their normal activities once the icebreaker has passed.

Vessels are unlikely to strike bearded seals. Bearded seals predominantly use polynyas, leads, and the ice front in areas of pack ice. They have good visual and auditory acuity and are agile in the water. These factors make vessel strikes unlikely.

Vessel traffic associated with the Proposed Action is subject to typical mitigation measures (see Section 2.3) required under the MMPA which also covers marine mammals listed under the ESA. These mitigation measures are designed to avoid or minimize adverse effects to bearded seals.

5.2.2.4.2. Potential Effects from Aircraft Traffic

The majority of aircraft associated with the First Incremental Step of the Proposed Action would occur during the open water season. Some disturbance to bearded seals could occur early in the season as aircraft fly from onshore areas to exploration sites/facilities, however any such incidents would be infrequent and the routine 1,500 ft aircraft altitude restrictions should avoid aircraft disturbance to ringed seals. Some seals may still leave the ice and enter the water until the aircraft has passed. Such brief and occasional disturbances should not have serious adverse effects to bearded seals.

Aircraft activities associated with the Proposed Action are subject to typical mitigation measures required under the MMPA. These mitigation measures are designed to avoid or minimize adverse effects to bearded seals.

5.2.2.4.3. Potential Effects from Seismic and Other Surveys

Most seismic surveys use airguns of various sizes and array designs. Bearded seals conceivably could be disturbed or harmed by seismic survey noise in certain situations during the First Incremental Step of the Proposed Action. Mitigation measures are designed to avoid these situations. In this section we consider the level of seismic activity and the mitigation measures typically required under an IHA issued by NMFS (Section 2.3.1.3). The following sections make a distinction between typical seismic surveys and those surveys that are sufficiently different to require a separate analysis. The categories are seismic surveys using airguns, and in-ice seismic surveys. This analysis addresses the potential level of effect from both in-ice and open-water seismic surveys and does not include vessel presence and noise, aircraft presence and noise, discharges, etc.

5.2.2.4.4. Potential Effects from Seismic Surveys using Airguns

Marine seismic surveys conducted during the First Incremental Step of the Proposed Action could affect many bearded seals in the Action Area, however, the most common response of bearded seals to ongoing seismic activities has been swimming and looking behavior from within a few hundred meters until the seismic vessel and airguns depart the area (Harris, Miller, and Richardson, 2001; Miller and Davis, 2002; Blees, Hartin, and Ireland, 2010; Reiser et al., 2010). Existing observations indicate a possible minor avoidance reaction by bearded seals from the firing of airgun arrays, but not to an excessive degree. Consequently bearded seals could briefly divert around active seismic surveys before resuming travel. The Proposed Action considers that no more than one deep penetration survey may occur annually during the First Incremental Step. Offshore seismic surveys are less likely to affect bearded seals because bearded seals prefer the areas with sea ice, areas avoided by typical marine surveys.

Bearded seal reactions to deep penetration surveys are expected to be restricted to small distances and brief durations, with no long-term effects. Southall et al. (2007) proposed that PTS could occur to ice seals exposed to single sound pulses at 218 dB re: 1 μ Pa (rms) in water, however, injury from seismic surveys may occur only if animals entered the zone immediately surrounding the sound source.

Because noise loss occurs rapidly with distance from operating airguns, some bearded seals may hear some level of underwater sound, but bearded seals are not expected to experience seismic noise levels that could result in a TTS or PTS.

The Proposed Action also considers that no more than two ancillary seismic or other site clearance surveys may occur annually during the First Incremental Step. High-resolution ancillary seismic surveys are of shorter duration and have a smaller zone of influence than deep penetration seismic surveys. These activities use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys.

Mitigation measures associated with seismic surveys using airguns include implementation of power-down and shut-downs to avoid exposure of bearded seals to TTS-level sounds, active monitoring to avoid collisions, and regular recording of observations whether actively conducting seismic surveys or not. Data from routine survey and weekly industry reports is used by an inter-agency team to assess the potential for overlapping or interacting activities on the Action Area to further minimize effects on bearded seals. Implementation of typical mitigation measures for active seismic operations decreases the potential for adverse effects.

In-Ice Seismic Surveys. Bearded seals have occasionally been reported to maintain breathing holes in sea ice; however, in winter they are found primarily in areas with persistent leads or cracks in broken areas within the pack ice, particularly if the water depth is <200 m. Bearded seals apparently also feed on ice-associated organisms when they are present, and this allows a few bearded seals to live in areas 200 m deep or more.

Impacts to bearded seals from in-ice surveys would primarily be disturbance or displacement. It is unlikely that large numbers of bearded seals would be encountered during an in-ice seismic survey because most bearded seals would typically migrate south into the Chukchi and Bering seas in fall with the advancing pack ice. It is more likely that some bearded seals would be encountered during an in-ice seismic survey in the Action Area.

The 190-dB received sound level typically varies from 670 m to 215 m depending according to equipment and water depth. PSOs are unlikely to identify bearded seals at these distances, particularly during periods of poor visibility or darkness. Some individual bearded seals may be exposed to sound at the 190-dB level with minor short-term impacts. Implementation of typical mitigation measures for in-ice seismic operations decreases the potential for adverse effects.

Summary of Potential Effects from Seismic Surveys : The greatest effect of seismic surveys on bearded seals is the site-by-site disturbance effect as bearded seals move away from underwater sounds. This displacement would separate the seals from sounds that would injure them. Some bearded seals in open water may be disturbed, although many will be close to the nearshore zone and areas with sea ice, depending on water depths. As many as several thousand bearded seals could hear and react to seismic surveys in the Action Area. The Proposed Action includes marine deep penetration seismic, ancillary site clearance and other survey activities. These can include open-water and in-ice techniques and equipment. The implementation of typical mitigation measures for all forms of seismic operations decreases the potential for adverse effects.

5.2.2.4.5. Potential Effects from Onshore Base Construction

The First Incremental Step of the Proposed Action includes construction of one on-shore base at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months and construction is limited to land so effects will be minimal. Construction would produce low energy localized noise from activities such as equipment operation and generators. Noise from on-land pile driving would be the loudest source of noise. No marine pile-driving would occur during the First Incremental Step. Excavation and construction are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as plans are submitted. Companies would have to work with landowners (i.e. BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permits.

Vessel (during the open-water season) and aircraft traffic would be associated with the construction of an on-shore facility and potential effects from these sources have been addressed above.

The loudest noise associated with construction would be pile-driving on land, and Greene et al. (1995) described marine pile-driving noise levels of 131–135 dB re 1 μ Pa (rms) (40 – 100 Hz) at 1 km from the source. On-shore levels are expected to be less. The audibility range for phocid seals occurs in a 50 Hz – 80 kHz band (Ciminello et al., 2012), overlapping the 100 Hz – 2 kHz frequency noise range produced by marine pile driving. Though there is overlap in the noise frequencies affected by pile-driving and the noise frequencies used by bearded seals, the overlap occurs at the bottom of the audibility spectrum for seals. Furthermore it is generally assumed that seals, would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities.

Seals likely would avoid activities that bothered them; the distances vary according to individual and site-specific conditions (activity type, duration, and timing, etc.).

Noise and disturbance from on-shore facility construction may affect nearby bearded seals. Ringed seals near Northstar in 2000 and 2001 established lairs and breathing holes in the landfast ice within a few meters of Northstar, before and during the onset of winter oil activity. Seal use of the habitat continued despite low-frequency noise and vibration, construction, and use of an ice road (Williams et al., 2006). Blackwell et al. (2003) determined ringed seal densities were significantly higher around offshore industrial facilities. Another study by Frost and Lowry (1988) found ringed seal densities between 1985 and 1986 were higher in industrialized areas than in the controls in the Central Beaufort Sea. These activities will not affect food availability as construction is all onshore.

5.2.2.4.6. Potential Effects from Exploratory Drilling Operations

Exploration drilling operations during the First Incremental Step of the Proposed Action would generate continuous type underwater sounds that could affect bearded seals. Bearded seals may avoid areas around an active drill site. As individual bearded seals encounter the continuous noise source, they would not be expected to proceed towards a noise source that was bothering them. Drilling operations using fixed or floating platforms are expected to displace small numbers of bearded seals from an area around the drilling platform.

Exploration wells would be drilled into the formation, introducing drilling noise into the environment. Exploratory drilling would occur during the open water period when MODUs could be brought to the drill site. Such operations could affect bearded seals since broadband source levels from the drillship *Noble Discoverer* ranged from 177 to 185 dB re 1 μ Pa (rms) during Chukchi Sea drilling activities in 2012 (Shell 2011), and jack-up rigs are assumed to produce lower noise levels than drillships. Koski and Johnson (1987) concluded the area of effects for exploratory drilling noise would radiate approximately 12.4+ mi (20+ km) from an operating drillship. The limited number of exploration wells (4 per year), would affect some bearded seals however seals near the Northstar Production facility in the Beaufort Sea seem to have habituated to the activity and construction, with slightly higher numbers detected around the Northstar Production facility than in waters further from the production facility.

5.2.2.4.7. Potential Effects from Discharges

Authorized Discharges

The Arctic NPDES general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. This includes permit limits on the

discharges such that it would tend to reduce the potential for impacts to the environment and species. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012).

Discharges from First Incremental Step activities of the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. No adverse effect from regulated wastewater discharges have been noted for bearded seals in the Alaskan OCS. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or through affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, typical discharge criteria and other mitigation measures few affects to bearded seals are anticipated.

Unauthorized Discharges

Potential effects of oil spills on ice seals are discussed in Section 5.2.1.5.2. Oil spills are accidental or unlawful events that are evaluated according to different size categories: small and large.

Small Oil Spills

Small oil spills are defined as being <1,000 bbl. Zero to six small spills in total (0–3 annually) could occur during geological and geophysical activities and 0–14 small spills total (0–2 annually) could occur during exploration and delineation drilling activities during the First Incremental Step for a total of 0–20 small spills (0–5 annually). Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers spill prevention measures fail or fuel lines rupture. There are no reported historical fuel spills from geological or geophysical operations on the Chukchi Sea OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum potential annual levels of geological and geophysical activities could range from 0 if no fuel spills occur to <13 bbl if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤ 55 bbl spill is estimated to occur during exploration drilling operations from refueling (USDOI, BOEM, 2014).

Some small spills could be in or close to areas used by bearded seals. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from bearded seals and reduce the opportunity for ice seals to contact these spills.

Large Oil Spills

No large oil spills are estimated to occur from exploration activities during the First Incremental Step (see Section 2.1.1.1.1 and USDOI, BOEM, 2014). The justification for this assumption is detailed in Section 2.2.1.1.4 of this BA. A hypothetical large oil spill scenario is evaluated under for Future Incremental Steps (Section 5.3.2).

Summary of Potential Oil Spill Effects on Bearded Seals in the Action Area

Some small spills could be in or close to areas used by bearded seals. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from bearded seals and reduce the opportunity for ice seals to contact these spills.

5.2.2.4.8. Summary of Potential Effects during the First Incremental Step.

The interaction of marine seismic surveys, geohazard surveys, geotechnical surveys, exploratory drilling from MODUs, and construction of shorebases and aircraft traffic may have short-term and localized impacts on bearded seals during the First Incremental Step. Though the noise levels from airguns could produce short-term and localized effects on bearded seals, mitigations typically required (see Appendix C of USDOI, BOEM, 2014) by NMFS would reduce the impacts to seals. Exploratory drilling operations using MODUs are expected to displace small numbers of bearded seals from an area around the drilling unit, but is not expected to affect distribution of the species on a broad geographic scale. Small oil spills would have minimal effects on bearded seals due to their small volume, rapid weathering, and rapid dispersal.

5.2.2.5. Potential Effects of the First Incremental Step on the Ringed Seal

Direct and indirect effects to ringed seals could arise during the First Incremental Step of the Proposed Action from vessel and aircraft traffic, seismic surveys, geohazard and geotechnical surveys, onshore base construction, and exploratory drilling operations associated with the Proposed Action.

5.2.2.5.1. Potential Effects from Vessel Traffic

If vessel traffic related to the First Incremental Step of the Proposed Action is encountered, ringed seals would be expected to move away from these vessels. The effects of vessel presence on ringed seals in open water would likely be temporary and transient, affecting only a small number of the ringed seals in the region. Ringed seals resting on icebergs could move into the water when a vessel approached or passed them, but the seals would return to their normal activities once the vessel passed. Ice leads created by icebreakers refreeze within a matter of several hours in many cases.

Icebreakers are designed to function outside the open-water season, operating in ice habitats. The ice habitats most important to ringed seals are shorefast ice for breeding lairs. If icebreaking activities occur between mid-March and late-June, the likelihood of negative impacts (e.g., ringed seal den destruction, ringed seal mortalities, disturbance, and sea ice alteration) to ringed seals could increase. The Proposed Action does not include vessels operating in shorefast ice during the seal pupping season. Icebreakers could disturb some ringed seals resting on the sea ice, but the seals are expected to return to their normal activities once the icebreaker has passed.

Vessels are unlikely to strike ringed seals. Ringed seals predominantly use polynyas, leads, and the ice front in areas of pack ice. They have good visual and auditory acuity and are agile in the water. These factors make vessel strikes unlikely.

Vessel traffic associated with the First Incremental Step of the Proposed Action are subject to typical mitigation measures (see Section 2.3) required under the MMPA which also covers marine mammals listed under the ESA. These mitigation measures are designed to avoid or minimize adverse effects to ringed seals.

5.2.2.5.2. Potential Effects from Aircraft Traffic

The majority of aircraft associated with First Incremental Step activities of the Proposed Action would occur during the open water season. Some disturbance to ringed seals could occur early in the season as aircraft fly from onshore areas to exploration sites/facilities, however any such incidents would be infrequent and the routine 1,500 ft aircraft altitude restrictions should avoid aircraft disturbance to ringed seals. Some seals may still leave the ice and enter the water until the aircraft has passed. Such brief and occasional disturbances should not have serious adverse effects to ringed seals.

Aircraft activities associated with the Proposed Action are subject to typical mitigation measures required under the MMPA. These mitigation measures are designed to avoid or minimize adverse effects to ringed seals.

5.2.2.5.3. Potential Effects from Seismic and Other Surveys

Most seismic surveys use airguns of various sizes and array designs. Ringed seals conceivably could be disturbed or harmed by seismic survey noise in certain situations during the First Incremental Step of the Proposed Action. Mitigation measures are designed to avoid these situations. In this section BOEM and BSEE considers the level of seismic activity and the mitigation measures typically required under an Incidental Harassment Authorization issued by the NMFS (Section 2.3.1.3). This analysis addresses the potential level of effect from both in-ice and open-water seismic surveys and does not include vessel presence and noise, aircraft presence and noise, discharges, etc.

5.2.2.5.4. Potential Effects from Seismic Surveys using Airguns

The Proposed Action considers that no more than one deep penetration survey may occur annually during the First Incremental Step. Offshore seismic surveys are less likely to affect ringed seals because they are more offshore and ringed seals prefer the nearshore zone and areas with sea ice, areas avoided by typical marine surveys.

Ringed seal reactions to deep penetration surveys are expected to be restricted to small distances and brief durations, with no long-term effects. Southall et al. (2007) proposed that PTS could occur to ice seals exposed to single sound pulses at 218 dB re: 1 μ Pa (rms) in water, however, injury from seismic surveys may occur only if animals entered the zone immediately surrounding the sound source. Because noise loss occurs rapidly with distance from operating airguns, some ringed seals may hear some level of underwater sound, but ringed seals are not expected to experience seismic noise levels that could result in a TTS or PTS.

The Proposed Action also considers that no more than two ancillary seismic or other site clearance surveys may occur annually during the First Incremental Step. High-resolution ancillary seismic surveys are of shorter duration and have a smaller zone of influence than deep penetration seismic surveys. These activities use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys.

Mitigation measures associated with seismic surveys using airguns include implementation of power-down and shut-downs to avoid exposure of ringed seals to TTS-level sounds, active monitoring to avoid collisions, and regular recording of observations whether actively conducting seismic surveys or not. Data from routine survey and weekly industry reports is used by an inter-agency team to assess the potential for overlapping or interacting activities on the Action Area to further minimize effects on ringed seals. Implementation of typical mitigation measures for active seismic operations decreases the potential for adverse effects.

In-Ice Seismic Surveys. Ringed seals are likely to be the most commonly encountered marine mammal during an in-ice survey. Haley et al. (2009) reported that ringed seal was the most abundant seal species during vessel-based surveys in 2006–2008 in the Chukchi Sea with densities up to 0.054 and 0.171 seals/km² in summer and fall, respectively.

Impacts to ringed seals from in-ice surveys would primarily be disturbance or displacement. Ringed seals may be disturbed by the icebreaker and seismic vessel noise. Movement away from this disturbance is anticipated to result in some energetic cost and be temporary. Ringed seals maintain breathing holes in sea ice; however, in winter they are found primarily in areas with persistent leads or cracks in broken areas within the pack ice, particularly if the water depth is <200 m. Ringed seals also feed on ice-associated organisms when they are present. Some ringed seals may be drawn to the open water created by the icebreakers, but this open water lead is not expected to persist for very long.

The 190-dB received sound level typically varies from 670 m to 215 m depending according to equipment and water depth. PSOs are unlikely to identify ringed seals at these distances, particularly during periods of poor visibility or darkness. Some individual ringed seals may be exposed to sound at the 190-dB level with minor short-term impacts. Implementation of typical mitigation measures for in-ice seismic operations decreases the potential for impacts.

Summary of Potential Effects from Seismic Surveys. The greatest effect of seismic surveys on ringed seals is the site-by-site disturbance effect as ringed seals move away from underwater sounds. This displacement would separate the seals from sounds that would injure them. Some ringed seals in open water may be disturbed, although many will be close to the nearshore zone and areas with sea ice, depending on water depths. The Proposed Action includes marine deep penetration seismic, ancillary site clearance and other survey activities. These can include open-water and in-ice techniques and equipment. The implementation of typical mitigation measures for all forms of seismic operations decreases the potential for adverse effects.

5.2.2.5.5. Potential Effects from Onshore Base Construction

The First Incremental Step of the Proposed Action includes construction of one on-shore base at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months and construction is limited to land so effects will be minimal. Construction would produce low energy localized noise from equipment operation, generators, etc. Noise from on-land pile driving (no marine) would be the loudest source of noise. Excavation and construction are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as plans are submitted. Companies would have to work with landowners (i.e. BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permit.

Vessel (during the open-water season) and aircraft traffic would be associated with the construction of an on-shore facility and potential effects from these sources have been addressed above.

The loudest noise associated with construction would be pile-driving on land, and Greene et al. (1995) described marine pile-driving noise levels of 131–135 dB re 1 μ Pa (rms) (40 – 100 Hz) at 1 km from the source. On-shore levels are expected to be less. The audibility range for phocid seals occurs in a 50 Hz – 80 kHz band (Ciminello et al., 2012), overlapping the 100 Hz – 2 kHz frequency noise range produced by marine pile driving. Though there is overlap in the noise frequencies affected by pile-driving and the noise frequencies used by ringed seals, the overlap occurs at the bottom of the audibility spectrum for seals. Furthermore it is generally assumed that seals, would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities.

Seals likely would avoid activities that bothered them; the distances vary according to individual and site-specific conditions (activity type, duration, and timing, etc.).

Noise and disturbance from on-shore facility construction may affect nearby ringed seals. Ringed seals near Northstar in 2000 and 2001 established lairs and breathing holes in the landfast ice within a few meters of Northstar, before and during the onset of winter oil activity. Seal use of the habitat continued despite low-frequency noise and vibration, construction, and use of an ice road (Williams et al., 2006). Blackwell et al. (2003) determined ringed seal densities were significantly higher around offshore industrial facilities. Another study by Frost and Lowry (1988) found ringed seal densities between 1985 and 1986 were higher in industrialized areas than in the controls in the Central Beaufort Sea. These activities will not affect food availability as construction is all onshore.

5.2.2.5.6. Potential Effects from Exploratory Drilling Operations

Exploration drilling operations during the First Incremental Step of the Proposed Action would generate continuous type underwater sounds that could affect ringed seals. Ringed seals may avoid areas around an active drill site. As individual ringed seals encounter the continuous noise source, they would not be expected to proceed towards a noise source that was bothering them. Exploratory drilling operations using MODUs are expected to displace small numbers of ringed seals from an area around the MODUs, but would not affect the broader geographical distribution of the species.

5.2.2.5.7. Potential Effects from Discharges

Authorized Discharges

The Arctic NPDES general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. This includes permit limits on the discharges such that it would tend to reduce the potential for impacts to the environment and species. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012).

Discharges from the First Incremental Step activities of the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. No adverse effect from regulated wastewater discharges have been noted for ringed seals in the Alaskan OCS. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or through affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution or deposition of these materials. Because the discharges would be regulated through Section 402 of the CWA, typical discharge criteria and other mitigation measures no adverse effects to ringed seals are anticipated.

Unauthorized Discharges

Small Oil Spills

Small spills could occur during geological and geophysical activities or exploration drilling activities in the First Incremental Step. Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers oil spill prevention measures fail or fuel lines rupture. There are no reported historical fuel spills from geological or geophysical operations on the Chukchi Sea OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum potential annual levels of geophysical or geological activities could range from 0 if no fuel spills occur to <13 bbl if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤ 55 bbl spill during exploration drilling operations is estimated to occur from refueling (USDOI, BOEM, 2014).

Some small spills could be in or close to areas used by ringed seals. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from ringed seals and reduce the opportunity for ringed seals to contact these spills.

Large Oil Spills

No large oil spills are estimated to occur from exploration activities during the First Incremental Step (see Section 2.1.1.1.1 and USDOI, BOEM, 2014). The analysis supporting this estimate is detailed in Section 2.2.1.1.4 of this BA. A hypothetical large oil spill scenario is evaluated under for Future Incremental Steps (Section 5.3.2).

Summary of Potential Oil Spill Effects on Ringed Seals in the Action Area

Some small spills could be in or close to areas used by ringed seals. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance responses from ringed seals and reduce the opportunity for ringed seals to contact these spills.

5.2.2.5.8. Summary of Potential Effects during the First Incremental Step

The small scale of the Geohazard and Geotechnical surveys, the equipment used, and the few marine seismic surveys would not interact to produce anything beyond temporary, brief avoidance behavior by ringed seals. Drilling operations using MODUs are expected to displace small numbers of ringed seals from an area around the drilling unit, but is not expected to affect distribution of the species on a broad geographic scale. Small refined crude oil or other spills should produce no effects on ringed seals due to the limited spill size, weathering, and rapid dispersion of such a spill.

5.2.2.6. Potential Effects of the First Incremental Step on Proposed Critical Habitat for Ringed Seal

Direct and indirect effects to proposed critical habitat for ringed seals can arise during the First Incremental Step from vessel and aircraft traffic, seismic surveys, geohazard and geotechnical surveys, onshore base construction, and exploratory drilling operations associated with the Proposed Action.

5.2.2.6.1. Potential Effects from Vessel Traffic

Vessel traffic during the First Incremental Step of the Proposed Action would have the potential to affect ring seal proposed critical habitat primarily through physical disturbance and noise (79 FR 73010). Vessels can also be involved in accidental discharge of oil or other toxic substances carried by ships, but this will be addressed under the section on discharges.

Icebreaking vessels directly alter the physical characteristics of sea ice in their paths. Therefore, icebreakers have potential to directly affect the two essential features of proposed critical habitat that are directly related to sea ice (birth lairs and basking/molting platforms). Of the two activities for which icebreaking might be necessary during the First Incremental Step, only exploratory drilling (anticipated to occur from June through November) would temporally overlap with ringed seal use of birth lairs or molting platforms (March through July). The second activity (in-ice seismic surveys)

would occur from October through January, several months outside of the timeframe for whelping, nursing, basking, and molting.

Icebreaking associated with exploratory drilling could unintentionally fracture, collapse, or otherwise alter lairs. No data exists to define how far away from the icebreaking edge other ice may be distorted, but given the strength of ice, the characteristic linear path of vessels, and the short period of overlap between icebreaking and use of lairs, few lairs would likely be damaged or destroyed.

Icebreaking vessels would be less likely to affect the formation (compared to maintenance) of sea ice habitat suitable for birth lairs, due primarily to the spatial extent and timing of icebreaker activity. Ice breaking would create narrow linear strips that are a very small fraction of the total sea ice present, and breaking would not occur from at least February through May. Any leads created prior to that time would have adequate time to refreeze.

Sea ice suitable for basking and molting platforms could be fractured by ice breaking activities. However, because ringed seals will haul out on ice of many shapes and sizes, fractured ice would probably remain suitable as platforms.

The physical presence of any vessel (not just ice breakers) and the noise created by them would not directly affect the two sea ice related essential features of critical habitat; however, they could temporarily make the sea ice features near the vessels less attractive to ringed seals. Effects could last as long as the vessels are present. Icebreakers probably create more noise than other types of vessels due to the sound associated with cracking ice and friction against snow.

Vessel traffic would have negligible impact on the primary prey resources identified as essential features in the ringed seal critical habitat proposal. This is because the response of fish and invertebrates to vessels would be temporary, localized, and minor.

5.2.2.6.2. Potential Effects from Aircraft Traffic

The majority of aircraft associated with the First Incremental Step of the Proposed Action would occur during the open water season. Aircraft traffic would not alter the physical characteristics of any of the three essential features identified for critical habitat. However, the noise and commotion associated with aircraft traffic could make basking and molting platforms less attractive to ringed seals, or cause the seals to temporarily abandon the platforms. Aircraft traffic associated with the proposed action are subject to altitude restrictions and typical mitigation measures required under the MMPA. These measures are designed to avoid or minimize adverse effects to ringed seals; thus aircraft traffic is not likely to adversely affect ringed seals or their critical habitat. A negligible residual level of effect is anticipated.

5.2.2.6.3. Potential Effects from Seismic and Other Surveys

Seismic surveys, ancillary geohazard surveys, and geotechnical surveys conducted during the First Incremental Step of the Proposed Action all produce noise and commotion that could affect proposed ring seal critical habitat mainly through the essential feature of primary prey resources. In-depth information, including supporting references, on the potential effects of the proposed action to fish is found in the Draft Second SEIS for Lease Sale 193 (USDO, BOEM, 2014), and is briefly summarized here.

The types of noises produced by seismic and other surveys in the Proposed Action could cause hearing impairment and physical, physiological, and behavioral effects on fish and fish prey. Typical behavioral responses of fish to introduced sound, such as sound from seismic surveys, include: balance disturbance (i.e., staying in normal orientation); disoriented swimming behavior; increased swimming speed; disruption or tightening of schools; disruption of hearing; interruption of important biological behaviors (e.g., feeding, reproduction); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle behaviors. Both Arctic and saffron cod are fish with that

detect sound pressure and particle motion through use of their swim bladders, which are connected to or are very close to the otolith ear. This category of fish (with swim bladder involved in hearing) has the broadest and most sensitive hearing range and is also most sensitive to pressure changes. Arctic cod in particular is a hearing specialist and is known to be acoustically sensitive (Normandeau Associates, Inc. 2012). For more information on the potential responses of fish to these types of activities, see the SEIS section reference above. Little is known about the effects of noise on shrimps and amphipods. Changes in prey distribution, abundance or behavior may affect the ability of ringed seals to obtain adequate food resources, which could in turn displace seals from the area in which the survey activity is occurring.

Seismic surveys would not alter the physical characteristics of either of the two sea ice related essential features identified in the critical habitat proposal (i.e., lairs for whelping and nursing, and platforms for basking and molting). Noise and commotion from seismic surveys conducted in close proximity to these features could make them less attractive to ringed seals, or cause seals to temporarily abandon the features. However, all seismic surveys would occur outside of the whelping and nursing seasons, and only overlap with molting during one month of the year (July). For potential effects of this, please see the section pertaining to the ringed seal species.

5.2.2.6.4. Potential Effects from Onshore Base Construction

The First Incremental Step of the Proposed Action includes construction of one on-shore bases at a location near Wainwright or Barrow, Alaska (see Section 2.2.1.1.5 for details). Most construction would occur during the winter months and construction is limited to land so effects will be minimal. Construction would produce low energy localized noise from equipment operation, generators, etc. Noise from on-land pile driving (no marine) would be the loudest source of noise. Excavation and construction are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as plans are submitted. Companies would have to work with landowners (i.e., BLM, North Slope Borough, ANSCA Corporations) to obtain any required construction permits.

Vessel (during the open-water season) and aircraft traffic would be associated with the construction of an on-shore facility and potential effects from these sources have been addressed above.

These activities would be subject to typical mitigation measures that would help avoid disturbance to primary prey resources, sea ice habitats that would otherwise be suitable for formation and maintenance of ringed seal birth lairs, and sea ice that would otherwise be suitable for basking and molting platforms. For example, activities could be restricted during the pupping season or when shorefast ice is present. Thus, because of the small footprint of the onshore base and associated construction activities in relation to the size of the proposed critical habitat unit and the availability of the essential features within that unit, these activities are not likely to adversely modify critical habitat.

5.2.2.6.5. Potential Effects from Exploratory Drilling Operations

Drilling operations that would occur during the First Incremental Step of the Proposed Action could potentially affect the primary prey resources identified as essential features in the proposed critical habitat rule. Hearing impairment and physical, physiological, and behavioral effects on fish and fish prey could result from drilling noise. For example, the Arctic cod is known to be acoustically sensitive (Normandeau Associates, Inc. 2012). Drilling sounds could impair the availability of primary prey resources. This may affect the ability of ringed seals to obtain adequate food resources, and displace ringed seals from the area in which drilling is occurring.

Drilling noise and commotion from drilling activities conducted in close proximity to these features could make them less attractive to ringed seals, or cause seals to temporarily abandon the features.

Drilling operations would occur between June and November of a given year, which is outside of the whelping season, but has partial overlap with nursing and molting.

5.2.2.6.6. Potential Effects from Discharges

Authorized Discharges

The Arctic NPDES general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. This includes permit limits on the discharges such that it would tend to reduce the potential for impacts to the environment and species. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration in the Action Area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012e).

Discharges from the Proposed Action would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term.

Unauthorized Discharges

Spills during the First Incremental Step are expected to be small and consist of refined oils because crude and condensate oils would not be produced at this stage. Refined oil is used in the drilling activity for the equipment and refueling. BOEM and BSEE estimate that about 20 spills occur during the First Incremental Step ranging in size from < 1 bbl up to 55 bbls per spill. Sea ice is represented in two of three essential features identified in the critical habitat proposal (sea ice suitable for birth lairs and basking/molting platforms). Ice edges, whether associated with shorefast ice or pack ice, generally act as a barrier to the spread of oil (McLaren, 1990). Therefore, unless oil is released directly under ice, swept under by strong currents, otherwise dispersed in water, or tracked in by oiled animals, it would not likely spread into lairs, or on the adjacent subsurface of ice. Instead, oil would accumulate in leads and cracks that are connected to the spill source through open water. This would confine oil to the spaces between ice floes and tide-cracked landfast ice sheets that have a direct connection with the spill source.

Oil that does get under ice may heat ice and melt it (Thomas, 1984). A given volume of oil will melt roughly 1/200 of that volume of ice for each degree the oil is above freezing. In stationary or very slow moving ice over a blowout, melting may weaken the ice and make it more probable that trapped gas bubbles will fracture the ice and escape into the atmosphere. However, during much of the ice season, the air is so cold that it would cause oil to behave more like a solid than a liquid. The oil would therefore be limited to a small area on the surface until it pooled deep enough to begin spreading beneath the ice.

If oil gets underneath an ice sheet, several factors control the concentration and areal extent of the oil spread (Thomas, 1984). The primary factors include the bottom roughness of the ice, the presence of gas under the ice, the magnitude and direction of ocean currents, and the movement of ice cover. If oil alone is present, or if accompanying gas is vented, the oil would begin filling under-ice voids (such as lairs) near the blowout. As a void fills and oil is pressed downward, the oil eventually reaches a depth where it can progress along the underside of ice to the next void. If the ice is moving over the site of the blow-out, the voids may not be completely filled, and only that ice passing directly over the blowout plume collects oil.

Oil contacting ice can be frozen and incorporated into the ice, eventually being released when the ice melts. In this way, oil can be temporarily removed from sea ice features essential to the conservation of ringed seals, and released again later in time.

The third essential feature for ringed seal conservation, primary prey resources, may also be adversely affected by oil spills. Potential effects of a large spill to Arctic cod, saffron cod, and other fish are described in the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014).

A spill in the Chukchi Sea could affect fish through many pathways, including adsorption to outer body, respiration through gills, ingestion, and absorption of dissolved fractions into cells through direct contact. The severity of effects to fish would depend on several factors including the type of oil/gas mixture, the thickness of the oil, the duration of exposure, the season of year, and the life stage of the fish.

An oil spill can also affect the habitat of ringed seal primary prey resources. Arctic cod are associated with ice in various seasons and life stages for shelter. Arctic cod spawn under the ice during winter, and they feed on microorganisms on the underside of ice, such as amphipods, which are also a primary prey resource of ringed seal proposed critical habitat.

Oil and gas released in a winter scenario could pool under the ice in pockets presenting prolonged exposure to Arctic cod eggs and larvae, adults hiding among the ice, and amphipods inhabiting the under-ice environment. As noted previously, oil pooled under ice could take several pathways between winter and summer months, any of which could affect primary prey resources.

Small Oil Spills

Small spills could occur during geological and geophysical activities or exploration drilling activities. Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The <1 bbl volume considers dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers spill prevention measures fail or fuel lines rupture. There are no reported historical fuel spills from geological or geophysical operations on the Arctic OCS.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum potential annual levels of geophysical or geological activities could range from 0 if no fuel spills occur to <13 bbl if every operation refuels, every refueling operation has a fuel spill and spill prevention equipment functions properly. Refueling operations in the Chukchi Sea likely could occur at sea with the use of fuel supply vessels.

Small spills could also occur during exploration drilling operations. A ≤ 55 bbl spill during exploration drilling operations is estimated to occur from refueling (USDOI, BOEM, 2014).

A small spill would be localized and would not permanently affect Arctic cod, saffron cod, shrimps, or amphipods that constitute the primary prey resources for ringed seal. The amount of prey lost in such a spill likely would not be detectable compared to what is available within the critical habitat unit.

Large Oil Spills

No large oil spills are estimated to occur from First Incremental Step activities of the Proposed Action (see Section 2.2.1.1.4). A hypothetical large oil spill scenario is evaluated under for Future Incremental Steps (Section 5.3).

Summary of Potential Oil Spill Effects on Proposed Ringed Seal Critical Habitat in the Action Area

Some small spills could be in or close to areas containing essential features of proposed critical habitat. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in localized avoidance responses from ringed seals, temporarily rendering the essential features of proposed critical habitat unsuitable for use while these activities occur. However, these activities would not impair the long term conservation value of critical habitat.

5.2.2.6.7. Summary of Potential Effects during the First Incremental Step

The IPFs described above would mostly have negligible to short-term, minor impacts on the essential features of ringed seal proposed critical habitat.

5.2.3. Potential Effects of Future Incremental Step Activities

Development and production logically follow if a leaseholder finds an economically-developable field. Development activities include the construction or installation of a production facility and necessary pipelines that would convey oil or gas to existing infrastructure. Vessel and aircraft traffic, seismic surveys, and exploratory drilling activities have been discussed previously in Sections 5.2.1 and 5.2.2. Production activities are those that make use of the developments, the drilling of production wells, and the operation of pump stations and other facilities that move the oil and gas to existing infrastructure.

Development and production are not considered reasonably certain to occur and should it be proposed, a DPP would be submitted, be evaluated consistent with NEPA, and require additional consultation under the ESA. The purpose of this section is to describe the potential effects of a “single and complete project” that could arise from the leases issued under the Action Area program as it is currently understood. Subsequent evaluations would be based on site-specific information and additional details provided through the DPP process.

Section 5.2.1 (First Incremental Step, Potential Effects) describes background information on how noise affects listed whales and ice seals. The following subsections described the specific potential effects of:

- Vessel Traffic Section 5.2.1.1
- Aircraft Traffic Section 5.2.1.2
- Seismic Surveys Section 5.2.1.3
- Exploratory Drilling Operations Section 5.2.1.4
- Discharges Section 5.2.1.5

As these same types of activities would continue to occur during development and production, the potential effects are not repeated here. Many activities, such as vessel and aircraft traffic and drilling, will decrease after development is complete (see Section 2.2.2). The new activities described during development and production includes facility construction and facility operation. Decommissioning is considered the end-point of production and could include the removal of platforms and other infrastructure, but that aspect of production is so far into the future that evaluation would not be meaningful.

5.2.3.1. Potential Effects from Offshore Facility Construction

A production facility and new subsea pipelines are the largest components that would need to be constructed to support getting product to existing infrastructure. This would include 8 platforms, multiple subsea templates, pipeline, and a boat dock/barge terminal (see Section 2). Construction

could occur year round. Platform construction would produce lower energy localized noise from factors such as equipment operation and generators. The sounds from these activities would not be likely to travel as far as sound from 2D/3D or site clearance seismic surveys. Similarly, pipeline construction would involve a slow-moving sound source that would have a localized, low energy noise footprint that is smaller than 2D/3D or site clearance seismic surveys.

5.2.3.1.1. Whales

Listed whales would be expected to display variable responses to construction activity (ranging from no response to avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Bowhead whales do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary lasting from minutes (for vessels and aircraft). Similarly, whales could exhibit the same behaviors if they saw or smelled emissions from a construction activity, and move away from it.

Construction of production facilities would be a temporary activity, likely taking place year round. Some activities could be scheduled to take place during the winter when listed whales are largely absent from the Action Area. Individual and groups of bowhead whales engaged in migration during the fall-early winter period would be expected to defer migration route up to several kilometers in an avoidance response to encountering sufficient levels of construction noise.

5.2.3.1.2. Ice Seals

Noise and disturbance from production facility and pipeline construction may affect nearby ringed and bearded seals. Ringed seals near Northstar in 2000 and 2001 established lairs and breathing holes in the landfast ice within a few meters of Northstar, before and during the onset of winter oil activity. Seal use of the habitat continued despite low-frequency noise and vibration, construction, and use of an ice road (Williams et al., 2006). Blackwell et al. (2003) determined ringed seal densities were significantly higher around offshore industrial facilities. Another study by Frost and Lowry (1988) found ringed seal densities between 1985 and 1986 were higher in industrialized areas than in the controls in the Central Beaufort Sea.

The placement of bottom-founded structures may reduce the amount of habitat available to ice seals by a very small amount. Existing production facilities in the Beaufort Sea as a result of past oil and gas development may have altered a few sq km of benthic habitat. Trench dredging and pipeline burial could affect some benthic organisms, but some of these habitats are subject to periodic scour by ice keels and recovery is a slow, but natural cycle in disturbed areas.

This construction could temporarily cause sediment suspension or turbidity in the marine environment that would disappear over time. These activities are not expected to affect food availability over the long term because, for example, prey species such as Arctic cod, have a very broad distribution and ice seals appear are able to forage over large areas of the Chukchi Sea and do not exclusively rely on local prey abundance in open water conditions. In other instances, submerged structures may provide habitat for some prey species.

5.2.3.2. Potential Effects of Offshore Facility Operations

Once a development facility is constructed, routine production operations would begin. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted. The specific potential effects would depend on the type of facility being proposed, its location, and the equipment being used (i.e., pumps, motors, etc.).

5.2.3.2.1. Whales

Listed whales would be expected to display variable responses to routine operations (ranging from no response to limited avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Bowhead whales do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary lasting from minutes (for vessels and aircraft). Similarly, whales could exhibit the same behaviors if they saw or smelled emissions from a routine operation, and move away from it.

Monitoring at the offshore Northstar facility noted changes in the calling behavior of bowhead whales around the island; however, an expert panel interpreting these data were unable to determine if differences were due to changes in calling behavior or deflection.

5.2.3.2.2. Ice Seals

Bottom-founded drilling units can cover areas of benthic habitat that support benthic invertebrates used for food by marine mammals, and placement of fill material might result in habitat loss. This construction would temporarily cause sediment suspension or turbidity in the marine environment that would disappear over time. Alterations from trench dredging and pipeline burial are not expected to affect food availability over the long term because, for example, prey species such as Arctic cod, have a very broad distribution and ringed seals are able to forage over large areas of the Chukchi Sea and are not reliant exclusively on the abundance of local prey in open water conditions. In other instances, fill may provide habitat for some prey species.

5.2.3.3. Potential Effects from Discharges

5.2.3.3.1. Authorized Discharges

The potential effects of discharges were introduced in Section 5.2.1.5. There could be considerably smaller volume of materials discharged under development and production if some materials (e.g., cuttings, process water) are reinjected into a disposal well. Any discharges would require compliance with existing U.S. Coast Guard and EPA rules and regulations which are intended to reduce or mitigate environmental harm.

5.2.3.3.2. Unauthorized Discharges

The potential effects of spilled oil and response to oil spills on listed whales or ice seals were described in Section 5.2.1.6.2.

5.2.4. Effects Analysis by Species-Future Incremental Steps

The effects analysis evaluates the direct and indirect effects of hypothetical future development and production of hydrocarbon and natural gas resources in the anchor field, and exploration, development, and production of hydrocarbon and natural gas resource in a satellite field on bowhead whales, fin whales, humpback whales, ringed seals, ringed seal proposed critical habitat, and bearded seals in the Action Area. Future Incremental Step activities would continue to rely on vessels and aircraft to move people and equipment or supplies to OCS facilities. Under the Proposed Action, BOEM and BSEE estimate that development would include the installation of offshore facilities, including eight production platforms (five at the anchor field and three at the satellite field), 15 subsea templates, and 180 mi of subsea pipelines linking offshore production to onshore processing facilities and pipelines connecting to TAPS. Onshore facilities would be expanded and would include construction of a barge dock at or near the primary shorebase/onshore processing facility. Section 2.2.2.1 details infrastructure development and installation anticipated to occur if a commercially-viable discovery was made during the First Incremental Step. Deep penetration 2D/3D airgun operations are not anticipated during development of the anchor field; however, they may occur

during production at the anchor field. Both marine deep penetration 2D/3D seismic surveys and geotechnical and geohazards surveys could be conducted in the satellite field during Future Incremental Steps. Exploratory drilling, including VSP surveys, would be conducted in the satellite field. Offshore exploration and development activities would occur primarily during the open water season. Onshore construction activities would be conducted primarily during winter months; however, these activities could also occur year-round. The precise details of Future Incremental Step activities would be determined in the process of developing and submitting a DPP.

Once constructed, the production platforms would begin drilling production wells, with a total of 90 production wells drilled during the life of the Proposed Action (see Section 2.2.2.2) at a maximum rate of 16 wells per platform per year. Effects of activities such as vessel traffic, aircraft traffic, drilling, and discharges may be somewhat different once development activities are complete because production activities typically require relatively fewer vessel and aircraft trips (Sections 2.2.2.3 and 2.2.2.5). Some activities such as production drilling may occur all year. Decommissioning would occur once wells stop being productive (see Section 2.2.2.6 for further detail).

5.2.4.1. Potential Effects of Future Incremental Steps on Bowhead Whales

Development and production activities in the Arctic Region are dependent upon a discovery and any potential effects on bowhead whales would be dependent upon the specific location and footprint of, duration, intensity of activity, and infrastructure requirements. These will be further evaluated in incremental evaluation and consultation action when specifics become available. General effects resulting from similar activities such as vessel and aircraft traffic, drilling, construction (infrastructure, pipelines, platforms) noise, and discharges are substantially similar for development activities as those discussed for the First Incremental Step in Section 5.2.2.1.

This section described the potential direct and indirect effects from development and production based on specific activities that could arise from future proposals. Direct and indirect effects to bowhead whales can arise from vessel and aircraft traffic, seismic surveys, drilling operations, facility construction and operation, and discharges associated with the Proposed Action.

5.2.4.1.1. Potential Effects from Vessel Traffic

The potential for vessels to affect bowhead whales was described in Section 5.2.1.1. Vessel traffic could increase in order to access and support construction of production facilities on the Action Area, which could occur simultaneous to exploration of a satellite field. The potential effects during Future Incremental Steps could be slightly increased over those described for the First Incremental Step (Section 5.2.2.1.1, Vessel Traffic) and could increase the likelihood of vessel-whale collisions. Icebreakers actively engaged in ice management/breaking activities could cause short-term alterations in localized migration routes and spatial distribution. Vessel traffic is expected to decrease once exploration and development activities are complete.

Vessel collisions with whales often lead to the death of the whale that was struck, and any such incidents would produce moderate impacts on bowhead whales. Though most bowhead whales spend their summers in the eastern Beaufort Sea and near Barrow Canyon upwellings in the western Beaufort Sea, a few may occur in the Action Area during summer. Starting in September the majority of bowhead whales begin migrating from the Beaufort Sea, and across the Chukchi Sea, with their fall migration route passing through the Action Area. By the end of October most bowhead whales would be in the Chukchi Sea feeding near upwellings along the northern coast of Chukotka and later in the Gulf of Anadyr. Consequently, the preponderance of bowhead whales would be in the Beaufort Sea until late September when they begin migrating across the Chukchi Sea to Chukotka, placing them out of the Action Area until late September through October. Typical mitigation measures would help avoid adverse effects, including collisions, to bowhead whales.

5.2.4.1.2. Potential Effects from Aircraft Traffic

Aircraft traffic could increase in order to access and support construction of production facilities on the Action Area, which could occur simultaneous to exploration of a satellite field. The potential effects during Future Incremental Steps could be slightly increased over those described for the First Incremental Step (Section 5.2.2.1.1, Aircraft Traffic). Aircraft traffic is expected to decrease once exploration and development activities are complete. Typical mitigation measures would help avoid or minimize adverse effects to bowhead whales.

5.2.4.1.3. Potential Effects from Seismic and Other Surveys

Under the Proposed Action, seismic noise from deep penetration 2D/3D airgun operations would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Ancillary low energy surveys (including airgun supported surveys) for site clearance and shallow hazards would occur in localized areas near prospective drill sites and platform sites. BOEM and BSEE anticipate that 8 geotechnical surveys (with no more than two surveys per year) and eight geohazard surveys (with no more than two surveys per year, generally a maximum of one survey per year) could occur during the first 20 yrs of Future Incremental Step activities. Airgun-supported seismic deep penetration surveys may be conducted to explore the satellite field and, later in the life of the Proposed Action (Section 2.2.2). BOEM and BSEE anticipate six marine deep-penetration seismic surveys over approximately 20 yrs of the Future Incremental Step portion of the Proposed Action, with no more than one survey conducted per year (including in-ice surveys). The effects of these marine deep-penetration surveys would be similar in effects described for bowhead whales during the First Incremental Step (see Section 5.2.2.1). All surveys during Future Incremental Steps are anticipated to be in association with exploration and development of the satellite field. Seismic surveys would be subject to typical mitigation measures that would help avoid adverse effects on bowhead whales.

5.2.4.1.4. Potential Effects from Offshore Facility Construction

Development includes platform placement and installation of pipelines and other facilities. Noise from activities such as pile-driving, dredging, or equipment operation, would add to the existing noise level at the construction location. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source around a small noise footprint.

Subsea pipeline construction would be between a location near Wainwright or Barrow, Alaska, and the site of the first production platform. BOEM and BSEE estimate that 160 mi of subsea oil pipeline, 160 miles of subsea gas pipeline, and 30 miles of flowline connecting subsea templates to host platforms would ultimately be laid for development and production (see Table 2–4). Construction of the first platform should take approximately a year to complete. Between Years 10 and 30, approximately eight platforms would be constructed in the anchor field, approximately 5-mi apart, with a 20-mi distance from the Anchor field to the Satellite field where three more platforms would be built using similar 5-mi spacing.

The loudest noise associated with production platform construction would be pile-driving, and Greene et al. (1995) described pile-driving noise levels of 131–135 dB re 1 μ Pa (rms) (40–100 Hz) at 1 km from the source. Due to ice characteristics in the Chukchi Sea production platforms in the Chukchi Sea may require larger, or more, pilings to anchor each platform to the sea floor. In either situation pile-driving sound propagation characteristics could change. The audibility range for bowhead whales occurs within a 5 Hz–30 kHz range (Ciminello et al., 2012), overlapping the 100 Hz–2 kHz frequency noise range produced by pile driving. Since pile driving noise source levels from Cook Inlet, Alaska (Blackwell, 2005) were 190 dB re 1 μ Pa, and rapidly attenuated to 115–133 dB re 1 μ Pa (rms) within 1 km it is assumed similar attenuation of pile driving noise would occur in the Action Area. Though there is overlap in the noise frequencies affected by pile-driving and the noise frequencies used by

bowhead whales, the overlap occurs at the bottom of the audibility spectrum for bowheads. Furthermore, it is generally assumed that mysticete whales, including bowheads, would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. Pile-driving could occur during the open water season when most bowhead whales are feeding in the Beaufort Sea, and when bowheads pass through the Action Area during their fall migration. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight shifts in individual bowhead migration trajectories to avoid approaching the noises and activity. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities, dredging, or pipeline construction.

A total of eight production platforms would be installed in the anchor and satellite fields. The Molikpaq is a mobile Arctic drilling platform, similar in many ways to what would be expected for production platforms in the Action Area. Thomson and Johnson (1996) documented decibel levels of 112 dB at 1.4 km from the Molikpaq, with most of the energy occurring below 20 Hz. Assuming the decibel and frequency levels between the Chukchi Sea and Sea of Okhotsk are similar, and since 112 dB is approximately at or below ambient noise levels for the Chukchi Sea, the radii for effects should extend to 1.4 km (0.87 mi) or less from each production platform. Not all platforms would be drilling simultaneously; however, the noise production from drilling 32 wells from 8 platforms would average 4 wells per platform during the peak of drilling activity. The noise footprint from this level of drilling would amount to a 1.4-km zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz which is within the very bottom range of the auditory bandwidth for bowhead whales (5 Hz–30 kHz). With drilling restricted to two 10 mile diameter areas migrating bowheads should continue moving and migrating across the Chukchi Sea as needed, diverting around locations where drilling is occurring by 1.4 km. Once drilling is completed, bowhead whales should eventually habituate to the presence of production wells potentially passing near areas of active production platforms without effects (Aerts and Richardson, 2010; McDonald, Richardson, and Blackwell, 2010).

The location, timing, and specific actions have not been determined and would be evaluated as development and production plans are submitted to BOEM and BSEE. Individual bowhead whales likely would avoid activities that bothered them; the distances vary according to individual whale and site-specific conditions (activity type, duration, and timing, etc.). These activities, however, would be subject to typical mitigation measures that would help avoid adverse effects on bowhead whales.

5.2.4.1.5. Potential Effects from Development and Production Drilling Operations

Once the first production platform is constructed, production drilling would begin. Drilling operations generate continuous type underwater sounds that could affect bowhead whales in the same ways as previously discussed for exploration drilling (Section 5.2.1.4). Because drilling from production platforms produces much less noise than drilling from drillships, noise effects on bowheads from platform drilling would be reduced and restricted to the immediate vicinity of the platform. General effects for production drilling from drillships (i.e., for subsea wells) would be substantially similar to exploration activities. BOEM and BSEE anticipate that the drilling activities during Future Incremental Steps likely would occur year-round and continue over many years (see Section 2.2.2.2). Specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action areas become known.

Subsea wells would be drilled by MODUs, and the effects of such activity would be similar to the effects of drilling exploration wells. A maximum of 9 subsea production wells would be drilled in a single season. Throughout the life of the Proposed Action, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be used to conduct crew changeovers with 1–3 daily flights to each production platform during the production phase. The 1,500 ft

minimum altitude requirements (see USDOJ, BOEM, 2014) would lessen the effects of aircraft on bowhead whales to negligible levels. Vessel traffic during production would amount to 1–2 weekly trips between the coast and each platform during the open water season, which should not affect bowhead whales if the NMFS (2013a) mitigations are incorporated.

BOEM and BSEE estimate that 18 exploration wells would be drilled in the satellite field, with a maximum of four wells drilled per open-water season by a maximum of four MODUs (Section 2.2.2).

Some bowhead whales could experience noise exposure and adjust their path around active drilling operations. The degree of this alteration would depend on the timing and location of the drilling operation. These small adjustments would be temporary, non-lethal, and minor.

5.2.4.1.6. Potential Effects of Offshore Facility Operation

Once a development facility is constructed, production would begin. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted. Individual bowhead whales likely would avoid activities that bothered them; the distances vary according to individual whale and site-specific conditions (activity type, duration, and timing, etc.).

5.2.4.1.7. Potential Effects from Discharges

Authorized Discharges

The potential effects of discharges were described in Section 5.2.1.5. There could be considerably smaller volume of materials discharged under development and production if some materials (cuttings, process water, etc.) are reinjected into a disposal well. Any discharges would require compliance with existing EPA regulations which are intended to reduce or mitigate environmental harm. Overall, the level of effects from authorized discharges would be less than those described for the First Incremental Step (Section 5.2.2.1, Authorized Discharges) and is anticipated to have no effect on bowhead whales.

Unauthorized Discharges

This section describes the potential effects to bowhead whales from oil spills estimated to occur during Future Incremental Steps of the Proposed Action. The hypothetical oil spill scenarios for small and large spills in the Action Area are presented in Sections 2.2.2.1.4 and 2.2.2.4.2.

Bowhead whales migrate north and east from the Bering Sea into the Chukchi Sea spring lead system. Bowhead whales also migrate west across the Chukchi Sea during fall in a widely dispersed pattern. Effects to bowhead whales associated with an oil spill are likely to reflect seasonal habitat use, age structure, and proportion of population contacted and situational variables surrounding the spill itself. Potential effects of petroleum spills to bowhead whales are discussed in Section 5.2.1.5.2.

Small Oil Spills

Small spills are generally contained prior to reaching the marine environment. If a small spill escaped containment, the volumes are small and dissipate/weather quickly. Small spills would not travel very far, which limits the potential for contact with bowhead whales near production facilities. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance response from bowhead whales and reduce the opportunity for them to contact these spills.

For the purposes of analysis under the Scenario, BOEM and BSEE estimate that approximately 777 small spills (<1,000 bbl) could occur over the life of the Scenario (20 during the First Incremental Step and 757 during Future Incremental Steps) (Table 2–5).

Accidental small oil spills are considered reasonably foreseeable events that are anticipated to have minimal impacts to bowhead whales in the Action Area.

Large Oil Spills

BOEM and BSEE's estimate of the likelihood of one or more large spills occurring assumes that there is a 100% chance that development(s) will occur and 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced (see Section 2.1.1.1.1). BOEM and BSEE estimate that two large oil spills are reasonably foreseeable during Future Incremental Steps (see Section 2). One is reasonably expected to occur from a production platform and one could potentially occur from a subsea pipeline. The potential for large oil spills to contact bowhead whales in the Chukchi Sea was described in the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014). A detailed description of the OSRA model for large spills and results are also presented in Appendix A of the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014).

To evaluate the effect of a large oil spill resulting from development and production oil and gas activities, BOEM and BSEE estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go.

A large oil spill could result in some individual bowhead whales coming into contact with oil, potentially resulting in inhalation of hydrocarbon vapors, baleen fouling, and ingestion of contaminated prey. In addition, localized reduction of bowhead whale prey could occur, including long term impacts if hydrocarbons entered the benthos. Temporary displacement from feeding and resting areas, and temporary interruption of migration timing and route could also occur.

In particular, bowhead whales could experience contact with fresh oil during summer and fall feeding event aggregations and migration in the Chukchi Sea and western Beaufort Sea. Skin and eye contact with oil could cause irritation and various skin disorders. Toxic aromatic hydrocarbon vapors are associated with fresh oil. Prolonged inhalation within fresh oil could result in impaired endocrine system function that may result in reduced reproductive function (that may be temporary or permanent) and/or bowhead mortality in situations where prolonged exposure to toxic fumes occurs. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related noise and activity limits potential exposure of whales to prolonged inhalation of toxic fumes.

If an oil spill were to cause extensive mortality within a high latitude amphipod population with low fecundity and long generation times, a marked decrease in secondary production could ensue in some areas (Highsmith and Coyle, 1992). Such effects should not persist in some upwelling areas where bowhead whales prefer to feed, that receive pelagic invertebrate inputs from the Bering Sea and Arctic Ocean (Chukotka Upwelling, Barrow Canyon, etc.).

This section describes the results estimated by the OSRA model for a hypothetical large spill originating within six LAs and six PLs in the Action Area contacting specific Environmental Resource Areas (ERAs). The ERAs noted in this section are spatial representations (polygons) that indicate a geographic area important to listed whales (see Figure 5.1). For the purpose of this analysis, the hypothetical initial well control incident could occur any time between July 15 and October 31 and represents a "summer spill." A 60 day contact period for a summer open water season spill considers that a large spill could persist on the sea surface for up to three weeks before it has dissipated. Oil could continue to spill after October 31 and spilled oil could freeze into the newly forming ice, remain encapsulated in ice throughout the winter and be released as the ice warms and thaws in the spring; therefore, continued spillage of oil after October 31 is considered a "winter spill" with a conservative spilled oil contact period of 360 days. The sequence of events that would occur following a loss of well control event is detailed in Figure 5.2. To complete a relief well would take

approximately 39–74 days (USDOI, BOEM, 2014). The effectiveness of oil spill response activities is not factored into the results of the OSRA model.

Large oils spills contacting the spring lead systems such as Chukchi Spring Lead 2 (ERA 53) and Chukchi Spring Lead 3 (ERA 54); and, around Pt Lay-Barrow BH GW SSF (ERA 61), or during the September – October fall migration of bowhead whales would likely have the greatest effect to bowhead whales (see Figure 5.1). The OSRA model indicates Chukchi lead systems, Kasegaluk Lagoon, and the Pt Lay-Barrow BH GW SSF (ERA 61) are the most likely ERAs to be contacted by large crude oil spills. The OSRA model also estimates that trajectories from LAs 1–11 and PL1–9 could contact ERAs and BSs important to bowhead whales (Figure 5.1). The OSRA estimated that there was <0.5% probability of any trajectory originating from the Action Area LAs and PLs contacting Boundary Segments (BSs) important to bowhead whales (BS 2, 39–40). No important land segments (LSs) were identified for bowhead whales (USDOI, BOEM, 2014).

The combined probability of large spills occurring in a given ERA over the life of the Scenario is <10%, with the exception of the feeding aggregation area between Pt Lay and Barrow (ERA 61, 22–23% chance), and part of the Chukchi Spring Lead system (ERA53, 12% chance) (Table 5.1).

The location, timing, and magnitude of a large spill and the concurrent seasonal distribution and movement of cetaceans would determine whether or not contact with the oil occurs. The Oil Spill Risk Analysis (OSRA) modeled oil spill trajectories from six launch areas (LAs) and six pipeline segments (PLs).

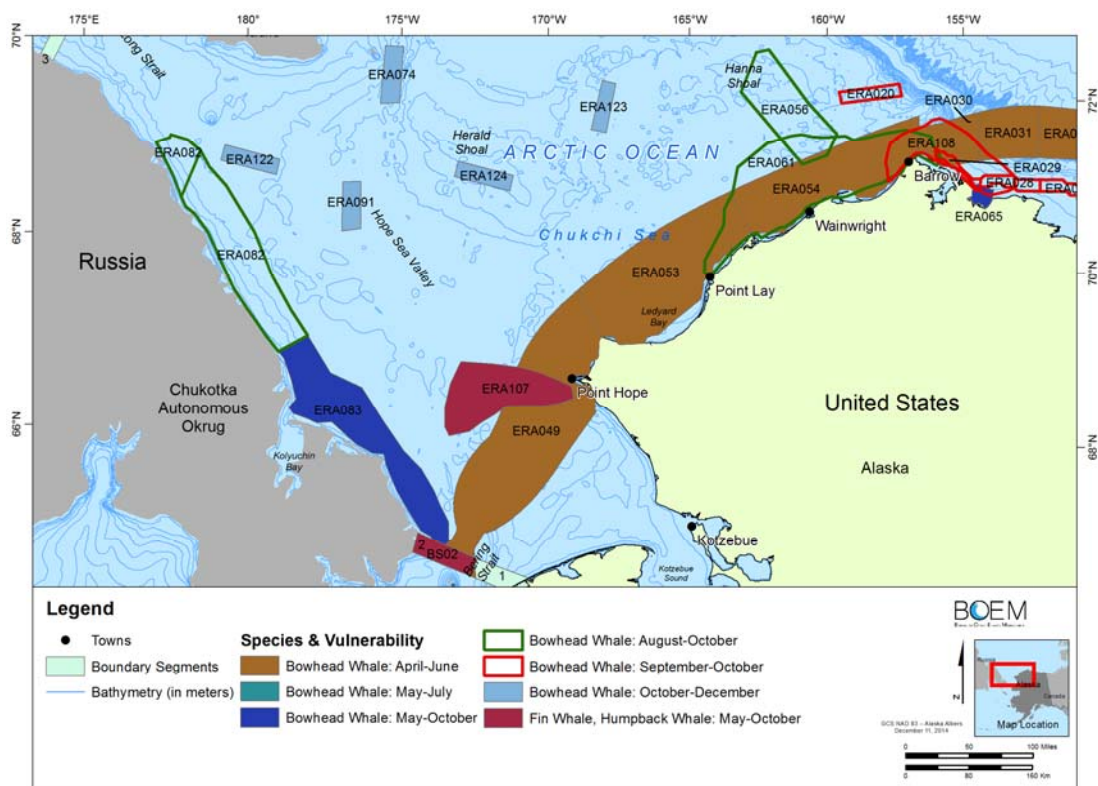
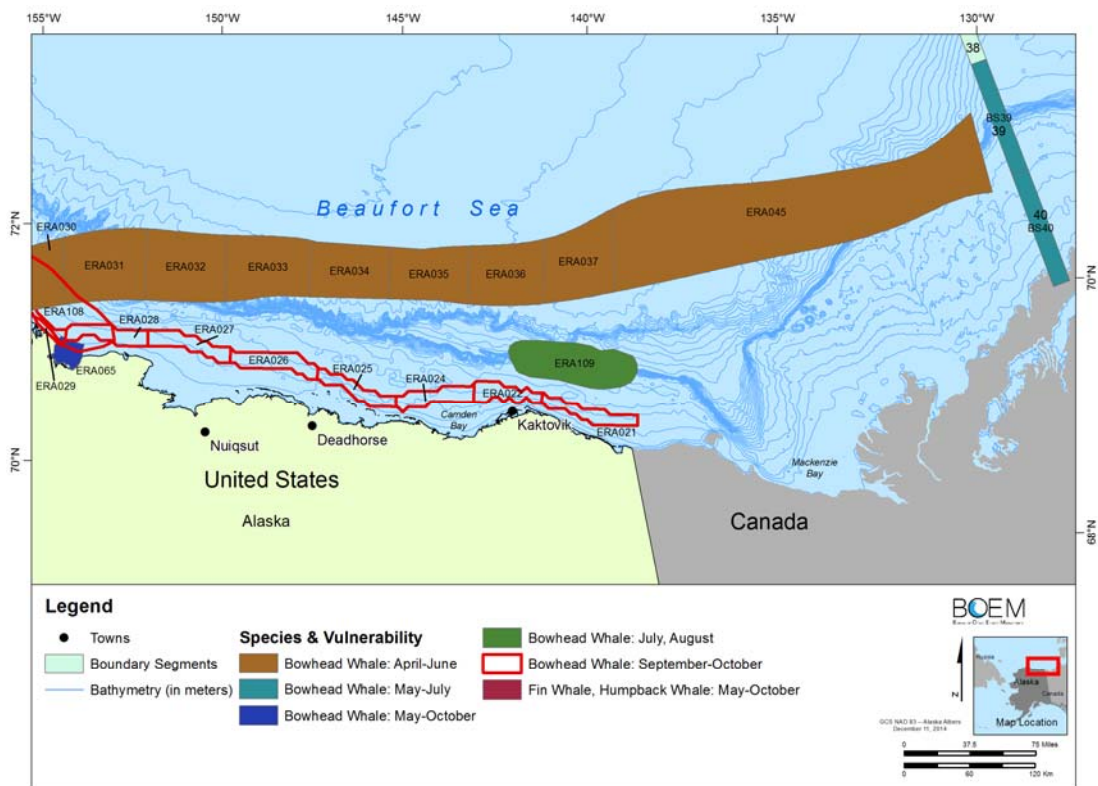


Figure 5-1 a and b. Environmental Resource Areas (ERAs) used in the Oil-Spill Trajectory Analysis for Whales



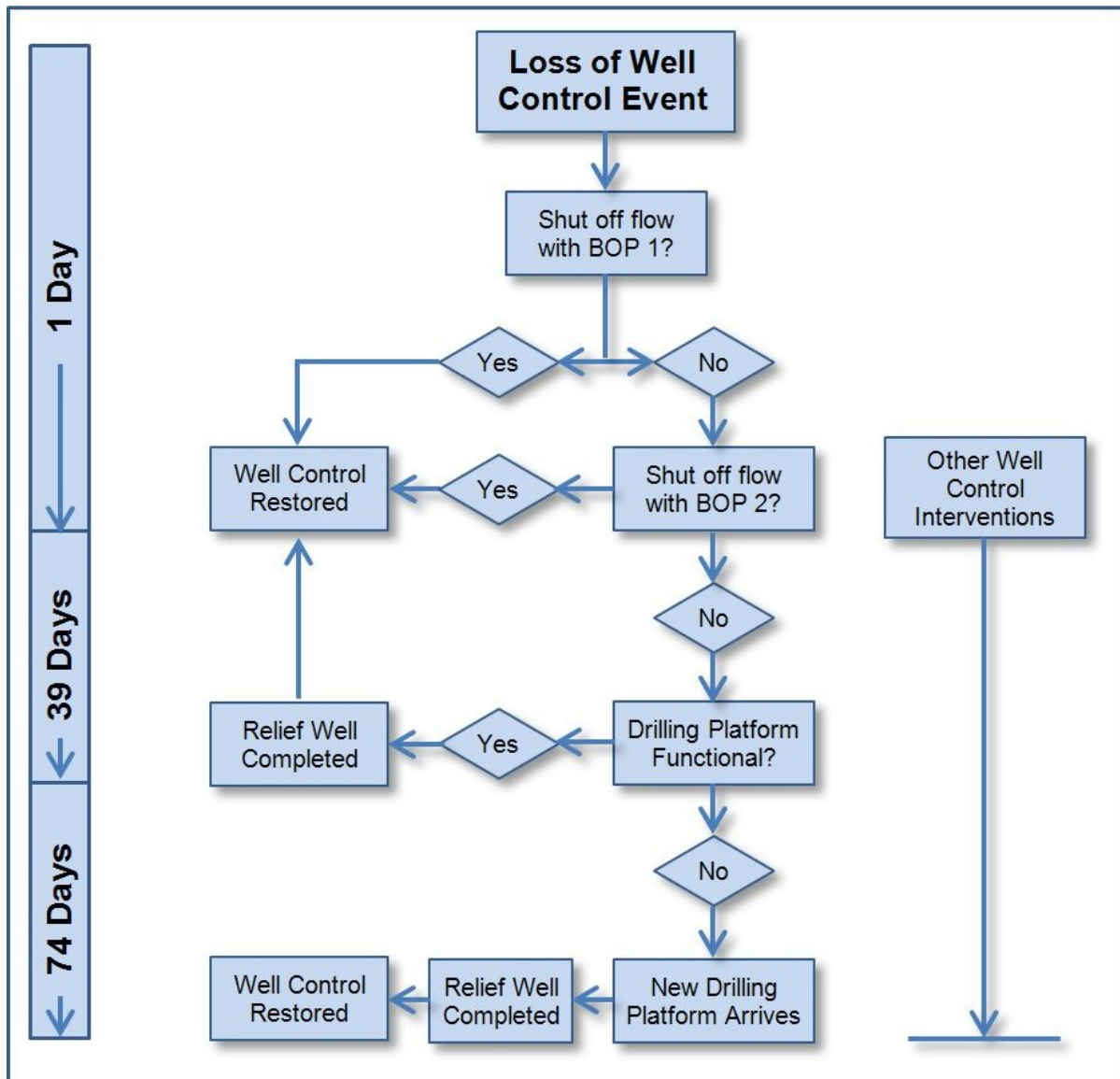


Figure 5-2. Timeline and sequence of response actions following a loss of well control event. The time scale on the left side indicates elapsed time from the initial loss of well control.

The OSRA model estimated the percent of trajectories from a hypothetical large spill contacting ERAs important to bowhead whales. The dynamics of oceanographic, climatic, and biotic factors affecting the distribution and abundance of prey, timing of accessibility to habitats, and corridors for movement determine the opportunity for bowhead whales and oil to come into contact.

The full large spill analysis for the Action Area is further described in Section 4.4 and Appendix A of the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014). The following discussion presents the results estimated by the OSRA model of the hypothetical large spill contacting ERAs important to bowhead whales. Trajectory contact with an ERA does not indicate the entire ERA is oiled, only that it is contacted somewhere.

Summer Spill Contacts within 60 Days

The OSRA model estimates <0.5 to 86% of the large spill trajectories starting at LA1–LA11 and PL1–9 could contact areas important to bowhead whales (Table 5–1) within 60 days if a large oil spill occurred during summer months. A large spill originating within LAs 10 or 11 represents the highest percentage of platform-sourced trajectories contacting, with 38% and 54% respectively. These LAs are adjacent to or in the immediate proximity of ERA 61. A large spill originating within PLs 6 and 9 represent the highest percentage of pipeline-sourced trajectories contacting, with 60% and 86%, respectively.

Table 5–1. Combined Probability of a Summer Large Oil Spill Contacting Important Bowhead Whale Areas within 60 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area (ERA) Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
20	East Chukchi Offshore	>0.5–2	6	>0.5–3	8
27	AK BFT Bowhead FM 6	>0.5–1	6	>0.5–1	8, 9
28	AK BFT Bowhead FM 7	>0.5–1	6	>0.5–1	8, 9
29	AK BFT Bowhead FM 8	>0.5–1	11	>0.5–1	8, 9
30	Beaufort Spring Lead 1	>0.5–2	11	>0.5–4	9
31	Beaufort Spring Lead 2	>0.5–1	11	>0.5–2	9
49	Chukchi Spring Lead 1	>0.5–1	10	>0.5–3	3
53	Chukchi Spring Lead 2	>0.5–11	10	>0.5–17	6
54	Chukchi Spring Lead 3	>0.5–9	11	3–16	9
56	Hanna Shoal Area	8–33	6	6–52	8
61	Pt Lay–Barrow BH GW SSF	16–54	11	25–86	9
63	North Chukchi	>0.5–5	1	>0.5–2	5, 8
65	Smith Bay	>0.5	ALL	>0.5–1	8, 9
70	North Central Chukchi	1–5	1	1–3	8
74	Offshore Herald Island	2–5	1	1–4	5, 8
82	N Chukotka Nrshr 2	2–9	1	2–8	2, 3
83	N Chukotka Nrshr 3	3–10	10	2–13	3
91	Hope Sea Valley	3–5	4	3–5	2, 5
107	Pt Hope Offshore	>0.5–4	10	1–7	3
108	Barrow Feeding Aggregation	1–6	6	1–10	9
109	AK BFT Shelf Edge	>0.5–1	6	>0.5–1	8
122	North Chukotka Offshore	1–3	4	1–3	2
123	AK Chukchi Offshore	3–9	5	3–8	5, 8
124	Central Chukchi Offshore	4–7	4	3–7	2

ERAs 21–22, 24–29, 61, 82–83, and 108 represent periodic fall and winter feeding aggregations for bowhead whales in September through October. The percentage of trajectories from LA1–LA11 and PLs 1–9 contacting these ERAs within a 60 day period are ≤5% with the exception of the Barrow

subsistence and Hanna Shoal areas (ERAs 56, 61, and 108), which are important bowhead feeding aggregations in most years, and the North nearshore areas of the Chukotka Peninsula (ERAs 82 and 83).

The percentage of trajectories from a LA contacting ERA 56 ranges from 8% to 33%, with the greatest percentages resulting from a spill in LA10. The percentage of PL trajectories contacting ERA 56 ranges from 8% to 52%, with the highest percentage resulting from a spill in PL9. The percentage of trajectories from a LA contacting ERA 61 ranges from 16% to 54%, with the greatest percentages resulting from a spill in LA11. The percentage of PL trajectories contacting ERA 61 ranges from 25% to 86%, with the highest percentage resulting from a spill in PL9 (Table 5–1).

The percentage of LA trajectories contacting ERA 108 ranges from 1% to 5%, and the percentage of PLs trajectories contacting ERA 108 ranges from 1% to 10%. The OSRA estimates the percentage of trajectories contacting ERAs 82 and 83 range from 2 to 9% and from 2–13%, respectively. A spill originating in LA10 has 7% and 10% of trajectories contacting ERA 82 and 83, respectively. A spill originating in PL3 has 8% and 13% of trajectories contacting ERA 82 and 83, respectively.

Summer Spill Contacts within 360 Days

The OSRA model estimates <0.5 to 86% of the large spill trajectories starting at LA1–LA11 and PL1–9 could contact areas important to bowhead whales (Table 5–2) within 360 days if a large oil spill occurred during summer months. A large spill originating within LAs 10 or 11 represents the highest percentage of platform-sourced trajectories contacting, with 38% and 55% respectively. A large spill originating within PLs 6 and 9 represent the highest percentage of pipeline-sourced trajectories contacting, with 60% and 86%, respectively.

Table 5–2. Combined Probability of a Summer Large Oil Spill Contacting Important Bowhead Whale Areas within 360 Days. (Dependent upon Spill Origin and Trajectory).

ID	Environmental Resource Area Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
20	East Chukchi Offshore	1–2	6, 11	1–4	9
26	AK BFT Bowhead FM 5	<0.5	ALL	<0.5–1	8, 9
27	AK BFT Bowhead FM 6	<0.5–1	6	<0.5–1	8, 9
28	AK BFT Bowhead FM 7	<0.5–1	5, 6, 11	<0.5–1	8, 9
29	AK BFT Bowhead FM 8	<0.5–1	5, 6, 11	<0.5–1	8, 9
30	Beaufort Spring Lead 1	<0.5–2	11	<0.5–4	9
31	Beaufort Spring Lead 2	<0.5–1	11	<0.5–2	9
32	Beaufort Spring Lead 3	<0.5	ALL	<0.5–1	9
49	Chukchi Spring Lead 1	<0.5–1	10	<0.5–3	3
53	Chukchi Spring Lead 2	<0.5–11	10	<0.5–17	6
54	Chukchi Spring Lead 3	<0.5–9	11	2–16	9
56	Hanna Shoal Area	9–35	6	6–54	8
61	Pt Lay–Barrow BH GW SSF	17–55	11	26–86	9
63	North Chukchi	1–5	1	<0.5–2	5, 8
65	Smith Bay	<0.5	ALL	<0.5–1	8, 9
70	North Central Chukchi	1–5	1, 6	1–4	8
74	Offshore Herald Island	2–5	1	1–5	8

ID	Environmental Resource Area Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
82	N Chukotka Nrshr 2	2–9	4	2–8	2, 3
83	N Chukotka Nrshr 3	4–10	10	3–13	3
91	Hope Sea Valley	3–6	4	3–5	2, 5
107	Pt Hope Offshore	<0.5–4	10	1–7	3
108	Barrow Feeding Aggregation	2–6	6, 11	1–10	9
109	AK BFT Shelf Edge	<0.5–1	1, 4, 5, 6, 11	<0.5–1	2, 5, 8, 9
122	North Chukotka Offshore	1–3	4, 5	1–3	2, 5
123	AK Chukchi Offshore	4–9	5, 6, 11	3–8	5, 8
124	Central Chukchi Offshore	4–7	4	3–7	2

The percentage of trajectories from LA1–LA11 and PLs 1–9 contacting the ERAs that are important bowhead whale fall migration and feeding aggregation areas within a 360 day period after a summer spill are consistent with those described above for summer spills potentially contacting ERAs within 60 days.

ERAs 63, 70, 74, 91, and 122–124 represent the late fall migration corridor and periodic fall feeding aggregations for bowhead whales in October through December. The percentage of trajectories from LA1–LA11 and PLs 1–9 contacting these ERAs within a 360 day period are $\leq 0.5\%$ to 7% , with trajectories originating from LAs producing the highest probabilities of contact (Table 5.2).

The bowhead whale spring migration follows the Chukchi and Beaufort spring lead system (ERAs 30–37, 45, 49, 53–54), and, as a component, Smith Bay (ERA 65) and the Alaska Beaufort Sea shelf edge (ERA 109) can be important feeding and transit areas during spring and summer months. All trajectories from LA1–LA11 and PLs 1–9 have a $<5\%$ probability of contacting these ERAs, with the exception of some of the Chukchi Leads (ERAs 53–54). A spill originating within a LA has a $<0.5\%$ to 11% likelihood of contacting ERA 53 and a $<0.5\%$ to 9% likelihood of contacting ERA 54, with the highest percentage of trajectories originating from LAs 10 and 11, respectively. A spill originating within a PL has a <0.5 to 17% chance of contacting ERA 53 and a 2% to 16% chance of contacting ERA 54, with the highest percentage of trajectories originating from PLs 6 and 9, respectively. **Winter Spill Contacts within 360 Days**

Winter spills, which include fresh oil entering the marine environment after October 31 can, within 60 days, contact ERAs through which bowhead whales migrate during the month of November across the Chukchi Sea. Satellite tracking bowhead whales in 2006 through 2010 (Quakenbush et al., 2010) have indicated bowhead movement through ERAs 63, 70, 74, 83, 91, and 122–124 during November however; the OSRA estimates that only ERAs 123 and 124 have $>5\%$ of spill trajectories contacting within 60 days (9% from LA4, 6% from PL5, 8 and 7% LA4, PL2, respectively). Winter spilled oil trapped under ice in early winter that becomes free of ice in spring could contact ERAs important to spring migrating and calving bowhead whales within 360 days of a winter spill.

Table 5–3. Combined Probability of a Winter Large Oil Spill Contacting Important Bowhead Whale Areas within 360 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area (ERA) Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
20	East Chukchi Offshore	<0.5–1	6, 11	<0.5–1	8, 9
30	Beaufort Spring Lead 1	>0.5–3	11	<0.5–4	9
31	Beaufort Spring Lead 2	<0.5–1	10, 11	<0.5–3	9
32	Beaufort Spring Lead 3	<0.5	ALL	<0.5–1	9
49	Chukchi Spring Lead 1	<0.5–7	10	1–9	3
53	Chukchi Spring Lead 2	<0.5–17	10	2–27	6
54	Chukchi Spring Lead 3	<0.5–13	11	1–2	9
56	Hanna Shoal Area	1–2	4, 10, 11	1–2	3, 5, 6, 8
61	Pt Lay–Barrow BH GW SSF	1–3	4, 10	1–4	3
63	North Chukchi	<0.5–1	1, 6	<0.5	ALL
66	Herald Island	1	ALL	<0.5–1	2, 3, 5, 6, 8
70	North Central Chukchi	<0.5–2	1	<0.5–1	6
74	Offshore Herald Island	1–5	1	1–2	2, 5, 8
82	N Chukotka Nrshr 2	<0.5	ALL	<0.5–1	3
91	Hope Sea Valley	2–4	4	1–4	2
107	Pt Hope Offshore	<0.5	ALL	<0.5–1	3
109	AK BFT Shelf Edge	<0.5	ALL	<0.5–1	6
122	North Chukotka Offshore	1–2	1, 4, 5, 6	<0.5–2	2
123	AK Chukchi Offshore	1–9	5	1–6	6, 8
124	Central Chukchi Offshore	2–7	4	2–7	2

The Chukchi spring lead systems (ERAs 49, 53–54) are critical to spring migrating and calving bowhead whales from late March to mid-June. Winter spilled oil that entered the marine environment on or before January 4 (74 days after a spill event October 31) would have been trapped in ice and released over winter and spring. Much of the toxic aromatic hydrocarbon component would have had the winter period to dissipate into the atmosphere through cracks and moving ice and open water of the polynya system through which many bowhead whales calve and migrate; thereby much of the inhalation hazard is somewhat reduced. For ERA 49 the percentage of trajectories contacting within 360 days of a winter spill from ranges <0.5 to 7%, with the maximum percentage coming from LA10. A maximum of 9% of trajectories contact (from PL3) (Table–5.3).

For ERAs 53 and 54 the OSRA model estimates range from <0.5–17% of trajectories would contact within 360 days of a winter spill, with maximum percentages from spills originating in LA10 and LA11 (13% and 17%, respectively). For ERA 53 2 to 27% of trajectories originating from a PL are estimated, while a maximum of 2% of trajectories are estimated to contact 54 from a PL spill (Table 5.4).

The percentage of trajectories contacting ERAs 12 and 30–32 (Beaufort Sea spring polynya system through which bowhead whales migrate from Late March to late June) within 360 days during winter from LA1–LA11 and PL1–9 does not exceed 5%.

Table 5–4. Combined Probabilities (Expressed as Percent Chance), Over the Assumed Life of the Scenario, of One or More Spills $\geq 1,000$ Bbl, and the Estimated Number of Spills (Mean), Occurring and Contacting Bowhead Whale ERAs.

ID	Environmental Resource Area Name	60 days		360 days	
		% Chance	Mean number	% Chance	Mean Number
20	East Chukchi Offshore	1	0.01	1	0.01
30	Beaufort Spring Lead 1	2	0.02	2	0.02
31	Beaufort Spring Lead 2	1	0.01	1	0.01
49	Chukchi Spring Lead 1	3	0.03	3	0.03
53	Chukchi Spring Lead 2	12	0.13	12	0.13
54	Chukchi Spring Lead 3	9	0.09	9	0.09
56	Hanna Shoal Area	8	0.09	10	0.11
61	Pt Lay–Barrow BH GW SSF	22	0.25	23	0.26
63	North Chukchi	1	0.01	1	0.01
70	North Central Chukchi	1	0.01	2	0.02
74	Offshore Herald Island	3	0.03	3	0.03
82	N Chukotka Nrshr 2	3	0.03	3	0.03
83	N Chukotka Nrshr 3	3	0.03	4	0.04
91	Hope Sea Valley	4	0.04	4	0.04
108	Barrow Feeding Aggregation	2	0.02	2	0.03
109	AK BFT Shelf Edge	–	–	1	0.01
122	North Chukotka Offshore	2	0.02	2	0.02
123	AK Chukchi Offshore	6	0.06	6	0.06
124	Central Chukchi Offshore	5	0.06	5	0.06

The chance of a large oil spill contacting an ERA important to bowhead whales is not the same as chance of oil contacting whales. Effects of oil contacting whales must consider whether whales are present and whale-oil contact occurs, the duration of contact, the age of spilled oil, atmospheric mixing other variable circumstances of a specific spill event, location, movement, avoidance capability/opportunity, numbers, age classes, and whale activity in an oil-contacted ERA.

Prolonged exposure of whales to volatile aromatic hydrocarbons could occur but is unlikely with the degree of atmospheric mixing that occurs in the Chukchi Sea area. Such a spill would age and

dissipate to a much greater degree than oil and not remain on the water surface for a long period. Prolonged periods of calm that would allow the heavier and toxic components of gas to remain concentrated at or near the ocean surface are unlikely.

If migrating whales delay or concentrate to feed in a spill area, prolonged exposure could occur. The potential for prolonged exposure of migrating bowhead whales to fresh (<10-day old oil) is not likely, as migrating whales would transit rapidly through a spill area. Some whales could experience physiological function impairment and possible mortality from inhalation of aromatic hydrocarbons; however, numbers affected are likely to be small, and cleanup activity would promote whales

Some individual bowhead whales could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, localized reduction or contamination of prey sources, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route. Potential effects of exposure of bowhead whales to spilled oil may result in lethal effects to some individuals, and most individuals exposed to spilled oil likely would experience temporary, nonlethal effects that may cause temporary or permanent impairment of physiological functions and potential productivity.

If a spill resulting in fresh oil with high aromatic hydrocarbon release and retention in the atmosphere near the surface in the spring lead system when large numbers of bowhead whales are present and somewhat confined to the lead system, they could experience prolonged exposure to inhalation of aromatics. Given the probability that a large oil spill would occur, that spilled oil would be transported to the spring lead vicinity under a huge sheet of solid ice and break-up just as bowhead whales are arriving, and the whales would have to be trapped/remain in contact with the vapors for large-scale mortality to occur, this hypothetical situation appears highly unlikely.

Under another set of unique circumstances, large numbers of feeding bowhead whales concentrated in high prey density habitats that remained in prolonged contact with oil or vapors could experience adverse effects, including mortality or impaired fitness of some individuals. Both cases are considered very unlikely.

Oil Spill Response Activities

The effectiveness of oil spill response activities to large oil spills vary from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. In the event of an oil spill in the Chukchi Sea OCS, it is reasonable to expect emergency response and cleanup activities that involved aircraft and vessel deployment.

As Arctic sea ice continues to contract and thin, energy exploration and transportation activities will be increasing in the region, escalating the risk of oil spills and accidents. As a result, NOAA, BSEE, the Oil Spill Recovery Institute, and the University of New Hampshire's Coastal Response Research Center and its partners have developed an Environmental Response Management Application (ERMA) for the Arctic region (NOAA, 2014). ERMA is a web-based GIS tool that assists both emergency responders and environmental resource managers in dealing with incidents that may harm the environment.

ERMA integrates and synthesizes data—some of which happens in real time—into a single interactive map, providing a quick visualization of the situation and improving communication and coordination among responders and environmental stakeholders.

Arctic ERMA brings together all of the available information needed for an effective emergency response in the Arctic's distinctive conditions, such as the extent and concentration of sea ice, locations of ports and pipelines, and vulnerable environmental resources.

The spill response may include activities that intentionally deflect whales away from or around spilled oil or cleanup operations and other areas of human activity (large numbers of cleanup workers, boats, and additional aircraft). Such activities may have limited success depending on whale

opportunity, ability, and inclination to avoid the activity, delay migration, or detour around a spill. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with NMFS regarding whale management activities in the event of a spill. In an actual spill, NMFS likely would be active within the Incident Command organization to review and approve proposed activities and monitor their effects. As a member of the team, NMFS personnel would be largely responsible for providing critical information affecting response activities to protect bowhead whales in the event of a spill.

Some displacement from high-value feeding habitats could occur, depending on the circumstances of a specific spill event, if a spill occurs, and that an area important to whales is affected when they are present. Cleanup activity during the open water period is anticipated to result in a negligible level of effect to bowhead whales, because the tendency and opportunity to avoid activity would not be hindered by ice conditions.

Much of the spring lead system and bowhead migration in the Chukchi Sea is nearshore. Existing leases occupy areas offshore of the spring lead system. Avoidance by whales of active vessels, deployment of deterrent devices, and low flying aircraft would buffer whale contact with a spill. However, if there is an active response in or near the spring lead system, bowhead whales may have few opportunities to relocate. Sources of fresh oil could be from pipelines or result from winter-spilled oil trapped under and within the ice; weathered oil would be released into the spring lead system when whales are present. It is anticipated that, depending on the location, timing, and circumstances of a spill, delayed spring bowhead migration and route alteration could occur for some whales.

Prey Reduction or Contamination: Reduction or contamination of food sources would be localized relative to the available prey in the Chukchi Sea to bowhead whales. Exposure to contaminated prey multiple times over the long lifetime of these whales could increase contamination of bowhead whale tissues through accumulation. This likely would not affect large numbers of whales, because they would be exposed to contaminated prey in localized areas. Because the percent chance of large oil spills occurring is unlikely, infrequent consumption of contaminated prey is unlikely to accumulate to levels that would harm individual whales.

Summary of Potential Oil Spill Effects on Bowhead Whales in the Action Area

Accidental small oil spills are considered reasonably foreseeable events that are not likely to adversely affect bowhead whales.

Several factors have to be taken into consideration when assessing the risk of a large spill to bowhead whales. First, while still unlikely, a large oil spill is more associated with oil production than exploration and the probability of a successful commercial find in the Chukchi Sea Planning Area is low. Secondly, the location of the oil or gas find and subsequent specific design of development platform and attendant features (i.e., pipelines) could influence the probability that a spill would occur as well as the chance that a large oil spill would reach resource areas important to bowhead whales when they are present. Third, the numbers and ages of whales and the duration and type of oil exposure would influence the degree of adverse effect.

In the unlikely event of a large oil spill, some individual bowhead whales may experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, the number affected likely would be small. Some individual whales could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, localized reduction or contamination of prey, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route.

Potential effects of exposure of bowhead whales to a large oil spill may result in lethal effects to some individuals, and most individuals exposed to spilled oil likely would experience temporary, nonlethal effects that may cause temporary or permanent impairment of physiological functions. Although very

unlikely, a large spill event resulting in fresh oil with high aromatic hydrocarbon release and retention in the atmosphere near the surface in the spring lead system, at a time and place where large numbers of bowhead whales are present and confined to the lead system, could cause prolonged exposure of whales to inhalation of aromatics. This could result in mortalities. Extended exposure of feeding bowhead whales concentrated in high prey density could result in a similar impact. However, both cases are considered very unlikely.

5.2.4.1.8. Summary of Potential Effects during Future Incremental Steps on Bowhead Whales

The interaction of marine seismic surveys, geohazard surveys, geotechnical surveys, pile driving, and drilling from drillships, and aircraft traffic, would have short-term and localized impacts on bowhead whales in the Action Area since most bowheads would not be in the area but in the Beaufort Sea until mid-September to mid-October. During the fall, bowheads migrate through the area; however, activities in the development, production and decommissioning of infrastructure on the Action Area should have few observable effects on whales. Mitigations required (see Appendix C of USDO, BOEM, 2014) for activity associated with airguns, dredging, and pile driving would reduce the impacts to bowhead whales. Small oil spills would have negligible impacts on bowhead whales due to their small volume, rapid weathering, and rapid dispersal. Large crude oil or condensate spills would likely have negligible impacts on bowhead whales during much of the summer; however such spills could have an adverse effect if they were to contact spring lead systems, feeding areas such as occurs near Barrow Canyon, or occurred during the fall migration as bowheads migrate through and around the Action Area. The potential effects from vessel traffic could be long-lasting and widespread to individual bowhead whales. Considering the levels of vessel traffic associated with the Exploration and Development Scenario some impacts would be likely, particularly during the spring and fall migrations when all of the bowhead whale stock passes between the Action Area and the Alaska coast. Though mortalities would be unlikely to occur in any given year of the Scenario, over the life of the project the probability of such an incident occurring would be much more likely however affects would not occur at the population level.

5.2.4.2. Potential Effects of Future Incremental Steps on Fin Whales

This section described the potential direct and indirect effects from development and production based on specific activities that could arise from future proposals. Direct and indirect effects to fin whales may arise from vessel and aircraft traffic, seismic surveys, drilling operations, facility construction and operation, and discharges associated with the Proposed Action. Individual and small groups of fin whales have been documented in portions of the Chukchi Sea Planning Area; however, no consistently used areas have been identified.

Construction of a production facility and pipeline may occur year around during the development phase. Once constructed, the production facility would begin drilling wells. Various support activities are needed. Effects of activities such as vessel traffic, aircraft traffic, drilling, and discharges are substantially similar to those described during the First Incremental Step. Some activities such as production drilling and aircraft traffic may extend year around operations. Deep penetration airgun supported 2D/3D surveys are not anticipated during development. See Section 2 for details of the Action during Future Incremental Steps.

5.2.4.2.1. Potential Effects from Vessel Traffic

Vessel traffic could increase in order to access and support a production facility on the Action Area. The potential effects could be slightly increased over those described for the First Incremental Step (Section 5.2.2.1, Vessel Traffic).

Few individuals or groups of fin whales would be encountered by vessels in the Action Area. Fin whales are found in the Chukchi Sea during the open water period when ice management may be needed; however, icebreaker activity is unlikely to affect fin whales. There are relatively small numbers of fin whales in the Chukchi Sea planning area as compared to the overall population of North Pacific fin whales.

As noted in Section 4, Environmental Baseline, available information indicates that vessel strikes of whales in the region are low and there is no indication that strikes will become an important source of injury or mortality. Typical mitigation measures would help avoid any affects, including collisions, to fin whales.

5.2.4.2.2. Potential Effects from Aircraft Traffic

Aircraft traffic would be at somewhat elevated levels to access and support a production facility on the Action Area. The potential effects could be slightly increased over those described for the First Incremental Step (Section 5.2.2.2, Aircraft Traffic) because the duration and intensity of such activities likely would be years longer than exploration and may occur all year.

Aircraft traffic could affect fin whales in the same ways as previously discussed for bowhead whales and impacts, if any, are minimal. Few individuals or groups of fin whales would be encountered by aircraft in the Action Area. There are relatively small numbers of fin whales in the Chukchi Sea planning area as compared to the overall population of North Pacific fin whales. Typical mitigation measures would help avoid any affects to fin whales.

5.2.4.2.3. Potential Effects from Seismic and Other Surveys

Seismic noise from deep penetration 2D/3D airgun operations would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Ancillary low energy surveys (including airgun supported surveys) for site clearance and shallow hazards would occur in localized areas near prospective drill sites and platform sites. Airgun supported seismic deep penetration surveys may be conducted to assess reservoir status and would be similar in effects described for fin whales during exploration (but are limited to the area over the reservoir).

Few individuals or groups of fin whales would be encountered by seismic survey activities in the Action Area given the low density and scant distribution in the Action Area. Potential effects to fin whales from these limited activities are similar to those described in Section 5.2.2.1. Seismic surveys would be subject to typical mitigation measures that would help avoid any affects to fin whales.

5.2.4.2.4. Potential Effects from Offshore Facility Construction

Development includes platform placement and installation of pipelines and other facilities. Noise from pile driving, dredging, equipment operation, etc. would add to the existing noise level at the construction location. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

Individual fin whales likely would avoid activities that bothered them; the distances vary according to individual whale and site-specific conditions (activity type, duration, and timing, etc.). These activities, however, would be subject to typical mitigation measures that would help avoid impacts to fin whales. Given the low density and scant distribution of fin whales in the Action Area no more than a minor level of affect from construction activities during development and production is anticipated.

5.2.4.2.5. Potential Effects from Development and Production Drilling Operations

Once a development facility is constructed, production drilling would begin. Drilling operations generate continuous type underwater sounds that could affect fin whales in the same ways as previously discussed for exploration drilling (Section 5.2.1.4). Potential affects for production drilling would be similar to those described in the First Incremental Step; however drilling activities likely would occur year round until production wells are completed. Drilling could also occur from a fixed platform or gravel island, which could have less sound transmission from exploration drilling using a drillship. Specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action areas become known.

Some fin whales could experience noise exposure and adjust their path around active drilling operations, however this is unlikely given their low density and scant distribution in the Action Area. The degree of adjustment would depend on the timing and location of the drilling operation. These small adjustments would be temporary, non-lethal, and, given the small number of fin whales occurring in the Action Area, negligible impact is anticipated.

5.2.4.2.6. Potential Effects of Offshore Facility Operation

Once a development facility is constructed, routine production operations would begin. Routine operations include the use of pumps, motors, etc. Operational noises from equipment at a production facility on a gravel island in shallow waters would have fewer effects than a similar production facility in deeper, open water. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted. Individual fin whales likely would avoid activities that bothered them; the distances vary according to individual whale and site-specific conditions (activity type, duration, and timing, etc.).

5.2.4.2.7. Potential Effects from Discharges

Authorized Discharges

The potential effects of discharges were described in Section 5.2.1.5. There could be considerably smaller volume of materials discharged under development and production if some materials (cuttings, process water, etc.) are reinjected into a disposal well. Any discharges would require compliance with existing U.S. Coast Guard and EPA rules and regulations which are intended to reduce or mitigate environmental harm. Overall, the level of effects from authorized discharges would be less than those described for the First Incremental Step (Section 5.2.2.2, Authorized Discharges).

Unauthorized Discharges

This section describes the potential effects to fin whales from oil spills estimated to occur during Future Incremental Steps in the Action Area. The hypothetical oil spill scenario for small and large spills in the Action Area were presented in Section 2.0.

Small Oil Spills

Small spills are generally contained prior to reaching the marine environment. If a small spill escaped containment, the volumes are small and dissipate/weather quickly. Small spills would not travel very far, which limits the potential for contact with fin whales near production facilities. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance response from fin whales and reduce the opportunity for them to contact these spills.

For the purposes of analysis under the Scenario, BOEM estimates that approximately 777 small spills (<1,000 bbl) could occur over the life of the Scenario (20 during the First Incremental Step and 757

during Future Incremental Steps) (Table 2–6). Accidental small oil spills are considered reasonably foreseeable events that are anticipated to have no adverse effects to fin whales in the Action Area.

Large Oil Spills

BOEM's estimate of the likelihood of one or more large spills occurring is predicated on successful development and that 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced (see Section 2.1.1.1.1). BOEM and BSEE estimate that two large oil spills are reasonably foreseeable during Future Incremental Steps (see Section 2). One large spill is reasonably foreseeable from a production platform and one is possible from a subsea pipeline. The potential for large oil spills to contact bowhead whales in the Chukchi Sea was described in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014). A detailed description of the OSRA model for large spills and results are also presented in Appendix A of the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014).

To evaluate the effect of a large oil spill resulting from development and production oil and gas activities, BOEM estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM also estimated the mean number of large spills and the chance of one or more large spills occurring over the life of the Scenario (see Section 2.1.1.1.1).

Fin whales are only present during the open water season and occur in very low numbers and appear widely distributed in the U.S. Chukchi Sea with greater abundance occurring in the Russian portions of the Chukchi Sea. The observation and data records regarding fin whales observed in the Action Area indicate so few occur there that only one important habitat was identified; ERA#107. ERA#107 is off shore of Point Hope June to September (see Figure 5.1). A few individual fin whales could experience similar effects as noted for bowhead whales above if contacted by oil during the ice free period. A large oil spill could result in some individual fin whales coming into contact with oil, potentially resulting in inhalation of hydrocarbon vapors, baleen fouling, and ingestion of contaminated prey. Temporary displacement from feeding and resting areas could also occur. Fin whale prey (schooling forage fish and zooplankton) could be reduced or contaminated, leading to modified distribution of whales. Temporary and/or permanent injury and non-lethal effects could occur, but mortality is not likely.

Reduction or contamination of food sources would be localized relative to the available prey in the Chukchi Sea to fin whales. Exposure to contaminated prey multiple times over the long lifetime of these whales could increase contamination of fin whale tissues through accumulation. This likely would not affect large numbers of whales, because they would be exposed to contaminated prey in localized areas. Because the percent chance of large oil spills occurring is unlikely, infrequent consumption of contaminated prey is unlikely to accumulate to levels that would harm individual whales.

Oil Spill Response Activities

The effectiveness of oil spill response activities to large oil spills vary from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. In the event of a petroleum spill in the Chukchi Sea OCS, it is reasonable to expect emergency response and cleanup activities that involved aircraft and vessel deployment.

The spill response may include activities that intentionally deflect whales away from or around spilled oil or cleanup operations and other areas of human activity (large numbers of cleanup workers, boats, and additional aircraft). Fin whales would likely avoid the noise related to a spill response, cleanup and post-event human activities similar to that noted for bowhead whales. Such activities may have limited success depending on whale opportunity, ability, and inclination to avoid the activity, or detour around a spill. Specific animal deterrence activities would be employed as the

situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with NMFS regarding whale management activities in the event of a spill. In an actual spill, NMFS likely would be active within the Incident Command organization to review and approve proposed activities and monitor their effects. As a member of the team, NMFS personnel would be largely responsible for providing critical information affecting response activities to protect fin whales in the event of a spill.

Some displacement from high-value feeding habitats could occur, depending on the circumstances of a specific spill event, if a spill occurs, and that an area important to whales is affected when they are present. Cleanup activity during the open water period is anticipated to result in few impacts to fin whales, because the tendency and opportunity to avoid activity would not be hindered by ice conditions.

Summary of Potential Oil Spill Effects on Fin Whales in the Action Area

Fin whales may be found throughout the OCS of the Chukchi Sea during the open water season; however, the numbers of individuals detected have always been very low. Though fin whales differ from bowhead whales in many ways, their auditory abilities, sensitivities, behavior, and physiology are comparable to bowhead whales such that the effects analysis for bowhead whales is applicable to fin whales. The few fin whales that could be in the Action Area are anticipated to experience similar types of adverse effects as bowhead whales but at a much reduced degree because: (1) they are much less abundant in the action area; (2) they typically occur only during the open-water season; (3) there are few calves (conceivably the most vulnerable component of a population); and, (4), they have a more dispersed prey base. There are no hypothetical situations or scenarios where a large number of fin whales would be anticipated to experience an adverse effect.

The effects of hydrocarbon exposure on fin whales are analyzed in the 2007 FEIS, 2011 SEIS, 2014 Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014), and the Arctic Region Biological Opinion (NMFS, 2013a); the physiological effects of oil spills on fin whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on fin whales refer to the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014).

Small refined oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual fin whales could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal. Fin whales are few in the Chukchi Sea and the likelihood of any fin whale encountering a large crude oil or condensate spill is low. The physiological effects of contact with crude oil on fin whales should be similar to what was described for other baleen whales.

5.2.4.2.8. Summary of Potential Effects during Future Incremental Steps on Fin Whales

The potential effects of the Proposed Action on fin whales are not significant and preclude any population-level effects to their stock because of their scarcity, particularly in the northern Chukchi Sea, and their seasonal use of the Chukchi Sea.

5.2.4.3. Potential Effects of Future Incremental Steps on Humpback Whales

This section described the potential direct and indirect effects from Future Incremental Steps that include exploration of a satellite field, and development and production of an anchor and satellite field (for more details see Section 2). Direct and indirect effects to humpback whales can arise from vessel and aircraft traffic, seismic surveys, drilling operations, facility construction and operation, and

discharges associated with the Proposed Action. Individual and small groups of humpback whales have been documented in the Chukchi Sea; however, no consistently used areas have been identified.

5.2.4.3.1. Potential Effect from Vessel Traffic

Vessel traffic could increase in order to access and support a production facility on the Action Area. The potential effects could be slightly increased over those described for the First Incremental Step (Section 5.2.2.1, Vessel Traffic).

There are relatively few humpback whales in the Action Area as compared to the overall population of humpback whales. Individual or groups of humpback whales would be encountered by vessels in the Action Area. Humpback whales may be found in the Chukchi Sea during the open water period when ice management may be needed; however, icebreaker activity is unlikely to affect humpback whales.

As noted in Chapter 4, Environmental Baseline, available information indicates that vessel strikes of whales in the region are low and there is no indication that strikes will become an important source of injury or mortality. Vessel traffic associated with this Action will have typical mitigation measures and approach regulations that are designed to avoid or minimize adverse impacts.

5.2.4.3.2. Potential Effects from Aircraft Traffic

Aircraft traffic could affect humpback whales in ways previously described in Section 5.2.1.2. Aircraft traffic would be at somewhat elevated levels to access and support a production facility on the Action Area. The potential effects could be slightly increased over those described for the First Incremental Step (Section 5.2.2.2.1, Aircraft Traffic), because the duration and intensity of such activities likely would be years longer and may occur all year.

Few individuals or groups of humpback whales would be encountered by aircraft in the Action Area. There are relatively small numbers of humpback whales in the Action Area as compared to the overall population of humpback whales. Currently, 1,500 ft (456 m) is the current mitigation applied to industry-operational aircraft in the OCS to protect marine mammals, including the humpback whale. Typical mitigation measures would help avoid adverse effects on humpback whales.

5.2.4.3.3. Potential Effects from Seismic and Other Surveys

Seismic noise from deep penetration 2D/3D airgun operations would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Ancillary low energy surveys (including airgun supported surveys) for site clearance and shallow hazards would occur in localized areas near prospective drill sites and platform sites. Airgun supported seismic deep penetration surveys may be conducted to assess reservoir status and would be similar in effects described for humpback whales during the First Incremental Step (but are limited to the area over the reservoir).

Few humpback whales would be encountered by seismic survey activities during production in the Action Area. Seismic surveys would be subject to typical mitigation measures that would help avoid adverse effects on humpback whales.

5.2.4.3.4. Potential Effects from Offshore Facility Construction

Development includes platform placement and installation of pipelines and other facilities. Noise from activities such as pile driving, dredging, and equipment operation, would add to the existing noise level at the construction location. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

Individual humpback whales likely would avoid activities that bothered them; the distances vary according to individual whale and site-specific conditions (e.g., activity type, duration, and timing). These activities, however, would be subject to typical mitigation measures that would help avoid adverse effects on humpback whales.

5.2.4.3.5. Potential Effects from Development and Production Drilling Operations

Potential effects for production drilling would be similar to exploration activities; however drilling activities likely would occur year round until production wells are completed. Drilling could also occur from a fixed platform, which could have less sound transmission from exploration drilling using a drillship. Specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action areas become known.

Drilling operations generate continuous type underwater sounds that could affect fin whales in the same ways as previously discussed for exploration drilling (Section 5.2.1.4). Some humpback whales could experience noise exposure and adjust their path around active drilling operations. The degree of adjustment would depend on the timing and location of the drilling operation. These small adjustments would be temporary, non-lethal, and, given the small number of humpback whales occurring in the Action Area, a negligible impact is anticipated.

5.2.4.3.6. Potential Effects of Offshore Facility Operation

Once a development facility is constructed, routine production operations would begin. Routine operations include the use of pumps, motors, and other equipment. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted. Individual humpback whales likely would avoid activities that bothered them; the distances vary according to individual whale and site-specific conditions (e.g., activity type, duration, and timing).

5.2.4.3.7. Potential Effects from Discharges

Authorized Discharges

The potential effects of discharges were described in Section 5.2.1.5. There could be considerably smaller volume of materials discharged under development and production if some materials (e.g., cuttings and process water) are reinjected into a disposal well. Any discharges would require compliance with existing U.S. Coast Guard and EPA rules and regulations which are intended to reduce or mitigate environmental harm. Overall, the level of effects from authorized discharges would be less than those described for the First Incremental Step (Section 5.2.2.3, Authorized Discharges) and a negligible level of effect to humpback whales is anticipated.

This section describes the potential effects to humpback whales from oil spills estimated to occur during Future Incremental Steps in the Action Area. The hypothetical oil spill scenario for small and large spills in the Action Area were presented in Section 2.0.

Development and Production in the Chukchi Sea OCS is not reasonably certain to occur. This evaluation is conducted on a hypothetical scenario that includes the most likely development outcome, should development be proposed. Large oil spills remain highly unlikely and are not reasonably certain to occur.

Unauthorized Discharges

This section describes the potential effects to humpback whales from oil spills estimated to occur during Future Incremental Steps in the Action Area. The hypothetical oil spill scenario for small and large spills in the Action Area were presented in Section 2.0. The potential effects of hydrocarbon

exposure on humpback whales are analyzed in the 2007 FEIS, 2011 SEIS, and 2014 Draft Second SEIS for Lease Sale 193, and the Biological Opinion (NMFS, 2013a), and the physiological effects of oil spills on humpback whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on fin whales refer to the 2014 SEIS.

Future Incremental Steps in the Action Area are not reasonably certain to occur. This evaluation is conducted on a hypothetical scenario that includes the most likely development and production outcome. Large and very large oil spills remain highly unlikely and are not reasonably certain to occur.

Small Oil Spills

Individual humpback whales could be exposed to small spills, which would have negligible impacts on their health, due to small spill sizes, weathering, and rapid spill dispersal. Small spills are generally contained prior to reaching the marine environment. If a small spill escaped containment, it will rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Small spills would not travel very far, which limits the potential for contact with humpback whales. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance response from humpback whales and reduce the opportunity for them to contact these spills.

For the purposes of analysis under the Scenario, BOEM estimates that approximately 777 small spills (<1,000 bbl) could occur over the life of the Scenario (20 during the First Incremental Step and 757 during Future Incremental Steps) (Table 2–6). Accidental small oil spills are considered reasonably foreseeable events that are anticipated to have negligible impacts to humpback whales in the Chukchi Sea.

Large Oil Spills

BOEM's estimate of the likelihood of one or more large spills occurring assumes that development occurs and that 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced (see Section 2.1.1.1.1). BOEM and BSEE estimate two large oil spills are reasonably foreseeable during Future Incremental Steps (see Section 2). One could occur from a production platform and one is possible from a subsea pipeline. The potential for large oil spills to contact bowhead whales in the Chukchi Sea was described in the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014). A detailed description of the OSRA model for large spills and results are also presented in Appendix A of the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014).

To judge the effect of a large oil spill resulting from Scenario activities, BOEM estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM also estimated the mean number of large spills and the chance of one or more large spills occurring over the life of the Scenario (see Section 2.1.1.1.1).

Humpback whales are only present during the open water season and occur in very low numbers in the Action Area. A large oil spill could result in some individual humpback whales coming into contact with oil, potentially resulting in inhalation of hydrocarbon vapors, baleen fouling, and ingestion of contaminated prey. Temporary and/or permanent injury and non-lethal effects could occur, but mortality is not likely. Temporary displacement from feeding and resting areas could also occur. The observation and data records regarding humpback whales observed in the Action Area indicate so few occur there that only two important habitats were identified; ERA#107 and BS#2 (see Figure 5.1). ERA#107 is off shore of Point Hope June to September and BS#2 is RusCH C Dezhnev in the Bering Strait May to October. Concentration areas for humpback whales include a June–September aggregation area at Pt Hope Offshore (ERA 107), and a May–October feeding area at

RusCH C Dezhnev in the Bering Strait (BS 2) (Table A.1–11, and Maps A–2f and A–1 in 2014 SEIS), with annual contact chances <5% at 30 and 360 days (Tables A.2–21 and A.2–24 in 2014 SEIS). The effects of large crude oil or condensate spills, or natural gas releases would be similar to what was described for bowhead whales.

Localized reduction of humpback whale prey (primarily schooling forage fish) could occur, including long term impacts if hydrocarbons entered the benthos. Exposure to contaminated prey multiple times over the long lifetime of these whales could increase contamination of humpback whale tissues through accumulation. This likely would not affect large numbers of whales, because they would be exposed to contaminated prey in localized areas. Because the percent chance of large oil spills occurring is unlikely, infrequent consumption of contaminated prey is unlikely to accumulate to levels that would harm individual whales.

Oil Spill Response Activities

The effectiveness of oil spill response activities to large oil spills vary from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. In the event of a petroleum spill in the Chukchi Sea Planning Area, it is reasonable to expect emergency response and cleanup activities that involved aircraft and vessel deployment. The spill response may include activities that intentionally deflect whales away from or around spilled oil or cleanup operations and other areas of human activity (large numbers of cleanup workers, boats, and additional aircraft). Such activities may have limited success depending on whale opportunity, ability, and inclination to avoid the activity, or detour around a spill. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with NMFS regarding whale management activities in the event of a spill. In an actual spill, NMFS likely would be active within the Incident Command organization to review and approve proposed activities and monitor their effects. As a member of the team, NMFS personnel would be largely responsible for providing critical information affecting response activities to protect humpback whales in the event of a spill.

Cleanup activity during the open water period is anticipated to result in a negligible level of effect to humpback whales, because the tendency and opportunity to avoid activity would not be hindered by ice conditions. Avoidance by whales of active vessels, deployment of deterrent devices, and low flying aircraft would buffer whale contact with a spill.

Summary of Potential Oil Spill Effects on Humpback Whales in the Action Area

A few humpback whales have been observed in coastal areas of the southern Chukchi Sea during the open water season but could occur in other areas of the Chukchi Sea in very low numbers. Humpback whales differ from bowhead whales in many ways, however their auditory abilities, sensitivities, behavior, and physiology are considered comparable to that of bowhead and fin whales such that the effects analysis for bowhead and fin whales is applicable to humpback whales. The few humpback whales that could be in the Action Area are anticipated to experience similar types of adverse effects as bowhead whales but at a much reduced degree because: (1) they are much less abundant in the action area, (2) they typically occur only during the open-water season, (3) there are few calves (conceivably the most vulnerable component of a population), and (4), they have a more dispersed prey base. There are no hypothetical situations or scenarios where a large number of humpback whales would be anticipated to experience more than a minor level of affect.

Summary of Potential Effects during Future Incremental Steps on Humpback Whales

The effects of the Proposed Action on humpback whales are not significant and preclude any population-level effects to their stock because of humpback scarcity and seasonal use of the Chukchi Sea.

5.2.4.4. Potential Effects of Future Incremental Steps on Bearded Seals

This section described the potential direct and indirect effects from Future Incremental Steps. Direct and indirect effects to bearded seals can arise from vessel and aircraft traffic, seismic surveys, drilling operations, facility construction and operation, and discharges associated with the Proposed Action.

Bearded seals spend their summers feeding on benthic organisms on the continental shelf in the Chukchi Sea. During winter, and spring they mostly utilize leads and polynya systems where they can access patches of open water to feed and pack ice to rest. Bearded seals have been consistently documented in the Action Area throughout the year and they are usually the second most common marine mammal present, after ringed seals. During fall a large proportion of the Beringian DPS of bearded seals migrates south into the Bering Sea with the formation of sea ice in the Bering Sea.

5.2.4.4.1. Potential Effects from Vessel Traffic

Vessel traffic could affect bearded seals in the same ways as previously discussed in Section 5.2.1.1. Vessel traffic could increase in order to access and support a production facility on the Action Area. The potential effects could be slightly increased over those described for the First Incremental Steps (Section 5.2.2.5, Vessel Traffic). As noted in Chapter 4, Environmental Baseline, available information indicates that vessel strikes of seals in the region are low and there is no indication that strikes will become an important source of injury or mortality.

Bearded seals may be found in the Chukchi Sea all year, but are associated with ice and icebreaker activity could disturb them. There is a short period of time where bearded seal pups may be inadvertently killed during icebreaking or ice management activities. Timing stipulations would likely avoid adverse effects to newborn bearded seal pups. Typical mitigation measures (see Section 2.3) and approach regulations designed to avoid or minimize adverse impacts.

5.2.4.4.2. Potential Effects from Aircraft Traffic

Aircraft traffic could affect bearded seals in the same ways as described in Section 5.2.1.2. Aircraft traffic would be at somewhat elevated levels to access and support a production facility in the Action Area because the duration and intensity of such activities likely would be years longer than exploration and may occur all year. The potential effects to bearded seals could be slightly increased over those described for the exploration phase (Section 5.2.2.5, Aircraft Traffic). If sea ice is present one could reasonably expect seals to become startled and abandon sea ice for the ocean. Over time, seals may habituate to aircraft traffic.

A 1,500 ft (456 m) altitude is the current mitigation applied to industry-operational aircraft in the Arctic OCS to protect marine mammals, including bearded seals. Typical mitigation measures would help avoid adverse effects on bearded seals.

5.2.4.4.3. Potential Effects from Seismic and Other Surveys

During development and production, seismic noise from deep penetration 2D/3D airgun operations would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, and echosounders. Ancillary low energy surveys (including airgun supported surveys) for site clearance and shallow hazards would occur in localized areas near prospective drill sites and platform sites. Airgun supported seismic deep penetration surveys may be conducted to assess reservoir status and would be similar in effects described for exploration (but are limited to the area over the reservoir).

Marine seismic surveys could affect many bearded seals in the Action Area, however, the most common response of bearded seals to ongoing seismic activities has been swimming and looking behavior from within a few hundred meters until the seismic vessel and airguns depart the area (Harris, Miller, and Richardson, 2001; Miller and Davis, 2002; Blees, Hartin, and Ireland, 2010;

Reiser et al., 2010). Existing observations indicate a possible minor avoidance reaction by bearded seals from the firing of airgun arrays, but not to an excessive degree. Consequently bearded seals could briefly divert around active seismic surveys before resuming travel. The small scale of the geohazard and geotechnical surveys, the equipment used, and the few marine seismic surveys would not interact to produce anything beyond temporary, brief avoidance behavior by bearded seals.

Seismic surveys would be subject to typical mitigation measures that would help avoid adverse effects on bearded seals. For example, seismic surveys could be timed to avoid seal pupping seasons. When seismic surveys are being conducted around the production facility, PSOs could monitor for the presence of seals as is done during exploration.

5.2.4.4.4. Potential Effects of Offshore Facility Construction

Development includes platform placement and installation of pipelines and other facilities. Noise from activities such as pile driving, dredging, and equipment operation, would add to the existing noise level at the construction location. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

Subsea pipeline construction would be between a location near Wainwright or Barrow, Alaska, and the site of the first production platform. BOEM and BSEE estimate that 160 mi of subsea oil pipeline, 160 miles of subsea gas pipeline, and 30 miles of flowline connecting subsea templates to host platforms would ultimately be laid for development and production (see Table 2–4). Construction of the first platform should take approximately a year to complete. Between Years 10 and 30, approximately eight platforms would be constructed in the anchor field, approximately 5-mi apart, with a 20-mi distance from the Anchor field to the Satellite field where three more platforms would be built using similar 5-mi spacing. Because drilling from production platforms produces much less noise than drilling from drillships, noise effects on seals would be reduced and restricted to the immediate vicinity of the platform.

The loudest noise associated with production platform installation would be pile-driving, and Greene et al. (1995) described pile-driving noise levels of 131–135 dB re 1 μ Pa (40 – 100 Hz) at 1 km from the source. Due to ice characteristics in the Chukchi Sea production platforms in the Chukchi Sea may require larger, or more, pilings to anchor each platform to the sea floor. In either situation pile-driving sound propagation characteristics could change. The audibility range for phocid seals occurs in a 50 Hz – 80 kHz band (Ciminello et al. 2012), overlapping the 100 Hz – 2 kHz frequency noise range produced by pile driving. Since pile driving noise source levels from Cook Inlet, Alaska (Blackwell, 2005) were 190 dB re 1 μ Pa, and rapidly attenuated to 115–133 dB re 1 μ Pa within one kilometer it is assumed similar attenuation of pile driving noise would occur in the Action Area. Though there is overlap in the noise frequencies affected by pile-driving and the noise frequencies used by bearded seals, the overlap occurs at the bottom of the audibility spectrum for seals. Furthermore it is generally assumed that seals, would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. Pile driving could occur during the open water season when most bearded seals are feeding and some seals would pass through, or remain in the Action Area. With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities, dredging, or pipeline construction.

Individual bearded seals likely would avoid activities that bothered them; the distances vary according to individual seal and site-specific conditions (activity type, duration, and timing, etc.). These activities, however, would be subject to typical mitigation measures that would help avoid

adverse effects on bearded seals. For example, activities could be restricted during the pupping season.

5.2.4.4.5. Potential Effects from Development and Production Drilling Operations

Once a development facility is constructed, production drilling would begin. Drilling operations generate continuous type underwater sounds that could affect ringed seals in the same ways as previously discussed in Section 5.2.1.4. Potential effects for production drilling would be similar to exploration activities; however drilling activities likely would occur year round until production wells are completed. Drilling could also occur from a fixed platform, which could have less sound transmission from exploration drilling using a drillship. Specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action

Subsea wells would be drilled by MODUs, and the effects of such activity would be similar to the effects of drilling exploration wells. A maximum of 9 wells would be drilled in a single season. The Molikpaq is a mobile Arctic drilling platform, similar in many ways to what would be expected for production platforms in the Action Area. Thomson and Johnson (1996) documented decibel levels of 112 dB at 1.4 km from the Molikpaq, with most of the energy occurring below 20 Hz. Assuming the decibel and frequency levels between the Chukchi Sea and Sea of Okhotsk would be remotely similar, and since 112 dB is approximately at or below ambient noise levels for the Chukchi Sea, the radii for adverse effects should extend to 1.4 km (0.87 mi) or less from each production platform. Not all platforms would be drilling simultaneously, however, the noise production from drilling 32 wells from 8 platforms would average 4 wells per platform in year 25 during the peak of drilling activity. The noise footprint from this level of drilling would equate to a 1.4 km zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz which is within the very bottom range of the auditory bandwidth for bearded seals (50 Hz – 80 kHz). The frequencies involved with drilling lie mostly below the auditory range for seals, and any impacts from drilling noise should be minimal. Once drilling is completed, bearded seals should eventually habituate to the presence of production wells and such platforms might be expected to serve as reef habitat for some benthic and pelagic organisms as has been noted elsewhere (Todd, et al., 2009).

Throughout the 77 years of the Scenario, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be the likeliest means of conducting crew changeovers with 1–3 daily flights to each production platform during the production phase. Aircraft are not used with a great deal of regularity during seismic surveys, although the capability exists and they have been used historically to support seismic operations in the Chukchi Sea on a case-by-case basis. Assuming minimum altitude requirements of 1000 to 1500 ft ASL/AGL are applied in the Scenario, the effects of aircraft on bearded seals should be minimal. Vessel traffic during the production phase would amount to 1–2 weekly trips between the coast and each platform during the open water season, which could affect bearded seals if seals are sucked into bow thrusters or ducted propeller systems as has occurred in other high-latitude regions (Thompson, et al., 2010). The applicable mitigations from NMFS (2013) should prevent such accidents from occurring if incorporated into the scenario.

Drilling operations are likely to displace some bearded seals. Some bearded seals could experience noise exposure and avoid an active drilling operation. The degree of adjustment would depend on the timing and location of the drilling operation. These small adjustments would be temporary and non-lethal.

5.2.4.4.6. Potential Effects from Offshore Facility Operations

Once a development facility is constructed, routine production operations would begin. In total 8 production platforms may be installed in the satellite and anchor fields during Future Incremental

Steps. Routine operations include the use of pumps, motors, etc. Operational noises from equipment at a production facility on a gravel island in shallow waters would have fewer effects than a similar production facility in deeper, open water. Facility operations can periodically generate continuous type underwater sounds that could affect bearded seals in the same ways as previously discussed for drilling during the First Incremental Step (Section 5.2.1.4). Bearded seals should eventually habituate to the presence of production wells and such platforms might be expected to serve as reef habitat for some benthic and pelagic organisms as has been noted elsewhere (Todd, et al., 2009). The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

These operations could displace some bearded seals if they experienced noise exposure and chose to avoid the production facility area. The degree of displacement would depend on the timing, location, timing, sound level, etc. of the operation. These small avoidance adjustments would be temporary and non-lethal.

5.2.4.4.7. Potential Effects from Discharges

Authorized Discharges

The potential effects of discharges were described in Section 5.2.1.5. There could be considerably smaller volume of materials discharged under development and production if some materials (cuttings, process water, etc.) are reinjected into a disposal well. Any discharges would require compliance with existing U.S. Coast Guard and EPA rules and regulations which are intended to reduce or mitigate environmental harm. Overall, the level of effects from authorized discharges would be less than those described for the First Incremental Step (Section 5.2.2.5, Authorized Discharges).

Unauthorized Discharges

This section describes the potential effects to bearded seals from oil spills estimated to occur during Future Incremental Steps in the Action Area. The hypothetical oil spill scenario for small and large spills in the Action Area were presented in Section 2.1. The potential effects of exposure to oil on bearded seals are described in the Biological Opinion *Oil and Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska* (NMFS, 2013a), and the physiological effects of oil spills on bearded seals remains consistent with what was previously described.

The BOEM assessments of oil spill impacts are based on a combination of estimates, including the chance of one or more large oil spills occurring, spill size, spill duration, and weather. Spills could occur on land or in the marine environment. Spills into the marine environment have the potential to travel with water currents or ice and to spread rapidly, depending on season, wind, and weather. Spills have the greatest potential to affect bearded seals in the Chukchi Sea.

Small Oil Spills

Small spills are generally contained prior to reaching the marine environment. If a small spill escaped containment, the volumes are small and dissipate/weather quickly. Small spills would not travel very far, which limits the potential for contact with bearded seals near production facilities. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance response from bearded seals and reduce the opportunity for them to contact these spills.

For the purposes of analysis under the Scenario, BOEM estimates that approximately 777 small spills (<1,000 bbl) could occur over the life of the Scenario (20 during the First Incremental Step and 757 during Future Incremental Steps) (Table 2–6).

Accidental small oil spills are considered reasonably foreseeable events that are anticipated to have a negligible level of effect to bearded seals in the Chukchi Sea.

Large Oil Spills

BOEM's estimate of the likelihood of one or more large spills is predicated on development occurring and that 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced. Two large spills (>1,000 bbl) could occur from platforms or pipeline during Future Incremental Steps (see Section 2). For OSRA in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014), BOEM assumed one of these large spills would be from an offshore pipeline.

To evaluate the effect of a large oil spill resulting from Scenario activities, BOEM estimated information regarding the general source(s) of a large oil spill (from a platform and pipeline), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM also estimated the mean number of large spills and the chance of one or more large spills occurring over the life of the Scenario (see Section 2.1.1.1.1).

The potential for large oil spills to contact bearded seals in the Chukchi Sea was described in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014). A detailed description of the OSRA model for large spills and results are also presented in Appendix A of the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014). The oil spill mitigation measures described in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014) is a condition for existing leases. For the oil spill trajectory model, the chance that a large oil spill would contact a specific resource area assumes no cleanup or mitigation is in place.

Bearded seal presence during the open water season is correlated with the presence of sea ice. Bearded seals are associated with relatively shallow waters over the continental shelf where they forage for benthic species. During the summer bearded seals spend much of their time foraging at sea. Bearded seals do not tend to be gregarious, but aggregate near polynyas, lead systems, and the ice edge. During winter months their presence is strongly linked to polynyas, areas of broken ice, and lead systems where they have immediate access to water and food resources. For this reason, bearded seal densities tend to be higher in the southern Chukchi Sea early in the spring, and decrease as the open water season progresses. The sub-population (part of the Beringia DPS of bearded seals) of resident bearded seals in the Chukchi Sea is estimated at around 27,000 residing year-round (Cameron et al., 2010). Throughout the year bearded seals avoid nearshore areas including areas of shorefast ice. Because of this LSs and GLs were not analyzed for bearded seals because this species is strongly associated with sea ice and generally are not found on the shoreline.

The ERAs for bearded seals are shown in Figure 5.3 and were described in Appendix A, Table A.1–14 of the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014), and include:

- Hanna Shoal (ERA 6)
- A 12 nmi buffer around Wrangel Island (ERA 46)
- The Chukchi spring lead system (ERA 48)
- Herald Shoal Polynya (ERA 62).

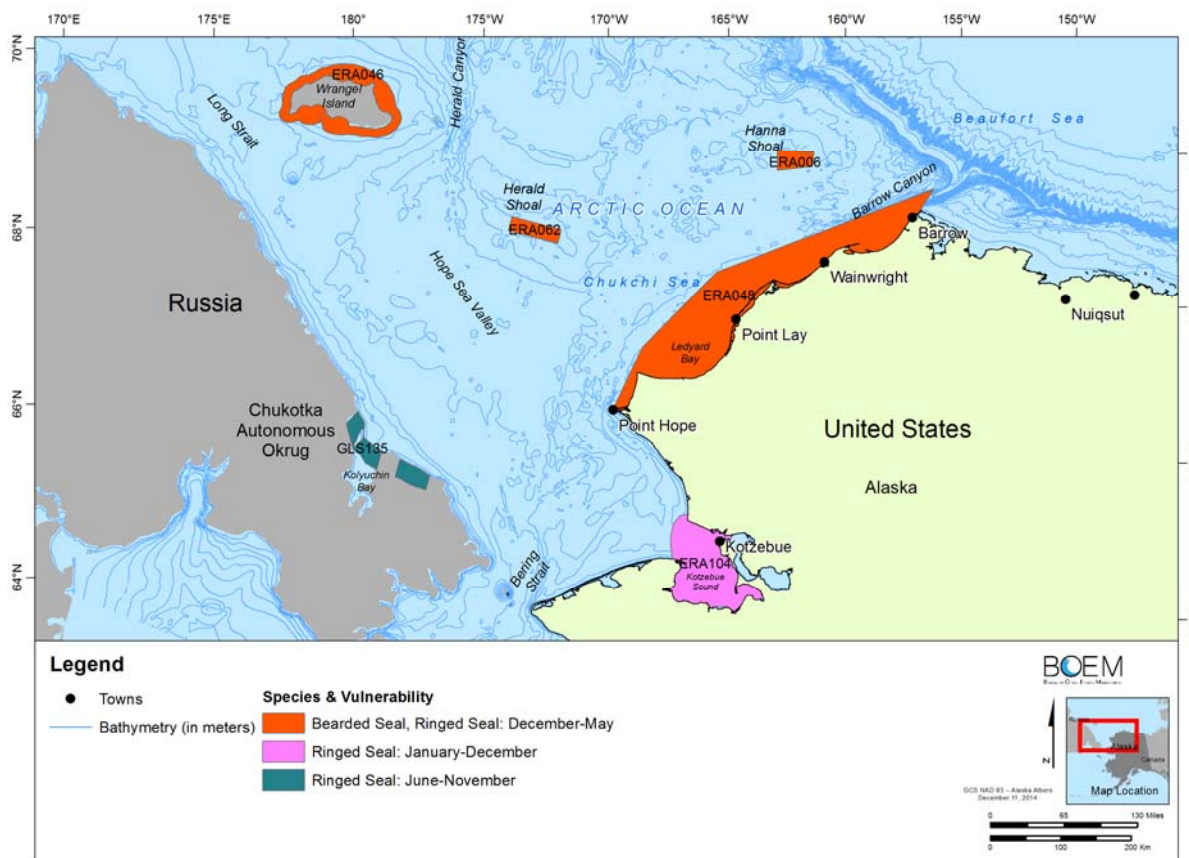


Figure 5-3. Environmental Resource Areas (ERAs) used in the Oil-Spill Trajectory Analysis for Ice Seals

Summer within 60 Days

Higher densities of bearded seals occur in open water near areas of sea ice, and spills are most likely to affect them anywhere in the open water. However, the shallow waters of shoals make them lucrative hunting areas from the perspective of a benthos-feeding bearded seal. Consequently, one may expect somewhat larger densities of bearded seals in the vicinity of Hanna Shoal (ERA 6) and LAs had a 5–24% of trajectories contacting Hanna Shoal (ERA 6) within 60 days. Spills originating in PLs had a 3–37% chance of contacting Hanna Shoal. However, any spills in the open water could very likely affect some bearded seals since they are somewhat ubiquitous in the northern Chukchi and Beaufort seas.

Summer within 360 Days

The OSRA model estimates Hanna Shoal (ERA 6) has a 5–25% of trajectories contacting from all LAs and PLs within 360 days.

Winter within 360 Days

A large spill event from the LAs or PLs could contact spring lead systems, the shear zone around Wrangel Island, Russia, and polynya systems. Spring lead systems in the Beaufort Sea include Beaufort Spring Lead 1 (ERA 30), and Beaufort Spring Lead 2 (ERA 31), which have a 1–3% of trajectories contacting within 360 days from a winter large spill. Lead systems in the Chukchi Sea that have a >0.5% of trajectories contacting contact include the Chukchi Lead System 4 (ERA 48) which

has a 5–36% of trajectories contacting from a winter large spill. The leads produced by the shear zone surrounding Wrangel Island 12 nmi (14 mi or 22 km) Buffer 2 (ERA 46) have 5–15% of trajectories contacting from a LA-associated winter spill within 360 days and 3–11% of trajectories contacting from a PL-associated spill (Table 5.5).

Polynya systems that could be contacted by a LA spill occur at Hanna Shoal (ERA 6), and Herald Shoal Polynya 2 (ERA 62), which have 6–20%, and a 10–21% of trajectories contacting within 360 days from a winter large spill respectively, other ERAs have <0.5% of trajectories contacting from all LAs. Hanna Shoal has a 5–29% chance of being contacted by a spill trajectory originating from a PL (Table 5.5). However, if a spill made its way into a lead or polynya system, any remaining volatile compounds would begin weathering out of the slick, albeit at a slower rate than would occur during a summer spill. The oil weathering models estimate that approximately 30% of oil from a slick would remain from a 60,000 bbl per day summer spill after 30 days, and 48% would remain from a winter (meltout) spill after 30 days (USDOI, BOEM, 2014). These estimates assume that wind speeds remain consistent with typical measurements for the Action Area (approximately 4 m/s, USDOI, BOEM, 2014). At higher wind speeds, the oil slick would be dispersed and evaporate more quickly. Consequently, at least half of the oil in any of the leads or polynyas would quickly weathered out of the slick and the ensuing effects on bearded seals might be moderated to one degree or another.

The combined probability of large spills occurring in a given ice seal-relevant ERA over the life of the Scenario is <10%, with the exception of Hanna Shoal (ERA 6, 11–13% chance), and part of the Chukchi Spring Lead system (ERA 48, 21% chance) (Table 5–5).

Table 5.5 indicates Chukchi Lead System 4 (ERA 48), Herald Shoal Polynya 2 (ERA 62), and Hanna Shoal (ERA 6) are the only lead system or polynyas found to have $\geq 5\%$ chance of a large spill occurring and contacting within 30 and 360 days. Large spills contacting lead systems or polynya systems could result in a large number of bearded seal mortalities, particularly if young seal pups are present (St. Aubin, 1990). Such an occurrence would produce minor to moderate effects among bearded seals trapped in an oiled lead system, though they could haul out on ice, and only patches of the lead system would be oiled. Large winter spills contacting leads and polynyas would also require time to travel from the LA or PL to a lead or polynya, weathering and dispersing along the way, which would lower the actual volume of oil or condensate to contact the ERA. With the passage of time, much of the oil could gel or emulsify in low temperatures, making spill patches easier to observe and avoid by bearded seals if gelled, or it could become frozen in ice if emulsified. Assuming a large crude oil spill occurred during winter and in a nearshore pipeline passing under Chukchi Lead System 4 (ERA 48), the effects on bearded seals would be long-lasting and widespread as a spill would contact the polynya system at Hanna Shoal (6), or Herald Shoal (ERA 62).

Table 5–5. Combined Probabilities (Expressed as Percent Chance), Over the Assumed Life of the Scenario, of One or More Spills $\geq 1,000$ Bbl, and the Estimated Number of Spills (Mean), Occurring and Contacting Ice Seal ERAs.

ERA ID	Environmental Resource Area Name	60 days		360 days	
		%	mean	%	mean
6	Hanna Shoal	11	0.12	13	0.14
46	Wrangel Island 12 nmi Buffer 2	5	0.05	6	0.06
48	Chukchi Lead System 4	21	0.24	22	0.25
62	Herald Shoal Polynya 2	9	0.09	9	0.1
135	Kolyuchin Bay	2	0.02	2	0.02

In the event of a large crude oil or condensate spill, or a gas release, some bearded seals could be affected. Due to sea floor topography, bearded seals forage widely across much of the Chukchi Sea and so should not be concentrated in any one area during the open water season. Immersion studies by Geraci and Smith (1976b) resulted in 100% mortality in captive ringed seals. Unlike the animals in the immersion study, seals in the open water would have ice as a resting/escape platform as well as water depth and distance for escape routes from an oil spill, which they can detect and avoid (St. Aubin, 1990).

Several factors have to be taken into consideration when assessing the risk of a large spill to bearded seals. First, while still unlikely, a large oil spill is more associated with oil production than exploration and the probability of a successful commercial find in the Chukchi Sea Planning Area is low. Secondly, the location of the oil or gas find and subsequent development platform could influence the chance that a spill would occur as well as that it would reach ERAs important to bearded seals when they are present. Finally, the size and age composition of the bearded seal population and the duration and type of oil exposure influences the potential effects. Finally, avoidance by ice seals of active vessels, deployment of deterrent devices, and low flying aircraft responding to a spill would buffer seal contact with a spill.

Reduction or contamination of food sources would be localized relative to the available prey in the Chukchi Sea to bearded seals. Exposure to contaminated prey multiple times over the long lifetime of these seals could increase contamination of bearded seal tissues through accumulation. This likely would not affect large numbers of seals, because they would be exposed to contaminated prey in localized areas. Because the percent chance of large oil spills occurring is unlikely, infrequent consumption of contaminated prey is unlikely to accumulate to levels that would harm individual seals.

Oil Spill Response Activities

The effectiveness of oil spill response activities to large oil spills vary from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. In the event of a petroleum spill in the Chukchi Sea Planning Area, it is reasonable to expect emergency response and cleanup activities that involved aircraft and vessel deployment.

The spill response may include activities that intentionally deflect seals away from or around spilled oil or cleanup operations and other areas of human activity (large numbers of cleanup workers, boats, and additional aircraft). Such activities may have limited success depending on seal opportunity, ability, and inclination to avoid the activity, delay migration, or detour around a spill. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with NMFS regarding seal management activities in the event of a spill. In an actual spill, NMFS likely would be active within the Incident Command organization to review and approve proposed activities and monitor their effects. As a member of the team, NMFS personnel would be largely responsible for providing critical information affecting response activities to protect ice seals in the event of a spill.

Some displacement from high-value feeding habitats could occur, depending on the circumstances of a specific spill event, if a spill occurs, and that an area important to ice seals is affected when they are present. Cleanup activity during the open water period is anticipated to result in a negligible level of effect to ice seals, because the tendency and opportunity to avoid activity would not be hindered by ice conditions.

Summary of Potential Oil Spill Effects on Bearded Seals in the Action Area

The effects of hydrocarbon exposure on bearded seals are analyzed in the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014), and in the Biological Opinion (NMFS, 2013a) and the physiological effects of oil spills on them remain consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on bearded seals

refer to the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014) and the 2013 NMFS Biological Opinion (Sections 2.4.2.4.5., and 2.4.5.4.5).

Small spills could occur at any time during the Scenario, and would likely result from refueling accidents at sea. Small spills should have no effect on bearded seals because of the small spill size, the relatively small area contacted with oil, and the wide distribution of most bearded seals during the open water season when vessels would be in use. Bearded seals use offshore habitats throughout the year and could be affected by a large oil spill in the Action Area.

Spill response and cleanup activities of large spills during the open water season should be prompt and effective, so these spills could be much more easily be addressed. Spill response and cleanup in lead systems and polynyas during winter and spring could be problematic with no way to deliver vessels to the leads in winter and present logistical obstacles.

5.2.4.4.8. Summary of Potential Effects during Future Incremental Steps on Bearded Seals

The interaction of marine seismic surveys, geohazard surveys, geotechnical surveys, pile driving, and drilling from MODUs, and aircraft traffic, would have short-term and localized impacts on bearded seals in the Action Area since most of them will be widely dispersed, in sea ice, or during winter months. The noise levels from airguns, dredging, and pile driving would be sufficient to result in avoidance behavior; however, required mitigations would reduce the impacts while ensuring no takes of bearded seals occur. The small scale of the Geohazard and Geotechnical surveys, the equipment used, and the few marine seismic surveys would not interact to produce anything beyond temporary, brief avoidance behavior by bearded seals.

Drilling from production platforms produces much less noise than drilling from MODUs, therefore noise effects on seals would be reduced and restricted to the immediate vicinity of the platform. Drilling operations using fixed or floating platforms are expected to displace small numbers of bearded seals from an area around the drilling platform.

With audible noise levels slightly above those of ambient noise within a kilometer of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities, dredging, or pipeline construction.

Small refined crude oil, or other spills, should produce no effects on bearded seals due to the limited spill size, weathering, and rapid dispersion of such a spill. Large oil or condensate spills could have adverse effects on bearded seals. Minor effects to a few bearded seals would be expected during the summer and fall before sea ice blankets the Chukchi Sea. After winter sea ice sets in, bearded seals concentrate in lead systems, shear zones, and polynya areas to access water and forage. If large spills occurred during winter and contacted lead systems or polynya systems, large bearded seal mortalities could occur. For such an event to occur, a spill would most likely have to occur from a pipeline since the presence of sea ice throughout most of the Action Area would act to inhibit movement of spilled oil or condensate from most LAs to lead systems many miles away. If a successful method for spill response and cleanup becomes feasible, the effects of large crude oil or condensate winter spills should change.

5.2.4.5. Potential Effects of Future Incremental Incremental Steps on Ringed Seals

This section described the potential direct and indirect effects in future incremental. Direct and indirect effects to ringed seals can arise from vessel and aircraft traffic, seismic surveys, drilling operations, facility construction and operation, and discharges associated with the Proposed Action.

5.2.4.5.1. Potential Effects from Vessel Traffic

Vessel traffic could affect ringed seals in the same ways as previously discussed (see Sections 5.2.1.1 and 5.2.2.5, Vessel Traffic). Vessel traffic could increase in order to access and support a production facility in the Action Area. The potential effects could slightly increase over those described for the First Incremental Step for this species. As noted in Section 4, Environmental Baseline, available information indicates that vessel strikes of seals in the region are low and there is no indication that strikes will become an important source of injury or mortality.

Ringed seals may be found in the Chukchi Sea all year, but are associated with ice and icebreaker activity could disturb ringed seals. Ringed seal pups may be inadvertently killed during icebreaking or ice management activities during the mid-March to mid-June period. Timing stipulations would likely avoid adverse effects to newborn ringed seal pups, particularly when nursing and molting. Typical mitigation measures are required to avoid these effects.

5.2.4.5.2. Potential Effects from Aircraft Traffic

Aircraft traffic could affect ringed seals in the same ways as previously discussed (see Sections 5.2.1.1 and 5.2.2.5, Aircraft Traffic). Aircraft traffic would be at somewhat elevated levels to access and support a production facility on the Action Area because the duration and intensity of such activities likely would be years longer than exploration and may be in support of year round activities. The potential effects to ringed seals could be slightly increased over those described for the First Incremental Step. If sea ice is present one could reasonably expect seals to become startled and abandon sea ice for the ocean. Over time, seals may habituate to aircraft traffic.

A 1,500 ft (456 m) altitude is the current mitigation applied to industry-operational aircraft in the Chukchi Sea Planning Area to protect marine mammals, including the ringed seal. Typical mitigation measures would help avoid adverse effects on ringed seals.

5.2.4.5.3. Potential Effects from Seismic and Other Surveys

During development and production seismic noise from deep penetration 2D/3D airgun operations would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, and echosounders. Ancillary low energy surveys (including airgun supported surveys) for site clearance and shallow hazards would occur in localized areas near prospective drill sites and platform sites. Airgun supported seismic deep penetration surveys may be conducted to assess reservoir status and would be similar in effects described for exploration (but are limited to the area over the reservoir).

Seismic surveys would be subject to typical mitigation measures that would help avoid adverse effects on ringed seals. For example, seismic surveys could be timed to avoid seal pupping seasons. When seismic surveys are being conducted around the production facility, MMOs could monitor for the presence of seals as is done during exploration.

5.2.4.5.4. Potential Effects from Offshore Facility Construction

Development includes platform placement and installation of pipelines and other facilities. Noise from activities such as pile driving, dredging, and equipment operation would add to the existing noise level at the construction location. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

Individual ringed seals likely would avoid activities that bothered them; the distances vary according to individual seal and site-specific conditions (e.g., activity type, duration, and timing). These activities, however, would be subject to typical mitigation measures that would help avoid adverse

effects on ringed seals. For example, activities could be restricted during the pupping season or when shorefast ice is present.

5.2.4.5.5. Potential Effects from Development and Production Drilling Operations

Once a development facility is constructed, production drilling would begin. Drilling operations generate continuous type underwater sounds that could affect ringed seals in the same ways as previously discussed in Section 5.2.1.5. Potential effects for production drilling would be similar to the First Incremental Step; however drilling activities likely would occur year round until production wells are completed. Drilling could also occur from a fixed platform, which could have less sound transmission from exploration drilling using a drillship. Specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action areas become known.

Drilling operations are likely to displace some ringed seals; however, ringed seals were seen as close as 10 m from an active drilling platform (Brewer et al., 1993). Some ringed seals could experience noise exposure and avoid an active drilling operation. The degree of adjustment would depend on the timing and location of the drilling operation. These small adjustments would be temporary and non-lethal.

5.2.4.5.6. Potential Effects of Offshore Facility Operation

Once a development facility is constructed, routine production operations would begin. Routine operations include the use of pumps, motors, and other equipment. Operational noises from equipment at a production facility on a gravel island in shallow waters would have fewer effects than a similar production facility in deeper, open water. Facility operations can periodically generate continuous type underwater sounds that could affect ringed seals in the same ways as previously discussed for exploration drilling (Section 5.2.1.5). The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

These operations could displace some ringed seals if they experienced noise exposure and chose to avoid the production facility area. The degree of displacement would depend on the timing, location, timing, sound level and other particulars of the operation. These small avoidance adjustments would be temporary and non-lethal.

5.2.4.5.7. Potential Effects from Discharges

Authorized Discharges

The potential effects of discharges were described in Section 5.2.1.6. There could be considerably smaller volume of materials discharged in Future Incremental Steps if some materials (cuttings, process water, etc.) are reinjected into a disposal well. Any discharges would require compliance with existing U.S. Coast Guard and EPA rules and regulations which are intended to reduce or mitigate environmental harm. Overall, the level of effects from authorized discharges would be less than those described for the First Incremental Step (Section 5.2.2.5, Authorized Discharges).

Unauthorized Discharges

This section describes the potential effects to ringed seals from oil spills estimated to occur during Future Incremental Steps in the Action Area. The hypothetical oil spill scenario, for small and large spills in the Action Area, is presented in Section 2.

The effects of hydrocarbon exposure on ringed seals are analyzed in the *BO Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska* (NMFS, 2013a),

and the physiological effects of oil spills on ringed seals remains consistent with what was described in that document. For more detailed information relating to the effects of hydrocarbons on ringed seals refer to the BO. Ringed seals differ from bearded seals in many ways, but their auditory abilities, sensitivities, and behavior remains similar enough to bearded seals that the effects analysis for bearded seals is applicable to ringed seals.

Small Oil Spills

Small spills are generally contained prior to reaching the marine environment. If a small spill escaped containment, the volumes are small and dissipate/weather quickly. Small spills would not travel very far, which limits the potential for contact with ringed seals near production facilities. Vessel and aircraft traffic, noise, and human activity associated with oil spill response and cleanup is anticipated to result in avoidance response from ringed seals and reduce the opportunity for them to contact these spills.

For the purposes of analysis under the Scenario, BOEM estimates that approximately 777 small spills (<1,000 bbl) could occur over the life of the Scenario (20 during the First Incremental Step and 757 during Future Incremental Steps) (Table 2.6). Accidental small oil spills are considered reasonably foreseeable events that are anticipated to have negligible impacts to ringed seals in the Chukchi Sea.

Large Oil Spills

BOEM's estimate of the likelihood of one or more large spills occurring is predicated on development actually occurring and 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced (see Section 2.1.1.1.1). Large oil spills are reasonably foreseeable during Future Incremental Steps (see Section 2). One large spill is reasonably expected to occur from a production platform and one is possible from a subsea pipeline. The potential for large oil spills to contact ringed seals in the Chukchi Sea was described in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014). A detailed description of the OSRA model for large spills and results are also presented in Appendix A of the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014).

To evaluate the effect of a large oil spill resulting from Scenario activities, BOEM estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM also estimated the mean number of large spills and the chance of one or more large spills occurring over the life of the Scenario (see Section 2.1.1.1.1).

The likelihood of ringed seals being affected by a large oil spill is determined by a number of factors including: spill avoidance abilities; presence; distribution; habitat use; diet; timing of a spill; spill constituents; spill magnitude; and spill duration. Several factors have to be taken into consideration when assessing the risk of a large spill to ringed seals. First, while still unlikely, a large oil spill is more associated with oil production than exploration and the probability of a successful commercial find in the Chukchi Sea Planning Area is low. Secondly, the location of the oil or gas find and subsequent development platform could influence the chance that a spill would occur as well as that it would reach ERAs important to bearded seals when they are present. Finally, the size and age composition of the ringed seal population and the duration and type of oil exposure influences the potential effects.

Ringed seals have a strong association with sea ice. However, unlike bearded seals, ringed seals overwinter in areas of shorefast ice, particularly where heaves and irregularities create icy hummocks that can protect their lairs from polar bear predation. During summer, ringed seals associate with sea ice in the open waters and so may occur in the open ocean where they forage on fishes. It is assumed that their presence and densities in any given area will depend upon the food stocks in a local area, as well as the presence or absence of sea ice. Consequently LSs are not analyzed for ringed seals for a 60 day summer spill. Polynya and lead systems are analyzed for the 60 or 360 days summer, and 360

day winter time periods. The ERAs for ringed seals are shown in Figure 5.3 and were described in Appendix A, Table A.1–14 of the Draft Second SEIS for Lease Sale 193 (USDOI, BOEM, 2014), and include:

- Hanna Shoal (ERA 6)
- A 12 nmi buffer around Wrangel Island (ERA 46)
- The Chukchi spring lead system (ERA 48)
- Herald Shoal Polynya (ERA 62)
- Kotzebue Sound (ERA 104)

A single GLS was identified for ringed seals at Kolyuchin Bay (GLS 135; see Figure 5.3). The OSRA model results, unless otherwise noted, are expressed as percent of trajectories contacting within 60 and 360 days during summer, and 360 days during winter. The OSRA model results are described in more detail below.

Summer within 60 Days

The 60-day summer large spill analysis for ringed seals is similar to what is analyzed for bearded seals. The OSRA indicates that within 60 days of a summer spill, 1% of trajectories would contact the Wrangel Island buffer (ERA 46). Less than 0.5% of trajectories would contact Herald Shoal Polynya and Kotzebue Sound (ERA 104). Kolyuchin Bay (GLS 135) would have 1–4% of trajectories contacting from all LAs and PLs (Table 5.6). Hanna Shoal (ERA 6) would have the highest likelihood of contact from an LA or PL trajectory (24% and 37%, respectively).

Table 5–6. Combined Probability of a Summer Large Oil Spill Contacting Important Ice Seal Resource Areas within 60 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area (ERA) Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
6	Hanna Shoal	5–24	6	3–37	8
46	Wrangel Island 12 nmi Buffer 2	<0.5–1	1, 5, 6, 11	<0.5–1	5, 8, 9
48	Chukchi Lead System 4	<0.5	ALL	<0.5–1	6, 9
62	Herald Shoal Polynya 2	<0.5	ALL	<0.5	ALL
104	Kotzebue Sound	<0.5	ALL	<0.5	ALL
GLS (Grouped Land Segment) Name					
135	Kolyuchin Bay	1–4	4, 10	1–5	3

A large number of ringed seals would likely be within foraging distance from the ice front during the open water season; however, the ebbs and flows of the ice front make assigning a fixed area to the ice front impractical.

Summer within 360 Days

Ringed seals prefer areas of shorefast ice, mostly foregoing areas of pack ice. However they frequently use polynyas surrounded by stable pack ice, such as occurs at Hanna and Herald Shoals during the winter. The spring lead systems in the Chukchi Sea are also important to ringed seals since these systems allow seals to forage for fishes and rest on an icy platform if needed.

Within 360 days of a summer large spill, 1–2% of trajectories would contact the 12 nmi buffer around Wrangel Island (ERA 46). One percent of trajectories would contact the Chukchi Spring Lead system (ERA 48). Less than 0.5% of trajectories would contact Herald Shoal Polynya (ERA 62) and Kotzebue Sound (ERA 104). Kolyuchin GLS (GLS 135) has a 2–5% of trajectories contacting from

any given LA or PL (Table 5.7). Hanna Shoal (ERA 6) would have the highest likelihood of contact from an LA or PL trajectory (25% and 38%, respectively).

Table 5–7. Combined Probability of a Summer Large Oil Spill Contacting Important Ice Seal Resource Areas within 360 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area (ERA) Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
6	Hanna Shoal	5–25	6	4–38	8
46	Wrangel Island 12 nmi Buffer 2	1–2	5, 6, 11	<0.5–2	5, 8
48	Chukchi Lead System 4	<0.5–1	11	<0.5–1	6, 8, 9
62	Herald Shoal Polynya 2	<0.5	ALL	<0.5	ALL
104	Kotzebue Sound	<0.5	ALL	<0.5	ALL
GLS (Grouped Land Segment) Name					
135	Kolyuchin Bay	2–5	4, 10	1–5	3

Winter within 360 Days

A winter spill contacting the Hanna Shoal (ERA 6) polynya system would have a 5–20% of trajectories contacting from all LAs and PLs within 360 days. A winter large spill within 360 days would have a 8–21% of trajectories contacting Herald Shoal Polynya (ERA 62) from all LAs and PLs. The percent of trajectories contacting the Chukchi spring lead system (ERA 48) would be 5–36% from all LAs and <0.5–1% from all PLs (Table 5.8).

A large spill would also have a 3–15% of trajectories contacting the 12 nmi buffer around Wrangel Island (ERA 46) from all LAs and PLs within 360 days. Less than 0.5% of trajectories would contact Koztebue Sound (ERA 104). Lastly, GLS 135 would have a 1% of trajectories contacting from LA 10 within 360 days.

Table 5–8. Combined Probability of a Winter Large Oil Spill Contacting Important Ice Seal Resource Areas within 360 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area (ERA) Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
6	Hanna Shoal	6–20	6	5–29	8
46	Wrangel Island 12 nmi Buffer 2	5–15	1	3–11	5, 8
48	Chukchi Lead System 4	5–36	11	<0.5–1	6, 8, 9
62	Herald Shoal Polynya 2	10–21	4	8–21	2
104	Kotzebue Sound	<0.5	ALL	<0.5	ALL
GLS (Grouped Land Segment) Name					
135	Kolyuchin Bay	<0.5–1	10	<0.5–1	3

The combined probability of large spills occurring in a given ice seal-relevant ERA over the life of the Scenario is <10%, with the exception of Hanna Shoal (ERA 6, 11–13% chance), and part of the Chukchi Spring Lead system (ERA 48, 21% chance) (Table 5.9).

Table 5–9. Combined Probabilities (Expressed as Percent Chance), Over the Assumed Life of the Scenario, of One Or More Spills $\geq 1,000$ Bbl, and the Estimated Number of Spills (Mean), Occurring and Contacting Ice Seal ERAs.

ERA ID	Environmental Resource Area Name	60 days		360 days	
		%	mean	%	mean
6	Hanna Shoal	11	0.12	13	0.14
46	Wrangel Island 12 nmi Buffer 2	5	0.05	6	0.06
48	Chukchi Lead System 4	21	0.24	22	0.25
62	Herald Shoal Polynya 2	9	0.09	9	0.1
135	Kolyuchin Bay	2	0.02	2	0.02

Ringed seals occur in all sea ice habitats: shorefast, persistent flaw zones/leads, polynyas, divergence zones, and the ice edge or front. Like bearded seals, ringed seals prefer sea ice as molting, resting, and whelping habitat; often migrate from the Chukchi Sea into the Beaufort Sea during winter but leave a substantial proportion of their population behind as year-round residents of the Chukchi and Bering Seas. Unlike bearded seals, ringed seals whelp in subnivean chambers sequestered under pressure ridges, and folds in the sea ice; carve and maintain breathing holes through solid sea ice; prefer landfast sea ice while using lead systems; and generally shift foraging areas in tandem with the location of sea ice. The numbers of ringed seals in the Chukchi and Beaufort Seas likely number over a million animals (Kelly et al. 2010), and in the highly unlikely scenario of a large spill removing several thousand ringed seals, a large population number over 1 million individuals should quickly replenish those losses within a generation.

Reduction or contamination of food sources would be localized relative to the available prey in the Chukchi Sea to ringed seals. Exposure to contaminated prey multiple times over the long lifetime of these seals could increase contamination of ringed seal tissues through accumulation. This likely would not affect large numbers of seals, because they would be exposed to contaminated prey in localized areas. Because the percent chance of large oil spills occurring is unlikely, infrequent consumption of contaminated prey is unlikely to accumulate to levels that would harm individual seals.

Oil Spill Response Activities

The effectiveness of oil spill response activities to large oil spills vary from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. In the event of a petroleum spill in the Action Area, it is reasonable to expect emergency response and cleanup activities that involved aircraft and vessel deployment.

The spill response may include activities that intentionally deflect seals away from or around spilled oil or cleanup operations and other areas of human activity (large numbers of cleanup workers, boats, and additional aircraft). Such activities may have limited success depending on seal opportunity, ability, and inclination to avoid the activity, delay migration, or detour around a spill. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with NMFS regarding seal management activities in the event of a spill. In an actual spill, NMFS likely would be active

within the Incident Command organization to review and approve proposed activities and monitor their effects. As a member of the team, NMFS personnel would be largely responsible for providing critical information affecting response activities to protect ice seals in the event of a spill.

Some displacement from high-value feeding habitats could occur, depending on the circumstances of a specific spill event, if a spill occurs, and that an area important to ice seals is affected when they are present. Cleanup activity during the open water period is anticipated to result in a negligible impact to ice seals, because the tendency and opportunity to avoid activity would not be hindered by ice conditions.

Summary of Potential Oil Spill Effects to Ringed Seals in the Action Area

The effects of hydrocarbon exposure on ringed seals are analyzed in the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014), and in the Biological Opinion (NMFS, 2013a) and the physiological effects of oil spills on them remain consistent with what was described in those documents.

Small refined or crude oil spills should have a negligible effect on ringed seals at any time of the year because of the small spill sizes, the relatively small area contacted with oil, rapid dispersion rates, and the wide distribution of ringed seals through much of the year.

Ringed seals maintain a broad distribution across the Arctic and large crude oil or condensate spills could only affect large numbers of ringed seals are concentrated in lead or polynya systems described in the bearded seal large oil spill analysis above. The effects would be similar to what was described for bearded seals, with one main difference. Landfast sea ice is the preferred optimal winter habitat for ringed seals, however many ringed seals are believed to use sub-optimal pack ice winter habitat since there is not enough landfast sea ice to support ringed seal population estimates (Reeves 2014). For this reason large crude oil or condensate spills under pack ice could have adverse effects on ringed seals, though ringed seal population densities are likely lower per unit area on pack ice than on landfast ice. Nonetheless, mortalities are likely to occur among ringed seals wintering in pack ice if a large crude oil or condensate spill occurred during winter, though the effects would probably be less than with a similar spill event contacting a polynya or lead.

Gas winter releases could affect ringed seals in pack ice in a manner consistent with what has been described for large winter oil spills, because the presence of pack ice would inhibit the rapid dispersal and volatilization of dry gas by trapping it under ice. The effects of a gas release on ringed seals in pack ice would be moderate, and include mortalities for some ringed seals.

Summary of Potential Impacts during Future Incremental Steps on Ringed Seals

The interaction of marine seismic surveys, geohazard surveys, geotechnical surveys, pile driving, and drilling from MODUs, and aircraft traffic, would have short-term and localized impacts on ringed seals in the Action Area; however, large crude oil or condensate winter spills contacting ringed seals in polynyas, leads, or in pack ice may result in mortalities of some seals. Widespread mortalities are not envisioned for large winter oil or condensate spills considering the assumed spill sizes, and any population losses should be recouped within one year. The implementation of spill responses and cleanup should reduce the impacts from large crude oil or condensate spills from moderate to negligible for summer spills. If a successful method for winter spill response and cleanup becomes feasible, the effects of large crude oil or condensate winter spills should change.

5.2.4.6. Potential Effects of Future Incremental Steps on Ringed Seal Proposed Critical Habitat

This section described the potential direct and indirect effects from Future Incremental Steps. Direct and indirect effects to ringed seal proposed critical habitat can arise from vessel and aircraft traffic, seismic surveys, drilling operations, facility construction and operation, and discharges associated with the Proposed Action.

5.2.4.6.1. Potential Effects from Vessel Traffic

Vessel traffic could affect ringed seal proposed critical habitat in the same ways as previously discussed in Sections 5.2.1.1 and 5.2.2.6, Vessel Traffic. Vessel traffic could increase in order to access and support a production facility on the Action Area. The potential effects could be slightly increased over those described for the First Incremental Step for the species.

5.2.4.6.2. Potential Effects from Aircraft Traffic

Aircraft traffic could affect proposed critical habitat for ringed seals in the same ways as previously discussed in Sections 5.2.1.2 and 5.2.2.6, Aircraft Traffic. Aircraft traffic would be at somewhat elevated levels to access and support a production facility on the Action Area because the duration and intensity of such activities likely would be years longer than exploration and may be in support of year round activities. The potential effects to ringed seal proposed critical habitat could be slightly increased over those described for the First Incremental Step.

Aircraft traffic associated with the proposed action would be subject to altitude restrictions and typical mitigation measures required under the MMPA that would also apply to listed species. These measures are designed to avoid or minimize adverse effects to ringed seals.

5.2.4.6.3. Potential Effects from Seismic and Other Surveys

Development and production seismic noise from deep penetration 2D/3D airgun operations would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Ancillary low energy surveys (including airgun supported surveys) for site clearance and shallow hazards would occur in localized areas near prospective drill sites and platform sites. Airgun supported seismic deep penetration surveys may be conducted to assess reservoir status and would be similar in effects described for the First Incremental Step (but are limited to the area over the reservoir).

5.2.4.6.4. Potential Effects of Offshore Facility Construction

Development includes platform placement and installation of pipelines and other facilities. Noise from activities such as pile driving, dredging, and equipment operation, would add to the existing noise level at the construction location. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source around a small noise footprint. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

These activities would be subject to typical mitigation measures that would help avoid disturbance to primary prey resources, sea ice habitats that would otherwise be suitable for formation and maintenance of ringed seal birth lairs, and sea ice that would otherwise be suitable for basking and molting platforms. For example, activities could be restricted during the pupping season or when shorefast ice is present.

5.2.4.6.5. Potential Effects from Development and Production Drilling Operations

Once a development facility is constructed, production drilling would begin. Drilling operations generate continuous type underwater sounds that could affect ringed seals and proposed critical habitat in the same ways as previously discussed under the First Incremental Step. However drilling activities likely would occur year round until production wells are completed, thereby fully extending into the pupping season. Drilling could also occur from a fixed platform, which could have less sound transmission from exploration drilling using MODUs. Specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action areas become known.

Drilling operations are likely to displace some primary prey resources, and compromise the suitability of sea ice habitats otherwise suitable as birth lairs or platforms to ringed seals. The zone of avoidance by ringed seals or their primary prey resources is not fully known; however, ringed seals have been seen as close as 10 m from an active drilling platform (Brewer et al., 1993).

5.2.4.6.6. Potential Effects from Offshore Facility Operations

Once a development facility is constructed, routine production operations would begin. Routine operations include the use of pumps, motors, and other equipment. The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

Facility operations are likely to displace some primary prey resources, and compromise the suitability of sea ice habitats otherwise suitable as birth lairs or platforms to ringed seals. The zone of avoidance by ringed seals or their primary prey resources is not fully known. The zone of avoidance would depend on the timing, location, sound level, and other particulars of the operation. Given the extensive spatial extent of proposed critical habitat, and the small number of facilities expected over the life of the action, a negligible impact is anticipated to proposed critical habitat for ringed seals.

5.2.4.6.7. Potential Effects from Discharges

Authorized Discharges

The potential effects of discharges were described in Section 5.2.1.6. There could be considerably smaller volume of materials discharged in Future Incremental Steps if some materials (e.g., cuttings, and process water) are reinjected into a disposal well. Any discharges would require compliance with existing U.S. Coast Guard and EPA rules and regulations which are intended to reduce or mitigate environmental harm. Overall, the level of effects from authorized discharges would be less than those described for the First Incremental Step (Section 5.2.2.4, Authorized Discharges).

Unauthorized Discharges

This section describes the potential effects to ringed seals from oil spills estimated to occur during Future Incremental Steps in the Action Area. The hypothetical oil spill scenario, for small and large spills in the Action Area, is presented in Section 2. Potential effects of spills to the three essential features of proposed ring seal critical habitat would be similar to those discussed under the First Incremental Step, but the likelihood and number of spills occurring is increased.

Sea ice is represented in two of three essential features identified in the critical habitat proposal (sea ice suitable for birth lairs and basking/molting platforms). Ice edges, whether associated with shorefast ice or pack ice, generally act as a barrier to the spread of oil (McLaren, 1990). Therefore, unless oil is released directly under ice, swept under by strong currents, otherwise dispersed in water, or tracked in by oiled animals, it would not likely spread into lairs, or on the adjacent subsurface of ice. Instead, oil would accumulate in leads and cracks that are connected to the spill source through

open water. This would confine oil to the spaces between ice floes and tide-cracked landfast ice sheets that have a direct connection with the spill source.

Oil that does get under ice may heat ice and melt it (Thomas, 1984). A given volume of oil will melt roughly 1/200 of that volume of ice for each degree the oil is above freezing. In stationary or very slow moving ice over a blowout, melting may weaken the ice and make it more probable that trapped gas bubbles will fracture the ice and escape into the atmosphere. Large amounts of oil could collect there, and some could spill over onto the surrounding ice surface. However, during much of the ice season, the air is so cold that it would cause oil to behave more like a solid than a liquid. The oil would therefore be limited to a small area on the surface until it pooled deep enough to begin spreading beneath the ice.

If oil gets underneath an ice sheet, several factors control the concentration and areal extent of the oil spread (Thomas, 1984). The primary factors include the bottom roughness of the ice, the presence of gas under the ice, the magnitude and direction of ocean currents, and the movement of ice cover. If oil alone is present, or if accompanying gas is vented, the oil would begin filling under-ice voids (such as lairs) near the blowout. As a void fills and oil is pressed downward, the oil eventually reaches a depth where it can progress along the underside of ice to the next void. If the ice is moving over the site of the blow-out, the voids may not be completely filled, and only that ice passing directly over the blowout plume collects oil.

Oil contacting ice can be frozen and incorporated into the ice, eventually being released when the ice melts. In this way, oil can be temporarily removed from sea ice features essential to the conservation of ringed seals, and released again later in time.

The third essential feature for ringed seal conservation, primary prey resources, may also be adversely affected by oil spills. Potential effects of a large spill to Arctic cod, saffron cod, and other fish are described in Chapter 4.5.4 of the Draft Second SEIS for Lease Sale 193 (USDOJ, BOEM, 2014) and are summarized here.

A spill in the Chukchi Sea could affect fish through many pathways, including adsorption to outer body, respiration through gills, ingestion, and absorption of dissolved fractions into cells through direct contact. The severity of effects to fish would depend on several factors including the type of oil/gas mixture, the thickness of the oil, the duration of exposure, the season of year, and the life stage of the fish.

An oil spill can also affect the habitat of ringed seal primary prey resources. Arctic cod are associated with ice in various seasons and life stages for shelter. Arctic cod spawn under the ice during winter, and they feed on microorganisms on the underside of ice, such as amphipods, which are also a primary prey resource of ringed seal proposed critical habitat.

Oil and gas released in a winter scenario could pool under the ice in pockets presenting prolonged exposure to Arctic cod eggs and larvae, adults hiding among the ice, and amphipods inhabiting the under-ice environment. As noted previously, oil pooled under ice could take several pathways between winter and summer months, any of which could affect primary prey resources.

Small Oil Spills

For the purposes of analysis under the Scenario, BOEM estimates that approximately 777 small spills (<1,000 bbl) could occur over the life of the Scenario (20 during the First Incremental Step and 757 during Future Incremental Steps) (Table 2.6).

Accidental small oil spills are considered reasonably foreseeable events that are anticipated to have a negligible level of effect to ringed seals in the Chukchi Sea. Small spills are generally contained prior to reaching the marine environment. If a small spill escaped containment, the volumes are small and dissipate/weather quickly. Small spills would not travel very far, which limits the potential for contact with the essential features of proposed critical habitat. Vessel and aircraft traffic, noise, and human

activity associated with oil spill response and cleanup is anticipated to result in temporary and limited displacement of some primary prey resources, and a negligible, temporary impairment of sea ice habitats otherwise suitable for ringed use as birth lairs or platforms for basking and molting.

Large Oil Spills

BOEM's estimate of the likelihood of one or more large spills occurring is predicated on development actually occurring and 4.3 Bbbl of crude oil and natural gas liquid condensate will be produced (see Section 2.1.1.1.1). Two large oil spills are assumed to occur during Future Incremental Steps (see Section 2). One large spill is assumed to occur from a production platform and one is assumed to occur from a subsea pipeline.

To evaluate the effect of a large oil spill resulting from Scenario activities, BOEM estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM also estimated the mean number of large spills and the chance of one or more large spills occurring over the life of the Scenario (see Section 2.1.1.1.1).

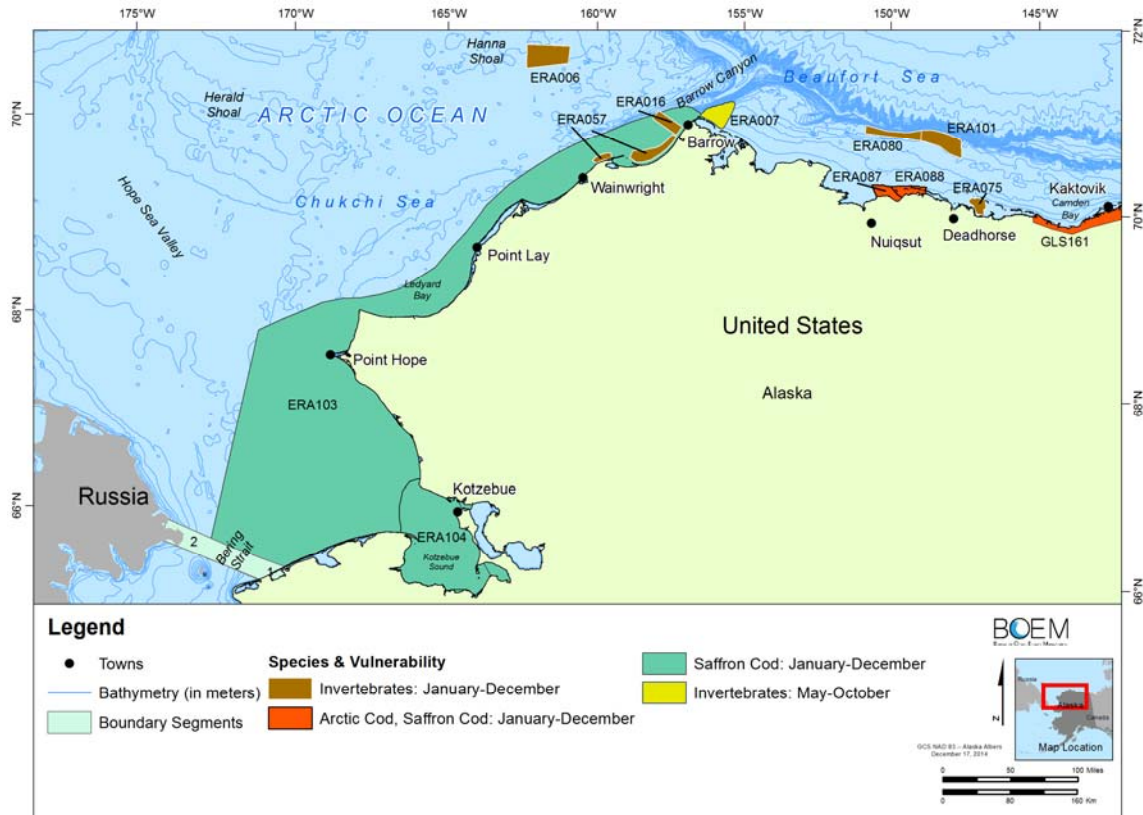
Several factors have to be taken into consideration when assessing the risk of a large spill to proposed critical habitat for ringed seal. First, while still unlikely, a large oil spill is more associated with oil production than exploration and the probability of a successful commercial find in the Chukchi Sea Planning Area is low. Secondly, the location of the oil or gas find and subsequent development platform could influence the chance that a spill would occur as well as that it would reach ERAs important to proposed ringed seal critical habitat when they are present. Finally, the presence of sea ice suitable for lairs and platforms, and the duration and type of oil exposure influences the potential effects.

The OSRA modeled oil spill trajectories from launch areas (LAs) and pipeline segments (PLs). Resources of concern, represented by ERAs and GLSs, were developed for Arctic cod, saffron cod, and as a collective group, invertebrates (see Figure 5.4); the fish were described in the Lease Sale 193 Draft SEIS Appendix A, Table A.1–15, and the invertebrates in Table A.1–16 (USDOI, BOEM, 2014). The invertebrates group is more inclusive than just shrimps and amphipods, but this is the best information available at this time. These ERAs and GLSs were combined into a single set to represent the essential feature of primary prey resources in the OSRA model, and they are analyzed for the time periods of 60 days summer, 360 days summer, and 360 day winter. The ERAs and GLSs for the primary prey resources of ringed seal proposed critical habitat are displayed in Figure 5.4 and are:

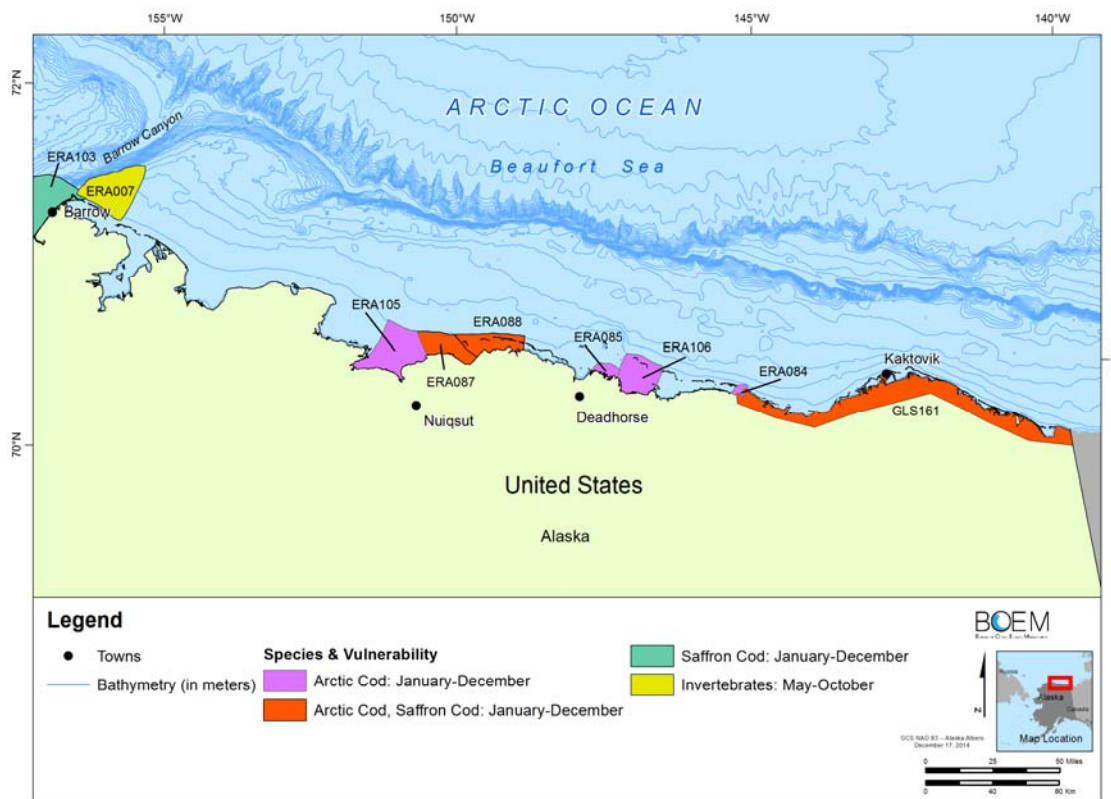
- Hanna Shoal (ERA 6)
- Krill Trap (ERA 7)
- Barrow Canyon (ERA 16)
- Skull Cliffs (ERA 57)
- Boulder Patch Area (ERA 75)
- Beaufort Outer Shelf 1 (ERA 80)
- Canning River Delta (ERA 84)
- Sagavanirktok River Delta (ERA 85)
- Harrison Bay (ERA 86)
- Colville River Delta (ERA 87)
- Simpson Lagoon (ERA 88)

- Beaufort Outer Shelf 2 (ERA 101)
- Saffron Cod EFH (ERA 103)
- Kotzebue Sound (ERA 104)
- Shaviovik River (ERA 106)
- Arctic National Wildlife Refuge (GSL 161)

No ERAs, BSs, GLSs or LSs were developed for either of the two sea ice related essential features identified in the critical habitat rule. This is primarily due to the difficulty of predicting where suitable sea ice for lairs and platforms (as defined in the critical habitat rule) might occur, and the late date at which critical habitat was proposed. Therefore, OSRA model results are not presented here for the essential features related to ringed seal birth lairs or basking and molting platforms.



Figures 5-4 a and b Environmental Resource Areas (ERAs) used in the Oil-Spill Trajectory Analysis for Proposed Ringed Seal Critical Habitat.



Summer within 60 Days

The OSRA indicates that within 60 days of a summer large spill, four ERAs with primary prey resources for ringed seal have greater than 10% probability of being contacted by a large spill originating from LAs or PLs Table 5.10). These are Hanna Shoal, Barrow Canyon, Skull Cliffs, and Saffron Cod EFH. An additional three ERA would have greater than a 1% chance of being contacted (Krill Trap, Beaufort Outer Shelf 1 and 2).

Table 5–10. Combined Probability of a Summer Large Oil Spill Contacting Ringed Seal Primary Prey Resource Areas within 60 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
6	Hanna Shoal	5–24	6	3–37	8
7	Krill Trap	2–7	11	3–10	9
16	Barrow Canyon	5–19	11	9–31	9
57	Skull Cliffs	3–10	11	4–16	9
75	Boulder Patch Area	<0.5	ALL	<0.5	ALL
80	Beaufort Outer Shelf 1	1–2	6, 11	<0.5–3	8, 9
84	Canning River Delta	<0.5	ALL	<0.5	ALL
85	Sagavanirktok River Delta	<0.5	ALL	<0.5	ALL
86	Harrison Bay	<0.5	ALL	<0.5	ALL
87	Colville River Delta	<0.5	ALL	<0.5	ALL
88	Simpson Lagoon	<0.5	ALL	<0.5	ALL
101	Beaufort Outer Shelf 2	<0.5–1	1, 4, 5, 6, 11	<0.5–2	8, 9
103	Saffron Cod EFH	12–49	10	24–67	9
104	Kotzebue Sound	<0.5	ALL	<0.5	ALL
106	Shaviovik River	<0.5	ALL	<0.5	ALL
	GLS (Grouped Land Segment) Name				
161	Arctic National Wildlife Refuge	<0.5	ALL	<0.5	ALL

Summer within 360 Days

The OSRA indicates that within 360 days of a summer large spill, no additional ERAs with primary prey resources for ringed seal would have greater than 10% probability of being contacted by a large spill than what is estimated under the 60 day summer model (Table 5.11). Similarly, no additional ERAs having greater than 1% probably of contact would be added. The likelihood of contact for any given ERA would be only marginally higher than under a 60 day large spill.

Table 5–11. Combined Probability of a Summer Large Oil Spill Contacting Ringed Seal Primary Prey Resource Areas within 360 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
6	Hanna Shoal	5–25	6	4–38	8
7	Krill Trap	3–7	11	3–10	9
16	Barrow Canyon	5–19	11	9–31	9
57	Skull Cliffs	3–10	11	4–16	9
75	Boulder Patch Area	<0.5	ALL	<0.5	ALL
80	Beaufort Outer Shelf 1	1–2	5, 6, 11	<0.5–3	9
84	Canning River Delta	<0.5	ALL	<0.5	ALL
85	Sagavanirktok River Delta	<0.5	ALL	<0.5	ALL
86	Harrison Bay	<0.5	ALL	<0.5	ALL
87	Colville River Delta	<0.5	ALL	<0.5	ALL
88	Simpson Lagoon	<0.5	ALL	<0.5	ALL
101	Beaufort Outer Shelf 2	1–2	6, 11	<0.5–2	8, 9
103	Saffron Cod EFH	13–49	10, 11	25–68	6
104	Kotzebue Sound	<0.5	ALL	<0.5	ALL
106	Shaviovik River	<0.5	ALL	<0.5	ALL
GLS (Grouped Land Segment) Name					
161	Arctic National Wildlife Refuge	<0.5	ALL	<0.5	ALL

Winter within 360 Days.

The OSRA indicates that within 360 days of a winter large spill, four ERAs with primary prey resources for ringed seal have greater than 10% probability of being contacted by oil (Table 5.12). They are the same four ERAs that would be contacted under a 60 or 360 day summer spill (Hanna Shoal, Barrow Canyon, Skull Cliffs, and Saffron Cod EFH). One ERA would have greater than a 1% chance of being contacted (Beaufort Outer Shelf 2), which is two fewer ERAs than estimated under either a 60 or 360 day large spill. In general, the probability of a large spill contacting ERAs important to ringed seal prey resources under a 360 day winter event is less than is estimated for summer events.

Table 5–12. Combined Probability of a Winter Large Oil Spill Contacting Ringed Seal Primary Prey Resource Areas within 360 Days, Dependent upon Spill Origin and Trajectory.

ID	Environmental Resource Area Name	Launch Area (LA)		Pipeline (PL)	
		Range (%)	Source of Maximum	Range (%)	Source of Maximum
6	Hanna Shoal	4–20	6	5–29	8
7	Krill Trap	<0.5–1	4, 5, 10, 11	<0.5–1	2, 3, 5, 6, 9
16	Barrow Canyon	2–9	11	3–16	9
57	Skull Cliffs	1–5	11	1–14	9
75	Boulder Patch Area	<0.5	ALL	<0.5	ALL
80	Beaufort Outer Shelf 1	<0.5–1	4, 10, 11	<0.5–1	3, 5, 6, 8, 9
84	Canning River Delta	<0.5	ALL	<0.5	ALL
85	Sagavanirktok River Delta	<0.5	ALL	<0.5	ALL
86	Harrison Bay	<0.5	ALL	<0.5	ALL
87	Colville River Delta	<0.5	ALL	<0.5	ALL
88	Simpson Lagoon	<0.5	ALL	<0.5	ALL
101	Beaufort Outer Shelf 2	<0.5–1	4, 10, 11	<0.5–1	3, 5, 6, 9
103	Saffron Cod EFH	6–35	10, 11	12–61	9
104	Kotzebue Sound	<0.5	ALL	<0.5	ALL
106	Shaviovik River	<0.5	ALL	<0.5	ALL
	GLS (Grouped Land Segment) Name				
161	Arctic National Wildlife Refuge	<0.5	ALL	<0.5	ALL

Should a large oil spill occur, oil contact could modify all three essential features of proposed critical ring seal habitat, rendering them unsuitable or detrimental for use until cleanup could occur, which could require multiple seasons given the capacity of ice to lock and release ice with freeze and thaw cycles. Areas within the actual spill trajectories would be most impaired while areas outside of the trajectories would not be affected. The essential feature of primary prey resources may take longer to recover from a large spill than the two sea ice essential features, due to potential effects on prey populations and reproduction.

The combined probability of large spills contacting a given ERA important to the primary prey resources essential feature over the life of the Scenario, as estimated by the OSRA model, is shown in Table 5.13. The ERA with the greatest chance of contact is Saffron Cod at 39–40% probability. Two ERAs are estimated to have more than 10% but less than 15% chance of contact by a large spill (Hanna Shoal and Barrow Canyon. Four ERAs are estimated to have at least 1% but less than 10% chance (Krill Trap, Skull Cliffs, Beaufort Outer Shelf 1 and 2). The remaining ERAs and the one GSL relevant to ringed seal primary prey resources are estimated to have less than 1% chance of contact with a large oil spill (Table 5.13).

Table 5–13. Combined Probabilities (Expressed as Percent Chance), Over the Assumed Life of the Scenario, of One or More Spills $\geq 1,000$ Bbl, and the Estimated Number of Spills (Mean), Occurring and Contacting ERAs and GSLs Relevant to Primary Prey Resources for Ringed Seal Proposed Critical Habitat.

ID	Environmental Resource Area Name	60 days		360 days	
		%	Mean	%	Mean
6	Hanna Shoal	11	0.12	13	0.14
7	Krill Trap	3	0.03	3	0.03
16	Barrow Canyon	11	0.12	12	0.13
57	Skull Cliffs	6	0.06	7	0.07
75	Boulder Patch Area	–	–	–	–
80	Beaufort Outer Shelf 1	1	0.01	1	0.01
84	Canning River Delta	–	–	–	–
85	Sagavanirktok River Delta	–	–	–	–
86	Harrison Bay				
87	Colville River Delta	–	–	–	–
88	Simpson Lagoon	–	–	–	–
101	Beaufort Outer Shelf 2	1	0.01	1	0.01
103	Saffron Cod EFH	39	0.49	40	0.51
104	Kotzebue Sound	–	–	–	–
106	Shaviovik River	–	–	–	–
	Grouped Land Segment Name				
161	Arctic National Wildlife Refuge	–	–	–	–

Summary of Potential Oil Spill Effects on Ringed Seal Proposed Critical Habitat in the Action Area

Small refined oil spills would have a negligible effect on proposed ringed seal critical habitat at any time of the year because of the small spill sizes, the relatively small area contacted with oil, rapid dispersion rates, and the vast size of proposed critical habitat.

A large spill would have correspondingly larger effects on the conservation value of proposed critical habitat. All three of the essential features could be adversely modified in the trajectory area for multiple seasons, though the trajectory would cover only a small fraction of the total critical habitat unit, and cleanup would eventually occur.

5.3. Cumulative Effects

5.3.1. Reasonably Certain Future Events

The Environmental Baseline (Section 4) describes past and present activities that have and are affecting listed species. Several of these activities are anticipated to occur in the future. “Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

5.3.1.1. Oil and Gas Exploration

State of Alaska: The State of Alaska has a Five-Year Oil and Gas Leasing Program (submitted to the Alaska State Legislature each January). The program outlines a stable and predictable schedule of proposed lease sales, which could result in the further development of Alaska's petroleum resources. The State of Alaska has no scheduled lease sale in the Chukchi Sea nearshore areas in the most recent Program.

Russia: Oil and gas exploration has also occurred in offshore areas the Russian Arctic and in areas around Sakhalin Island to the south of the Bering Straits. These activities are anticipated to continue into the future. There is little information on specific plans, but the effects of these activities are expected to be similar to those resulting from activities occurring in the U.S Arctic.

5.3.1.2. Natural Gas Development and Production

Activities related to natural gas development are only reasonably foreseeable if there is oil production and if there is a market found for the gas and a gas pipeline is constructed to transport the gas. Such activities may include the construction and installation of a gas pipeline to shore from OCS production facilities in the Chukchi Sea.

5.3.1.3. Mining

Mining takes place onshore from the Chukchi Sea. While the majority of mining activities take place onshore, marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals. The world's largest known zinc resources are located in the western Brooks Range. As much as 25 million tons of high-grade zinc is estimated to be present near Red Dog Mine, approximately 40 mi from the southwest corner of the NPR-A (Schoen and Senner 2003). In 2012 Red Dog produced approximately 958,000 tonnes of zinc concentrate and 175,000 tonnes of lead concentrate (AK DNR 2013). All concentrates are exported to world markets via the DeLong Mountain Transportation System that connects the mine to port facilities on the Chukchi Sea.

5.3.1.4. Transportation

Reductions in sea ice cover will likely lead to increased activity from shipping and resource extraction industries, with associated increased threat of marine accidents and pollution discharge (Pagnan, 2000). It is also reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities and Red Dog Mine will continue. In some specific cases, described below, transportation and associated infrastructure in the Proposed Action Area may increase as a result of increased industrial and commercial activity in the area.

Aircraft Traffic: Existing air travel and freight hauling for local residents is likely to continue at approximately the same levels. Air traffic to support mining is expected to continue to be related to exploration because there are no new large mining projects in the permitting process. Tourism air traffic will not likely change much because there are no reasonably foreseeable events that would draw large numbers of visitors to travel to or from the area using aircraft. Sport hunting and fishing demand for air travel will likely continue at approximately the same levels. Use of aircraft for scientific and search and rescue operations is likely to continue at present levels.

Vehicle Traffic: None of the potential future activities propose to construct permanent roads to the communities in the area. Construction of ice roads could allow industry vehicles access to community roads, and likewise allow residents vehicular access to the highway system.

Vessel Traffic: Vessel traffic through the Bering Strait has risen steadily over recent years according to USCG estimates, and Russian efforts to promote a Northern Seas Route for shipping may lead to continued increases in vessel traffic adjacent to the western portion of the Action Area.

An analysis done by the U.S. Coast Guard (USCG 2013) indicated that there had been a 188% increase in maritime transit through the Bering Strait from 2008–2012 and that one million tons of cargo was trans-shipped through the area in 2012. They also estimated that one million adventure tourists may have visited the region in 2013.

A site-specific analysis done by Shell Oil as part of a Revised Outer Continental Shelf Lease Exploration Plan for the Chukchi Sea (Shell, 2011) indicated that barge traffic passing through the Chukchi Sea during the month of July through October increased from roughly 2000 miles of non-seismic vessel traffic in 2006 to roughly 11,500 miles of non-seismic vessel traffic in 2010. In comparison, the same analysis estimated that vessel miles associated with seismic surveys in 2006 were roughly 70,000 miles, compared to roughly 30,000 miles in 2010.

Vessel traffic within the Action Area can currently be characterized as traffic to support oil and gas industries, barges or cargo vessels used to supply coastal villages, smaller vessels used for hunting and local transportation during the open water period, military vessel traffic, and recreational vessels such as cruise ships and a limited number of ocean-going sailboats. Barges and small cargo vessels are used to transport machinery, fuel, building materials and other commodities to coastal villages and industrial sites during the open water period. For example, villages along the Chukchi sea coast are serviced by vessels from Crowley Alaska and or Northern Transportation Company. Additional vessel traffic supports the Arctic oil and gas industry, and some activity is the result of emergency-response drills in marine areas.

In addition, research vessels, including NSF and USCG icebreakers, also operate in the Action Area. USCG anticipates a continued increase in vessel traffic in the Arctic. Cruise ships and private sailboats sometimes transit through the proposed action area. Changes in the distribution of sea ice, longer open water periods, and increasing interest in studying and viewing Arctic wildlife and habitats may support an increase in research and recreational vessel traffic in the proposed action area regardless of oil and gas activity.

Spill records indicate most accidental petroleum spills in Alaska occur in harbors and from groundings. Vessel-related spills on the high seas are considered infrequent. Concern has been expressed of increasing tourism and shipping-vessel traffic between the Bering Sea and the North Atlantic, especially vessels with crews unaccustomed or ill prepared for these remote and dangerous areas. Vessels transiting the Chukchi seas during ice periods are more prone to accidents. The ADEC (2007) reports the highest probability of spills of refined petroleum products occurs during bulk-fuel transfer operations at remote North Slope villages.

5.3.1.5. Community Development

Community development projects in Arctic communities involve both major infrastructure projects, such as construction of airports and response centers, as well as smaller projects. These projects could result in construction noise in coastal areas, and could generate additional amounts of marine and aircraft traffic to support construction activities. Marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals. No major community development projects are foreseeable at the present time.

5.3.1.6. Recreation and Tourism

Marine and coastal vessel and air traffic could contribute to potential cumulative effects through the disturbance of marine mammals. With the exception of adventure cruise ships that transit the Chukchi Sea coast in small numbers, much of the air sightseeing traffic is concentrated in the Arctic National Wildlife Refuge and should not impact species in the Action Area. Future recreation or tourism-related activities are anticipated to continue at current levels and in similar areas in the Arctic OCS.

5.3.1.7. Subsistence Hunting

The BOEM only considers the cumulative impacts of subsistence hunting on ice seals because there is no lawful take of humpback and fin whales in the Arctic Region and because there are regulations for bowhead whale subsistence hunting that are consulted on (via NMFS inter-Agency consultation) every five years, thus making it a Federal action. The take of ice seals by Alaska Native hunters represents the largest known human-related cause of mortality and is likely to remain so for the foreseeable future. The subsistence take, while additive, is small and this population is likely to have the capacity to absorb it. Available evidence indicates that subsistence hunting can cause disturbance, changes in behavior, and temporary effects on habitat use, including migration paths. Subsistence hunting activities will continue in the Arctic Region.

5.3.1.8. Research Activities

International and domestic entities are devoting more and more attention towards studying the Arctic. While generally authorized under scientific permits and MMPA authorizations, these studies are not without impact. Aircraft surveys often drop below levels specified to minimize disturbance effects and circle groups of marine mammals in order to count and photograph them. Aircraft activities associated with any one project can include hundreds of hours of flight time, generating a carbon footprint that is seldom quantified or assessed. Some scientists operate vessels or aircraft outside the stringent monitoring and mitigation protocols applied to industry. Incidental and direct take under legitimate permitting authority, is assumed to be factored into the total level of take authorized by NMFS under the ESA. While there are several Federal projects that warrant consultation under the ESA, there are often similar State or local governmental projects that contribute to vessel or aircraft traffic to the Action Area. To the extent that a project is funded by the BOEM, policy directs compliance with MMPA and the ESA. It is impossible to anticipate what projects could occur in future areas of the Action Area, but BOEM assumes these future projects would be conducted in compliance with existing laws.

Oil and gas exploration is not the only source of seismic surveying in the Action Area. For example, the University of Alaska Fairbanks conducted a 2-D survey in early-September through October 2011 in the Chukchi Borderland region using the NFS-owned R/V *Marcus G. Langseth*, a 235 ft, 3,834 gross ton research vessel. This vessel can tow up to four seismic hydrophone cables. The UAF team surveyed a grid of 2-D seismic lines over the Chukchi Borderland, to obtain images of the stratification of the rocks in the Borderland continental shelf, then, ran seismic lines south into the northern Chukchi Sea.

Other scientific endeavors include the NE Chukchi Sea aerial cetacean survey and the bowhead whale feeding study. The Chukchi Sea aerial cetacean survey, which has been conducted from 1 July – 31 October from 1982–1991, and again since 2008. This survey is designed to assess the distribution and relative abundance of cetaceans during the open-water season. Surveys typically follow standard line-transect protocols. Surveys are flown every day, weather permitting.

The bowhead whale feeding ecology study (BOWFEST) was a multiyear project conducted from 2007–2012 that focused on late summer (August through September) oceanography and whale prey densities over continental shelf waters within 100 miles north and east of Point Barrow, Alaska. Aerial surveys, acoustic monitoring, and boat-based surveys provided information on the spatial and temporal distribution of bowhead whales in the study area. Oceanographic sampling helped identify sources of zooplankton prey available to whales on the shelf and the association of this prey with physical characteristics which may affect mechanisms of plankton aggregation. A similar study, Arctic Whale Ecology Study (ARCWEST): Use of the Chukchi Sea by Endangered Baleen and other Whales, is a westward extension of BOWFEST, and consists of oceanographic and acoustic sampling year round, limited satellite tagging of baleen whales, and zooplankton sampling in the Chukchi Sea. This study will be conducted from 2012–2017.

BOEM has supported several marine mammal tagging and tracking projects in the Chukchi Sea. Beginning in 2005, the Alaska Department of Fish and Game, in conjunction with Alaska Native hunters and whalers and international groups, has been designing, developing, and putting satellite-linked tags on bowhead whales throughout the Arctic to determine movements and habitat use, and minimal encounter rate with industrial activities in U.S. waters, as well as to sample this endangered whale's environment. Over 50 whales have been tagged and followed for several months.

5.3.2. Effects Analysis

5.3.2.1. Cumulative Effects on the Bowhead Whale

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). These may be dynamic or stable, be stationary or mobile, be localized or widespread, or can function independently or in concert with other activities to affect bowhead whales. The following are the sometimes overlapping primary sources contributing to cumulative effects on bowhead whales in the Action Area.

Oil and gas exploration and development. Whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (Richardson, 1995c; NRC, 2003a and b). Oil and gas exploration activities, have been shaped by various mitigating measures and monitoring requirements. Mitigation measures imposed through the MMPA authorizations process are designed to avoid and minimize harassment, reduce the potential for population-level effects on bowhead whales, and avoid an immitigable adverse impact on their availability for subsistence purposes. Such mitigating measures, with monitoring requirements, were designed to reduce the impact on the whales and on potential impacts on whale availability to subsistence hunters. We assume future non-Federal activities in Federal OCS waters will have similar levels of protective measures.

Offshore exploration seismic surveys could result in some small incremental cumulative effects to bowhead whales by potentially excluding whales from feeding or resting areas. Analysis of the likely range of effects and the likelihood of exposures resulting in adverse behavioral effects supports a conclusion that the activities would result in no more than temporary adverse effects. Seismic surveys, as mitigated under future MMPA authorizations, are not expected to contribute appreciably to cumulative impacts on bowhead whales in the Action Area.

Available data indicates that noise and disturbance from oil and gas exploration and development activities since the mid-1970's have had localized, short-term adverse effects, but no lasting population-level adverse effect on bowhead whales. Furthermore, bowhead whales apparently continued to increase in abundance during periods of intense seismic in the Chukchi Sea in the 1980s, even without implementation of current mitigation requirements (NMFS, 2009). There is no indication that human activities (other than historic commercial whaling) have caused long-term displacement in bowhead whales.

Transportation. Climate change may result in increasing vessel traffic in the Northwest Passage or the Northern Sea Route, which are presently open for limited periods of time. This may lead to more large commercial and tourism vessels potentially passing through bowhead feeding grounds in the Eastern Beaufort, Barrow Canyon, and off the coast of Chukotka. Likewise, there could be serious impacts to bowhead whales passing through the Bering Strait during spring or fall migrations if the migrations fall out of synchronization with the fall formation and spring melt of sea ice in the northern Bering and southern Chukchi Seas. The effects of additional vessel traffic could include increased vessel strikes, small discharges and spills, and noise production into the marine environment. Increased military and Coast Guard activity would mostly include seasonal patrols of U.S. Navy and Coast Guard ships during the open water season, some submarine activity throughout

the year, and aircraft operations from bases onshore and possibly carriers towards the end of the 21st century. In an ice-free summer Arctic, the possibility of fielding an aircraft carrier becomes more plausible since there would be no additional risks to such a vessel. Under such conditions there will be no need for icebreaking during the July–October period, and the use of icebreakers will decline. Commercial vessel traffic is the human activity likely to have the greatest effect on bowhead whales, through vessel strikes. Other forms of vessel traffic would support scientific surveys, which are likely to increase into the future. Bowhead whales should remain capable of avoiding survey ships if those vessels operate at reasonable speeds.

Vessel discharges and accidental fuel spills have occurred historically in the Action Area. Bowhead whales have not been documented to be injured or killed from such events. Bowhead whales might contact spilled petroleum during the open water period or during various ice covered seasons and locations during spring or fall migrations and calving areas, would likely avoid the noise and disturbance of vessels engaged in response and cleanup activities. Bowhead whales also appear able to detect spilled oil and may avoid it.

Summary: The Proposed Action is likely to incrementally contribute to cumulative effects on bowhead whales in the Action Area. When considered collectively with existing and reasonably certain activities from other oil and gas exploration and development, mining, vessel and aircraft traffic noise and presence, research activities, discharges, community development, recreation and tourism, and research activities, the bowhead whale population is expected to continue to grow and be harvested until reaching carrying capacity in the Chukchi Sea.

5.3.2.2. Cumulative Effects on the Humpback Whale

Humpback whales occur in the Action Area as individuals or small groups in very low numbers representing a minute portion of the population. The following are the sometimes overlapping primary sources contributing to cumulative effects on humpback whales in the Action Area.

Oil and gas exploration and development. Whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (Richardson, 1995c; NRC, 2003a, b). Oil and gas exploration activities have been shaped by various mitigating measures and monitoring requirements. No documented incidence or response of humpback whales to oil and gas operations in the Beaufort Sea or Chukchi Sea is known. Mitigation measures imposed through the MMPA authorizations process are designed to avoid Level A Harassment (injury). Such mitigating measures, with monitoring requirements, were designed to reduce the impact on whales. We assume future non-Federal activities in Federal OCS waters will have similar levels of protective measures.

Transportation. Sea ice losses in the Arctic Ocean due to climate change will also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking humpback whales, and would introduce more sound into the marine environment. The numbers of scientific and industry survey vessels in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Commercial and scientific aircraft operations are expected to increase into the foreseeable future. Scientific surveys such as the ASAMM, BOWFEST, BWASP, etc. that use aircraft fly at altitudes sufficient to negate most transfer of sound into the water. Throughout the 21st century aircraft operations should have negligible effects on humpback whales.

Vessel discharges and accidental fuel spills have occurred historically in the Action Area. Humpback whales have not been documented to be injured or killed from such events. A few humpback whales might contact spilled petroleum during the open water period. Humpback whales may be able to detect spilled oil and avoid it.

Summary: The Proposed Action is likely to incrementally contribute to cumulative effects on humpback whales in the Action Area, but these would be seasonal as small numbers of humpback whales occur only in the Arctic Region in the open water period. When considered collectively with existing and reasonably certain activities from other oil and gas exploration and development, mining, vessel and aircraft traffic noise and presence, research activities, discharges, community development, recreation and tourism, and research activities, the humpback whale population is expected to continue colonizing the Chukchi Sea.

5.3.2.3. Cumulative Effects on the Fin Whale

Fin whales occur in the Chukchi Sea as individuals or small groups in very low numbers compared to the rest of the Northern Pacific population and represent a minute portion of the population. The following are the sometimes overlapping primary sources contributing to cumulative effects on fin whales in the Action Area:

Oil and gas exploration and development. Whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (Richardson, 1995c; NRC, 2003a, b). Oil and gas exploration activities have been shaped by various mitigating measures and monitoring requirements. Mitigation measures imposed through the MMPA authorizations process, and which are applicable to the listed marine mammal species, are designed to avoid take of marine mammals. Such mitigating measures, with monitoring requirements, were designed to reduce the impact on the whales. We assume future non-Federal activities in Federal OCS waters will have similar levels of protective measures.

Transportation. Summer sea ice losses in the Arctic Ocean due to climate change will also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking fin whales and introduce more sound into the marine environment. The numbers of scientific and industry survey vessels in the Chukchi and Beaufort Seas are also likely to increase along with the noise they produce.

Commercial and scientific aircraft operations are expected to increase into the foreseeable future. Scientific surveys using aircraft such as the ASAMM, BOWFEST, BWASP, etc. fly at altitudes sufficient to negate most transfer of sound into the water. Throughout the 21st century aircraft operations should have negligible effects on fin whales.

Vessel discharges and accidental fuel spills have occurred historically in the Action Area. Fin whales have not been documented to be injured or killed from such events. A few fin whales might contact spilled petroleum during the open water period. Fin whales may be able to detect spilled oil and may avoid it.

Summary: The Proposed Action is likely to incrementally contribute to cumulative effects on fin whales in the Action Area, but these would be seasonal as small numbers of fin whales occur only in the Chukchi Sea Planning area in the open water period. When considered collectively with existing and reasonably certain activities from other oil and gas exploration and development, mining, vessel and aircraft traffic noise and presence, research activities, discharges, community development, recreation and tourism, and research activities, the fin whale population is expected to continue colonizing the Chukchi Sea.

5.3.2.4. Cumulative Effects on the Bearded Seal

The bearded seal Beringia DPS population is estimated to number about 30,000. The following are the sometimes overlapping primary sources contributing to cumulative effects on bearded seals in the Arctic Region.

Oil and gas exploration and development. Oil and gas exploration activities have been shaped by various mitigating measures and monitoring requirements. Mitigation measures imposed through the MMPA authorizations process are designed to avoid Level A Harassment (injury). Such mitigating measures, with monitoring requirements, were designed to reduce the impact on ice-seals. We assume future non-Federal activities in Federal OCS waters will have similar levels of protective measures.

Transportation. Sea ice losses during the summer in the Arctic Ocean will also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking bearded seals, and would introduce more sound into the marine environment. In recent years, some seals have been sucked into ducted propeller systems on oceangoing vessels in the North Atlantic, and the potential exists for similar accidents to occur in the Chukchi Sea. However, seals are very agile in the water and easily avoid vessel strikes under normal conditions. The numbers of scientific and industry survey vessels in the Chukchi Sea are also likely to increase along with the noise they introduce into the environment.

Commercial and scientific aircraft operations are expected to increase into the foreseeable future. Scientific surveys using aircraft such as the ASAMM, BOWFEST, and BWASP, fly at altitudes sufficient to negate most transfer of sound into the water. Aircraft have little effect on bearded seals when they are in the water; however, hauled out bearded seals may display flight reactions if approached too closely by low-flying aircraft. Most flight reactions consist of quickly slipping into the water. Throughout the 21st century, aircraft operations should have negligible effects on bearded seals.

Oil and gas exploration is not the only source of marine discharges in the Action Area. Vessel discharges and accidental fuel spills have occurred historically in the Action Area. Bearded seals have not been documented to be injured or killed from such events. A few bearded seals might contact spilled petroleum during the open water period, but some bearded seals may be able to detect spilled oil and avoid it. It is unlikely, however, that the availability of food resources for bearded seals would be affected over the long term.

Cameron et al. (2010) concluded spills from vessels were the most likely source of hydrocarbons releases that would affect ice-seals in the Arctic. The probability of such an oil spill will increase as more vessels and greater volumes of oil are transported as cargo and fuel (Nuka Research and Planning Group, 2007).

Subsistence hunting. Thousands of bearded seals are harvested annually by Alaska Native hunters in the Action Area. The population for this subspecies in the Chukchi Sea is estimated at 27,000 animals and is conservatively estimated at 155,000 across its range (Allen and Angliss, 2014).

Summary: The Proposed Action is likely to incrementally contribute to cumulative effects on bearded seals in the Action Area. When considered collectively with existing and reasonably certain activities from other oil and gas exploration and development, mining, vessel and aircraft traffic noise and presence, research activities, discharges, community development, subsistence hunting, recreation and tourism, and research activities, the bearded seal is expected to continue to experience effects by the loss of sea ice associated with climate change in the Arctic Region.

5.3.2.5. Cumulative Effects on the Ringed Seal

The ringed seal population is estimated to number 1 million. The following are the sometimes overlapping primary sources contributing to cumulative effects on ringed seals in the Action Area.

Oil and gas exploration and development. Oil and gas exploration activities have been shaped by various mitigating measures and monitoring requirements. Mitigation measures imposed through the MMPA authorizations process are designed to avoid take of marine mammals. Such mitigating

measures, with monitoring requirements, were designed to reduce the impact on ice-seals. We assume future non-Federal activities in Federal OCS waters will have similar levels of protective measures.

Transportation. Sea ice losses during the summer in the Arctic Ocean will also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking ringed seals, and would introduce more sound into the marine environment. In recent years, some seals have been sucked into ducted propeller systems on oceangoing vessels in the North Atlantic, and the potential exists for similar accidents to occur in the Chukchi Sea. However, seals are very agile in the water and easily avoid vessel strikes under normal conditions. The numbers of scientific and industry survey vessels in the Chukchi Sea are also likely to increase along with the noise they introduce into the environment.

Scientific surveys using aircraft such as the ASAMM, BOWFEST, and BWASP, fly at altitudes sufficient to negate most transfer of sound into the water. Aircraft have little effect on ringed seals when they are in the water; however, hauled out ringed seals may display flight reactions if approached too closely by low-flying aircraft. Most flight reactions consist of quickly slipping into the water. Throughout the 21st century aircraft operations should have negligible effects on ringed seals.

Oil and gas exploration is not the only source of marine discharges in the Action Area. Vessel discharges and accidental fuel spills have occurred historically in the Action Area. Ringed seals have not been documented to be injured or killed from any such events. A few ringed seals might contact spilled petroleum during the open water period, but may be able to detect spilled oil and avoid it. It is unlikely, however, that the availability of food resources for ringed seals would be affected over the long term.

Cameron et al. (2010) concluded spills from vessels were the most likely source of hydrocarbons releases that would affect ice-seals in the Arctic. The probability of such an oil spill will increase as more vessels and greater volumes of oil are transported as cargo and fuel (Nuka Research and Planning Group, 2007).

Subsistence Hunting Alaska Native hunters annually harvest over 9,000 ringed seals in Alaska. The population for this subspecies is estimated at 300,000 animals (Kelly et al., 2010) but this is not considered a reliable abundance estimate, is likely an underestimate, as this estimate is based on surveys of a portion of the range and are greater than 8 years old (Allen and Angliss, 2014).

Summary: The Proposed Action is likely to contribute incrementally to cumulative effects on ringed seals in the Action Area. When considered collectively with existing and reasonably certain activities from other oil and gas exploration and development, mining, vessel and aircraft traffic noise and presence, research activities, discharges, community development, subsistence hunting, recreation and tourism, and research activities, the bearded seal is expected to continue to experience effects by the loss of sea ice associated with climate change in the Arctic Region.

5.3.2.6. Cumulative Effects on Ringed Seal Proposed Critical Habitat

The following are the sometimes-overlapping primary sources contributing to cumulative effects on ringed seal proposed critical habitat in the Action Area.

Oil and gas exploration and development. It is unlikely that many oil and gas exploration activities can be executed without Federal permits, meaning most would require future consultation under ESA Section 7 requirements. In the event any did occur, we assume they would be shaped by various mitigating measures and monitoring requirements similar to the protective measures adopted by the proposed action presented here.

Transportation. Sea ice loss in the Arctic Ocean will also permit increasing numbers of commercial, tourism, and scientific vessel activity, and extend the shoulder seasons in which vessels can be present. This may include increased use of icebreakers. Similarly, aircraft operations are expected to increase. Additional transportation activity may affect, primarily through noise and physical disturbance, the formation and maintenance of sea ice habitats otherwise suitable for use by ringed seals as birth lairs, or as platforms for basking and molting. The increased activities associated with transportation may also increase disturbance to primary prey species. However, given the temporary and localized nature of these types of transportation, and large spatial extent of proposed critical habitat, overall effects would be negligible to the conservation function of proposed critical habitat.

Subsistence Hunting. Subsistence hunting would have no cumulative impacts on the conservation function of proposed critical habitat.

Summary: The Proposed Action is likely to incrementally contribute to cumulative effects on ringed seal proposed critical habitat in the Action Area. When considered collectively with non-Federal actions that are reasonably certain to occur, no more than minor cumulative effects are anticipated on the conservation function of the essential features of proposed critical habitat.

5.5 Determination of Effects

The purpose of this Biological Assessment is to determine the effects of the Proposed Action. The effects of the Proposed Action on ESA threatened or endangered species and proposed critical habitat are considered along with the environmental baseline (Section 4.0) and assumed cumulative effects (Section 5.4). This section considers the following categories.

- The proposed actions would have no effect on the listed species or critical habitat.
- The proposed actions may affect the listed species or proposed critical habitat. Two categories:
 - The proposed action is likely to adversely affect the listed species or proposed critical habitat.
 - The proposed action is not likely to adversely affect the listed species or proposed critical habitat.

Although a final determination is left to NMFS, BOEM and BSEE through this Biological Assessment believe that the proposed exploration, development, and production of oil and gas in the Action Area will likely have the following effect on threatened or endangered marine mammals and critical habitat:

5.3.3. Bowhead Whale

Based on the hypothetical Scenario and the current healthy status of the bowhead whale population, the Proposed Action may affect, and is likely to adversely effects to bowhead whales, but is not likely to threaten, the continued existence of, the Western Arctic bowhead whale. Activities may result in localized, temporary, nonlethal adverse effects to a few individual bowhead whales. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Based on the information provided in this BA, BOEM and BSEE believe that the first increment of this action, up to submission of a DPP, will not violate Section 7(a)(2). Further incremental consultation would be necessary if development and production plans are submitted to BOEM.

5.3.4. Fin Whale

Based on the hypothetical Scenario and the limited range and low numbers of fin whales in the action area making any affects insignificant in relation to the magnitude of the overall affect, the Proposed Action may effect, but is not likely to adversely affect, the North Pacific fin whale. There is a

reasonable likelihood that the entire action will not violate Section 7(a)(2). Based on the information provided in this BA, BOEM and BSEE believe that the first increment of this action, up to submission of a DPP, will not violate Section 7(a)(2). Further incremental consultation would be necessary if development and production plans are submitted to BOEM.

5.3.5. Humpback Whale

Based on the hypothetical Scenario and the limited range and low numbers of humpback whales in the action area making any effects insignificant in relation to the magnitude of the overall effect, the Proposed Action may effect, but is not likely to adversely affect, the Western North Pacific humpback whale stock. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Based on the information provided in this BA, BOEM and BSEE believe that the first increment of this action, up to submission of a DPP, will not violate Section 7(a)(2). Further incremental consultation would be necessary if development and production plans are submitted to BOEM.

5.3.6. Bearded Seal

The Proposed Action may affect, and is likely to adversely affect, but not threaten the continued existence of, the Beringia DPS of bearded seal. Activities may result in localized, temporary, nonlethal adverse effects to bearded seals. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Based on the information provided in this BA, BOEM and BSEE believe that the first increment of this action, up to submission of a DPP, will not violate Section 7(a)(2). Further incremental consultation would be necessary if development and production plans are submitted to BOEM.

5.3.7. Ringed Seal

The Proposed Action may affect, and is likely to adversely affect, but not threaten the continued existence of, the ringed seal. Activities may result in localized, temporary, nonlethal adverse effects to ringed seals. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Based on the information provided in this BA, BOEM and BSEE believe that the first increment of this action, up to submission of a DPP, will not violate Section 7(a)(2). Further incremental consultation would be necessary if development and production plans are submitted to BOEM.

5.3.8. Ringed Seal Proposed Critical Habitat

The Proposed Action may affect, and is likely to adversely affect, proposed critical habitat for ringed seals; however, it is not likely to destroy or adversely modify the proposed critical habitat. Activities associated with development and production would likely occur at levels near those for exploration. Duration of development activity is likely to span a period of several years. Based on the hypothetical Scenario, these activities are not likely to result in destruction or a permanent adverse modification of this proposed critical habitat, because any production facilities exposed above the seafloor eventually would be removed. The Proposed Action will not result in any direct or indirect alterations that appreciably diminish the value of critical habitat for both the survival and recovery of a listed species. There is a reasonable likelihood that the entire action will not violate Section 7(a)(2). Based on the information provided in this BA, BOEM and BSEE believe that the first increment of this action, up to submission of a DPP, will not violate Section 7(a)(2). Further incremental consultation would be necessary if development and production plans are submitted to BOEM.

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Leasing Activities Information



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

Final Lease Stipulations Oil and Gas Lease Sale 193 Chukchi Sea February 6, 2008

- Stipulation 1. Protection of Biological Resources
- Stipulation 2. Orientation Program
- Stipulation 3. Transportation of Hydrocarbons
- Stipulation 4. Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources
- Stipulation 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities
- Stipulation 6. Pre-Booming Requirements for Fuel Transfers
- Stipulation 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities

Stipulation No. 1. Protection of Biological Resources. If previously unidentified biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

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

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

- (4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

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

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

Stipulation No. 2. Orientation Program. The lessee shall include in any exploration plan (EP) or development and production plan (DPP) submitted under 30 CFR 250.211 and 250.241 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence activities and pertinent mitigation.

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

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

Stipulation No. 3. Transportation of Hydrocarbons. Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of any Federal, State, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of an emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the RS/FO.

Stipulation No. 4. Industry Site-Specific Monitoring Program for Marine Mammal

Subsistence Resources. A lessee proposing to conduct exploration operations, including ancillary seismic surveys, on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears will be required to conduct a site-specific monitoring program approved by the RS/FO, unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with appropriate agencies and co-management organizations, determines that a monitoring program is not necessary. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. The RS/FO will provide the appropriate agencies and co-management organizations a minimum of 30 calendar days, but no longer than 60 calendar days, to review and comment on a proposed monitoring program prior to Minerals Management Service (MMS) approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead and beluga whales, ice seals, walruses, and polar bears are present in the vicinity of lease operations and the extent of behavioral effects on these marine mammals due to these operations. In designing the program, the lessee must consider the potential scope and extent of effects that the type of operation could have on these marine mammals. Experiences relayed by subsistence hunters indicate that, depending on the type of operations, some whales demonstrate avoidance behavior at distances of up to 35 miles. The program must also provide for the following:

- (1) Recording and reporting information on sighting of the marine mammals of concern and the extent of behavioral effects due to operations;
- (2) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project and other mandated aerial monitoring programs;
- (3) Inviting a local representative, to be determined by consensus of the appropriate co-management organizations, to participate as an observer in the monitoring program;
- (4) Submitting daily monitoring results to the RS/FO;
- (5) Submitting a draft report on the results of the monitoring program to the RS/FO within 90 days following the completion of the operation. The RS/FO will distribute this draft report to the appropriate agencies and co-management organizations;
- (6) Allowing 30 days for independent peer review of the draft monitoring report; and
- (7) Submitting a final report on the results of the monitoring program to the RS/FO within 30 days after the completion of the independent peer review. The final report will include a discussion of the results of the peer review of the draft report. The RS/FO will distribute this report to the appropriate agencies and co-management organizations.

The RS/FO may extend the report review and submittal timelines if the RS/FO determines such an extension is warranted to accommodate extenuating circumstances.

The lessee will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for bowhead whales. The lessee may be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for other co-managed marine mammal resources. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the appropriate agencies and co-management resource organizations. The results of these peer reviews will be provided to the RS/FO for consideration in final MMS approval of the monitoring program and the final report, with copies to the appropriate agencies and co-management organizations.

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

The MMS, NMFS, and FWS will establish procedures to coordinate results from site-specific surveys required by this stipulation and the LOA's or IHA's to determine if further modification to lease operations are necessary.

This stipulation applies to the following blocks:

NR02-06, Chukchi Sea:

6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:

6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert

6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island

6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West

6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal

6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow

6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright

6002-6006, 6052, 6053

NS04-08, (Unnamed)

6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

This stipulation applies during the time periods for subsistence-harvesting described below for each community.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area. Fall whaling occurs from August to October in an area extending from approximately 10 miles west of Barrow to the east side of Dease Inlet. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walrus. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright, with whaling camps sometimes as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September, walrus can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is

unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walrus from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bear are hunted from September to April along the coast, rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walruses are harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bears primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

This stipulation will remain in effect until termination or modification by the Department of the Interior after consultation with appropriate agencies.

Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities. Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities. This stipulation applies to exploration, development, and production operations on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears. The stipulation also applies to support activities, such as vessel and aircraft traffic, that traverse the blocks listed below or Federal waters landward of the sale during periods of subsistence use regardless of lease location. Transit for human safety emergency situations shall not require adherence to this stipulation.

This stipulation applies to the following blocks:

NR02-06, Chukchi Sea:

6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:

6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert

6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island

6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West

6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal

6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow

6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright

6002-6006, 6052, 6053

NS04-08, (Unnamed)

6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Prior to submitting an exploration plan or development and production plan (including associated oil-spill response plans) to the MMS for activities proposed during subsistence-use critical times and locations described below for bowhead whale and other marine mammals, the lessee shall consult with the North Slope Borough, and with directly affected subsistence communities (Barrow, Point Lay, Point Hope, or Wainwright) and co-management organizations to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Organizations currently recognized by the NMFS and the FWS for the co-management of the marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other marine mammal subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

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

In the event no agreement is reached between the parties, the lessee, NMFS, FWS, the appropriate co-management organizations, and any communities that could be directly affected by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the parties to specifically address the conflict and attempt to resolve the issues. The RS/FO will invite appropriate parties to a meeting if the RS/FO determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. Activities on a lease may be restricted if the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities.

In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts.

Subsistence-harvesting activities occur generally in the areas and time periods listed below.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area; fall whaling occurs from August to October in an area extending from approximately 10 miles west of Barrow to the east side of Dease Inlet. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walruses. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright, with whaling camps sometimes as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September, walruses can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is

unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walrus from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bears are hunted from September to April along the coast, rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walrus are harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bears primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

Stipulation No. 6. Pre-Booming Requirements for Fuel Transfers. Fuel transfers (excluding gasoline transfers) of 100 barrels or more will require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. The lessee's oil spill response plans must include procedures for the pre-transfer booming of the fuel barge(s).

Stipulation No. 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities. This stipulation will minimize the likelihood that spectacled and Steller's eiders will strike drilling structures or vessels. The stipulation also provides additional protection to eiders within the blocks listed below and Federal waters landward of the sale area, including the Ledyard Bay Critical Habitat Area, during times when eiders are present.

(A) General conditions: The following conditions apply to all exploration activities.

(1) An EP must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or drilling structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel, and aircraft or drilling structure involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

(2) The following conditions apply to operations conducted in support of exploratory and delineation drilling.

(a) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, to the maximum extent practicable. If surface vessels must traverse this area during this period, the surface vessel operator will have ready access to wildlife hazing equipment (including at least three *Breco* buoys or similar devices) and

personnel trained in its use; hazing equipment may be located onboard the vessel or on a nearby oil spill response vessel, or in Point Lay or Wainwright. Lessees are required to provide information regarding their operations within the area upon request of MMS. The MMS may request information regarding number of vessels and their dates of operation within the area.

(b) Except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation drilling operations will avoid travel within the Ledyard Bay Critical Habitat Area between July 1 and November 15. Vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.

(c) Aircraft supporting drilling operations will avoid operating below 1,500 feet above sea level over the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, or the Ledyard Bay Critical Habitat Area between July 1 and November 15, to the maximum extent practicable. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the FWS, during review of the EP. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.

(B) Lighting Protocols. The following lighting requirements apply to activities conducted between April 15 and November 15 of each year.

(1) Drilling Structures: Lessees must adhere to lighting requirements for all exploration or delineation drilling structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration or delineation drilling structures to minimize the likelihood that birds will strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment.

Measures to be considered include but need not be limited to the following:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- Types of lights;
- Adjustment of the number and intensity of lights as needed during specific activities;
- Dark paint colors for selected surfaces;
- Low-reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational, and management approaches that could be applied to their specific facilities and operations to reduce

outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an EP when it is submitted for regulatory review and approval pursuant to 30 CFR 250.203.

(2) Support Vessels: Surface support vessels will minimize the use of high-intensity work lights, especially when traversing the listed blocks and federal waters between the listed blocks and the coastline. Exterior lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog), otherwise they will be turned off. Interior lights and lights used during navigation could remain on for safety.

For the purpose of this stipulation, the listed blocks are as follows:

NR02-06, Chukchi Sea:

6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:

6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert

6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island

6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West

6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal

6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow

6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright

6002-6006, 6052, 6053

NS04-08, (Unnamed)

6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Nothing in this stipulation is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

**Existing Geological and Geophysical Permit Stipulations
for Oil and Gas Activities in Alaska OCS Waters**

**Programmatic Environmental Assessment (2006)
Arctic Ocean Outer Continental Shelf Seismic Surveys
Appendix A**

**Minerals Management Service
Alaska OCS Region
OCS/EIS/EA MMS 2006-038**

STIPULATIONS

From <http://www.mms.gov/alaska/re/permits/stips1-5/htm>

In the performance of any operations under the Permit and Agreement for Outer Continental Shelf Exploration, the Permittee shall comply with the following Stipulations:

1. As part of the requirements of 30 CFR 251.7-3, the Permittee shall submit to the Regional Supervisor, Resource Evaluation (hereinafter referred to as the Supervisor) within 30 days after the completion of the survey authorized under this Permit and Agreement a map at the same scale as that used ordinarily for such maps and showing the coordinates of latitude and longitude. In addition, each Permittee shall submit one (1) one-half inch, nine-track, final edited navigation tape of all locations in latitude and longitude degrees. The tape is to be in an ASCII or EBCDIC 1600 BPI format with fixed record length and fixed block size. Record length, block size, density and whether the tape is ASCII or EBCDIC must be on a label affixed to the tape. The label must also specify the geodetic reference system (NAD27 or NAD83) used. A printed tape listing and format statement are to be included with the tape.
2. As part of the requirements of 30 CFR 251.3-5, if any operation under this Permit and Agreement is to be conducted in a leased area, the Permittee shall take all necessary precautions to avoid interference with operations on the lease and damage to existing structures and facilities. The lessee (or operator) of the leased area will be notified by letter before the Permittee enters the leased area or commences operations, and a copy of the letter will be sent to the Supervisor executing this Permit and Agreement.
3.
 - (a) Solid or liquid explosives shall not be used except pursuant to written authorization from the Supervisor. Requests for the use of such explosives must be made in writing, giving the size of charges to be used, the depth at which they are to be suspended or buried, and the specific precautionary methods proposed for the protection of fish, oysters, shrimp, and other aquatic life, wildlife, or other natural resources.
 - (b) The following provisions are made applicable when geophysical exploration on the Outer Continental Shelf using explosives is approved:
 - (i) Each explosive charge will be permanently identified by markings so that unexploded charges may be positively traced to the Permittee and to the specific field party of the Permittee responsible for the explosive charge.
 - (ii) The placing of explosive charges on the seafloor is prohibited. No explosive charges shall be detonated nearer to the seafloor than five (5) feet.
 - (iii) No explosives shall be discharged within one thousand (1000) feet of any boat not involved in the survey.

4. Any serious accident, personal injury, or loss of property shall be immediately reported to the Supervisor.
5. All pipes, buoys, and other markers used in connection with work shall be properly flagged and lighted according to the navigation rules of the U.S. Corps of Engineers and the U.S. Coast Guard.
6. If the Permittee discovers any archaeological resource during geological and geophysical activities, the Permittee shall report the discovery immediately to the Supervisor. The Permittee shall make every reasonable effort to preserve the archaeological resource until the Supervisor has told the Permittee how to protect it.
7. In addition to the general provisions above, the following special provisions shall apply:
 - (a) This permit is applicable only to that portion of the program involving Federal OCS lands seaward of the submerged lands of the State of Alaska.
 - (b) The Permittee shall, on request of the Supervisor, furnish quarters and transportation for a Federal representative(s) or other designated observer to inspect operations.
 - (c) Operations shall be conducted in a manner to assure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions or unreasonably interfere with other uses of the area. Any difficulty encountered with other users of the area or any conditions which cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the Supervisor. Serious or emergency conditions shall be reported without delay.
 - (d) A final summary report (one copy) shall be submitted to this office within 30 days of completion or cessation of operations.

This report shall include:

- (i) Program commencement date.
- (ii) Program completion date.
- (iii) Field effort in crew weeks (actual work time based on 168-hour weeks).
- (iv) Line miles of surveys completed.
- (v) Summary of incidents or accidents from paragraph 4.
- (vi) Date or reasonable estimation of date when data will be available for inspection or selection.

(e) The Permittee shall notify the Commander, U.S. Coast Guard and the Commander, 3rd Fleet as to the approximate time and place the work is to be conducted and to keep them informed:

Commander, U.S. Coast Guard
17th Coast Guard District
Aids to Navigation Branch
P.O. Box 25517
Juneau, AK 99801
(907)586-7365

COMTHIRD
Pearl Harbor, HI
96860
(808)472-8242

8. Information to the Permittee

(a) Operations authorized under permit are subject to the Marine Mammal Protection Act of 1972 as amended (16 U.S.C. 1361 et seq), the Endangered Species Act as amended (16 U.S.C. 1531 et seq), regulations found in 50 CFR Part 18 (U.S. Fish and Wildlife Service), and 50 CFR Part 228 (National Marine Fisheries Service). Special attention should be given to the prohibition of the "taking" of marine mammals. "Taking" means to harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, collect, or kill any marine mammal. National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (F&WS) regulations allow, under certain conditions, the incidental taking by harassment of specific marine mammals. Such a taking of marine mammals is controlled through Letters of Authorization issued by NMFS or F&WS. Permittees are advised to consult the appropriate agencies regarding these laws and regulations. Further information may be obtained from

Regional Director
U.S. Fish and Wildlife Service
Alaska Region
1011 East Tudor Road
Anchorage, Alaska 99503
telephone (907) 786-3542

National Marine Fisheries Service
222 West 7th Avenue, Box 43
Anchorage, Alaska 99513
telephone (907) 271-5006

(b) It is recommended that you contact the appropriate Regional Supervisor, Commercial Fish Division, Alaska Fish and Game Department, or the National Marine Fisheries Service for information on the fisheries and fishing activities in the proposed area of operations in order to minimize potential conflict between your activities and fishing activities. We are attaching a list of the Fish and Game offices with addresses and telephone numbers and a map showing the boundaries of the fishing districts for your convenience.

In addition to the standard stipulations above, the following stipulation has been included in G&G permits for seismic surveys in the Alaska OCS Region since the 1980's:

- Operators must maintain a minimum spacing of 15 miles between the seismic source vessels for separate surveys. The MMS must be notified by means of the weekly report whenever shut down of operations occurs to maintain this minimum spacing.

THE FOLLOWING DOCUMENT PROVIDES INFORMATION TO THE PERMITTEE ON THE ENDANGERED SPECIES ACT OF 1973, AS IT MIGHT APPLY WHEN CONDUCTING FIELD OPERATIONS.

The Endangered Species Act prohibits harassment of endangered and threatened species whether the harassment occurs through an intentional or negligent act or omission. Harassment refers to conduct of activities that disrupt an animal's normal behavior or cause a significant change in the activity of the affected animal. In many cases the effect of harassment is readily detectable: a whale may rapidly dive or flee from an intruder to avoid the source of disturbance. Other instances of harassment may be less noticeable to an observer but will still have a significant effect on endangered whales.

The Permittee must be prepared to take all reasonable and necessary measures to avoid harassing or unnecessarily disturbing endangered whales. In this regard, the Permittee should be particularly alert to the effects of boat and airplane or helicopter traffic on whales.

In order to ensure that the Permittee may derive maximum benefits from their operations at a minimum cost to the health and well being of endangered whales, the following guidelines are offered to help avoid potential harassment of endangered whales:

- (1) (a) Vessels and aircraft should avoid concentrations or groups of whales. Operators should, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,000 feet when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas.

(b) When weather conditions do not allow a 1,000-foot flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known whale concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.
- (2) When a vessel is operated near a concentration of whales, the operator must take every precaution to avoid harassment of these animals. Therefore, vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.
- (3) Vessel operators should avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.
- (4) Small boats should not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to whales.

When any Permittee becomes aware of the potentially harassing effects of operations on endangered whales, or when any Permittee is unsure of the best course of action to avoid harassment of

endangered whales, every measure to avoid further harassment should be taken until the National Marine Fisheries Service is consulted for instructions or directions. However, human safety will take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of endangered whales.

Permittees are advised that harassment of endangered whales may be reported to the National Marine Fisheries Service. For further information contact the National Marine Fisheries Service, Federal Building, Room C-554, Anchorage, Alaska, 99513, telephone (907) 271-5006.

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