Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Issuance of Incidental Harassment Authorization under 101(a)(5)(D) of the Marine Mammal Protection Act to BP Exploration (Alaska), Inc. (BPXA) for Shallow Geohazard Survey in the U.S. Beaufort Sea, Foggy Island Bay, Alaska, during the 2014 Open Water Season

NMFS Consultation Number: *AKR-2014-9370*

Action Agency: *National Marine Fisheries Service, Office of Protected Resources-Permits and Conservation Division (PR1)*

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Bowhead Whale (*Balanea mysticetus*)	Endangered	Yes	No	N/A
Ringed Seal, Arctic subspecies (*Phoca hispida hispida*)	Threatened	Yes	No	N/A
Bearded Seal, Beringia DPS (*Erignathus barbatus barbatus*)	Threatened	Yes	No	N/A

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By: for Robert Dm

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Date: 6/19/14

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TERMS AND ABBREVIATIONS

µPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
AEWC	Alaska Eskimo Whaling Commission
ASAMM	Aerial Surveys of Arctic Marine Mammals
ATOC	Acoustic Thermometry of the Ocean Climate
BPXA	BP Exploration (Alaska), Inc.
BSAI	Bering Sea/Aleutian Island
BWASP	Bowhead Whale Feeding Ecology Study
CAA	Conflict Avoidance Agreement
CI	Confidence Interval
CPUE	Catch Per Unit Effort
CSEL	Cumulative Sound Exposure Level
cui	Cubic Inches
CWA	Clean Water Act
dB	Decibels
DDT	Dichloro-Diphenyltrichloroethane
DPS	Distinct Population Segment
EPA	Environmental Protection Agency
ERL	Effects Range Low
ERM	Effects Range Medium
ESA	Endangered Species Act
ft	Feet
gal	Gallons
GNSS	Global Navigation Satellite System
HR	High Resolution
IHA	Incidental Harassment Authorization
in^3	Cubic Inch
ION	ION Geophysical
IPCC	Intergovernmental Panel on Climate Change
IWC	International Whaling Commission
km	Kilometers
km^2	Square Kilometers
L	Liters
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
OBC	Ocean Bottom Cable
OC	organochlorine
Opinion	Biological Opinion

PAH	Polycyclic Aromatic Hydrocarbons
PBDE	Polybrominated Diphenyl
PBR	Potential Biological Removal
PBU	Prudhoe Bay Unit
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PPP	Precise Point Positioning
PR1	Office of Protected Resources- Permits and Conservation Division
PSO	Protected Species Observers
PTS	Permanent Threshold Shift
RMS	Root Mean Square
RPA	Reasonable Prudent Alternative
SONAR	Sound Navigation and Ranging
TTS	Temporary Threshold Shift
USFWS	United States Fish and Wildlife Service
VGP	Vessel General Permit
VMS	Vessel Monitoring System

1. INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1539(a)(2)) requires each federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a protected species, that agency is required to consult with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies may conduct this consultation informally if they conclude that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat, and NMFS or the U.S. Fish and Wildlife Service concurs with that conclusion (50 CFR §402.14(b)).

For the actions described in this document, the action agency is NMFS's Office of Protected Resources – Permits and Conservation Division (PR1), which proposes to issue an Incidental Harassment Authorization (IHA) to take marine mammals by harassment under the Marine Mammal Protection Act (MMPA) incidental to two-dimensional (2D), high-resolution, shallow geohazard seismic surveys in U.S. federal and state waters in the Foggy Island Bay area of the Beaufort Sea by BP Exploration (Alaska), Inc. (BPXA) between July 1, 2014 and September 30, 2014. The consulting agency for this proposal is NMFS's Alaska Regional Office. This document represents NMFS's biological opinion (opinion) on the effects of this proposal on endangered and threatened species.

The opinion and incidental take statement were prepared by NMFS in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402.

The opinion is in compliance with section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-5444) ("Data Quality Act") and underwent pre-dissemination review.

1.1 Background

This opinion considers the effects of the authorization of an IHA to take marine mammals by harassment under the MMPA incidental to open-water 2D seismic surveys to BPXA in the state and federal waters of Foggy Island Bay in the U.S. Beaufort Sea, Alaska from July 1 to September 30, 2014. These actions have the potential to affect the endangered bowhead whale (*Balaena mysticetus*), threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*), and threatened Beringia DPS of bearded seal (*Erignathus barbatus barbatus*). There is no critical habitat designated for these species.

This biological opinion is based on information provided in the February 2014, Incidental Harassment Authorization Application by BPXA; May 2013, Draft Environmental Assessment;

March 2013, Supplemental Draft Environmental Impact Statement on the Effects of Oil and Gas Activities in the Arctic Ocean; the updated project proposals, email and telephone conversations between NMFS Alaska Region and NMFS PR1 staff; and other sources of information. A complete record of this consultation is on file at NMFS's Juneau Alaska office.

1.2 Consultation History

On February 4, 2014, BPXA submitted an IHA application to NMFS for the non-lethal taking of cetaceans and seals in conjunction with their proposed 2D high resolution geohazard seismic survey in the Foggy Island Bay section of the Beaufort Sea, Alaska during the summer of 2014. On March 25, 2014, NMFS PR1 submitted a request to initiate section 7 consultation to the NMFS Alaska Region (NMFS 2014a).

2. DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

This opinion considers the effects of the authorization of an IHA to take marine mammals by harassment under the MMPA incidental to BPXA's 2D seismic high resolution geohazard survey in nearshore waters of the U.S. Beaufort Sea between July 1, 2014 and September 30, 2014. Airgun usage will occur no later than midnight on August 25, 2014, in order to mitigate potential impacts to migrating bowhead whales and the Nuiqsut subsistence hunters at Cross Island. Activities that occur after August 25 will involve the retrieval of equipment.

Project Purpose

The purpose for the proposed 2D seismic surveys is for BPXA to evaluate the existence and location of archaeological resources and potential geologic hazards on the seafloor and in the shallow subsurface.

2.1.1 BPXA's Proposed Activities

The proposed survey will acquire data in two phases. Phase 1 of BPXA's proposed project is focused on obtaining 2D high resolution shallow geohazard data using an airgun array and towed streamer in the Site Survey area. The survey will occur within 31 square kilometers (km^2) (12 square miles (mi^2) (see Figure 1). During phase 2, data will be acquired in both the Site Survey and Sonar Survey areas using the multibeam echosounder, sidescan sonar, subbottom profiler, and the magnetometer. Phase 2 will cover approximately 13 km^2 (5 mi^2) within the 75 km^2 (29 mi^2) area identified in Figure 1. Activities outside the area delineated in Figure 1 may include vessel turning while using airguns, vessel transit, and other vessel movements for project support and logistics (NMFS 2014a).

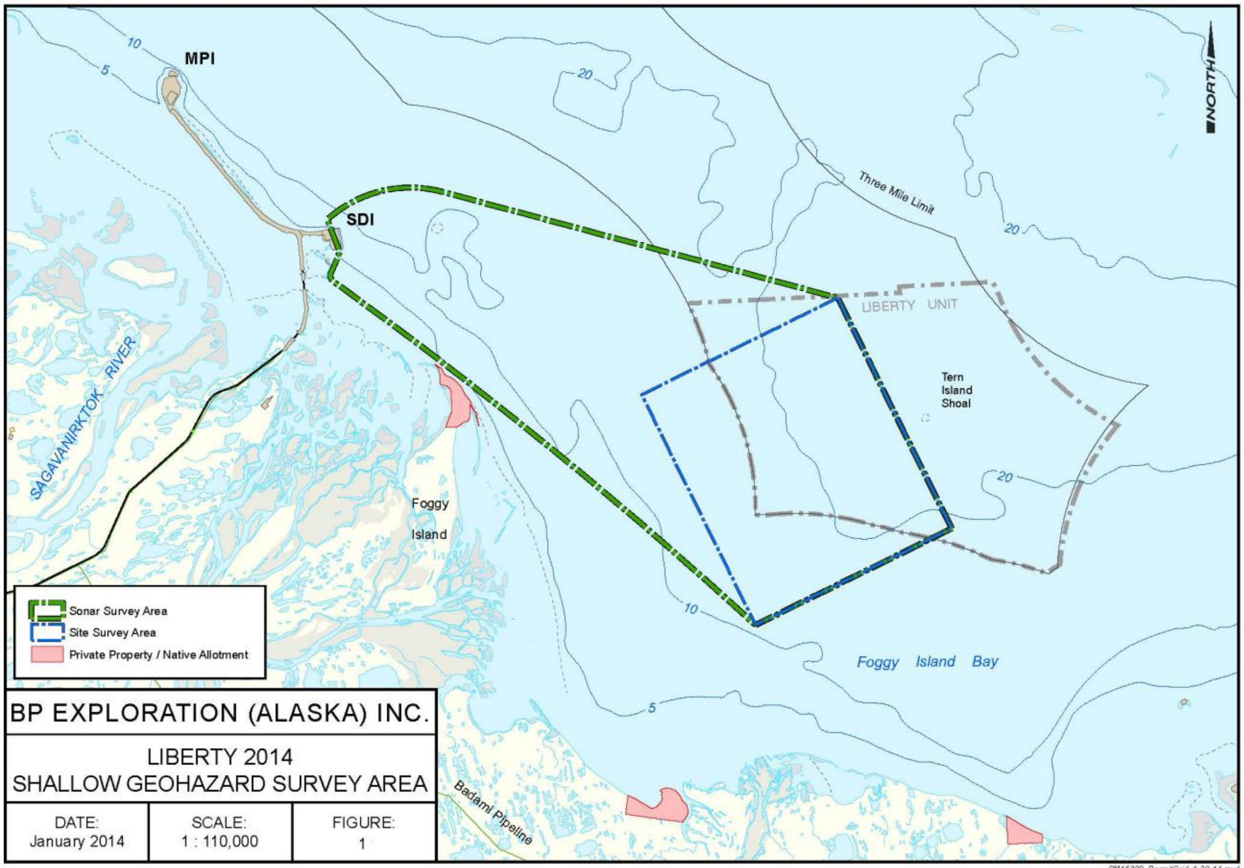

Figure 1. Proposed Liberty Geohazard Project Area, showing the Site Survey Area (Phase 1) and Sonar Survey Area (Phase 2)(BPXA 2014a).

2.1.1.1 Equipment and Personnel Mobilization and Demobilization

One vessel will be used for the geohazard survey and will be transported to Deadhorse by truck and prepared and launched at West Dock or Endicott (both of which are located in Prudhoe Bay) (BPXA 2014a).

Vessel preparation will include assembly of navigation and source equipment, testing receiver deployment and retrieval systems, loading recording and safety equipment, and initial fueling. Once assembled, the systems (including airguns) will be tested at West Dock or at the project site (BPXA 2014a).

Demobilization of equipment is anticipated to be completed before the end of September.

Equipment will be retrieved as part of the operations and during demobilization. Receiver retrieval and demobilization of equipment and support crew will be completed by the end of September. BPXA does not expect site restoration and rehabilitation to be necessary for this type of work (BPXA 2013a).

2.1.1.2 Housing and Logistics

Approximately 20 people will be involved in the operation including seismic crew, management, mechanics, and Protected Species Observers (PSOs). Most of the crew will be accommodated at BPXA operated camps or Deadhorse. Some offshore crew will be housed on vessels.

Support activities, such as crew transfers and vessel re-supply are primarily planned to occur at Endicott and West Dock. However, support activities may also occur at other nearby vessel accessible locations if needed (e.g., East Dock). Equipment staging and onshore support will primarily occur at West Dock, but may also take place at other existing road-accessible pads within the Prudhoe Bay Unit area as necessary. For protection from weather, the vessel may anchor near West Dock, near the barrier islands, or other near shore locations (BPXA 2014a).

2.1.1.3 Seismic Data Acquisition

BPXA plans to conduct the surveys between July 1 and September 30, 2014. Data acquisition is expected to take approximately 20 days (occurring between July 1 and August 25), depending on weather. Demobilization of equipment and support crew will be completed by the end of September. To limit potential impacts to the bowhead whale fall migration and subsistence hunting, airgun operation dates will be in accordance with the dates agreed upon in the Conflict Avoidance Agreement (CAA) between the Alaska Eskimo Whaling Commission (AEWC), individual community Whaling Captain’s Associations, and BPXA, historically ending August 25. Demobilization would continue after airgun operations end.

The project area of the proposed Liberty shallow geohazard survey lies within Foggy Island Bay as shown in Figure 1. The Phase 1 Site Survey, focused on obtaining shallow geohazard data using an airgun array and a towed streamer, will occur within approximately 31 km^2 (12 mi^2). The Phase 2 Sonar Survey will occur over the Site Survey area and over approximately 13 km^2 (5 mi^2) within the 75 km^2 (29 mi^2) area identified in Figure 1. The Sonar Survey is focused on acquiring shallow geohazard data using the multibeam echosounder, sidescan sonar, subbottom profiler, and the magnetometer. Activity outside the area delineated on Figure 1 may include vessel turning while using airguns, vessel transit, and other vessel movements for project support and logistics. Each phase has an expected duration of about 7.5 days, based on a 24-hour workday. Between the first and second phase the operations will be focused on changing equipment for approximately 5 days (NMFS 2014a).

Equipment and Vessels

BPXA only anticipates using one vessel for the proposed survey. The proposed vessel (R/V Thunder or equivalent) is about 70 x 20 feet in size. The airgun and streamer, sidescan sonar, and magnetometer will be deployed from the vessel. The multibeam echosounder and subbottom profiler will be hull-mounted. No equipment will be placed on the sea floor as part of the proposed action (BPXA 2014a).

Vessel noises are often at source levels of 165-200 dB re 1 μPa at 1 m (Aerts et al. 2008), and typically operate at frequencies from 20-200 Hz (Greene and Moore 1995).

Navigation and Data Management

The vessel will be equipped with Differential Global Navigation Satellite System (GNSS) receivers capable of observing dual constellations and backup. Corrected positions will be provided via a precise point positioning (PPP) solution. A kinematic base station will be kept at the housing facilities in Deadhorse to mitigate against the inability to acquire a PPP signal.

A navigation software package will display known obstructions, islands, and identified areas of sensitivity. The software will also show the pre-determined source line positions within the two survey areas. The information will be updated as necessary to ensure required data coverage. The navigation software will also record all measured equipment offsets and corrections and vessel and equipment position at a frequency of no less than once per 5 seconds for the duration of the project (BPXA 2014a).

2D Seismic Operations

High resolution (HR) seismic data acquisition will only take place during Phase 1 in the Site Survey area. The 2D HR seismic source will consist of one of two potential arrays, each with a discharge volume of 30 cubic inches (cui) and containing multiple airguns. The first array option will have three 10 cui airguns and the second array option will have a 20 cui and a 10 cui airgun. Table 1 summarizes airgun array specifics for each option. A 5 cui airgun will be utilized as the mitigation gun. The tow depth will be about 3 ft (BPXA 2014a).

Table 1. Acoustic equipment BPXA anticipates using within the action area (BPXA 2014a).

Active Acoustic Source	Frequency (kHz)	Maximum Source Level (dB re 1 μPa at 1m)
30 cui airgun array (Option1)	<1	209
30 cui airgun array (Option 2)	<1	207

Multibeam echosounder	200-400	220
Sidescan sonar	120-450	215
Subbottom profiler	2-16	216
Vessel Noise[1]	<1	200

[1] Vessel Noise includes source vessels, recorder vessels, housing vessel, crew transport vessels, and bow pickers. The loudest vessel is anticipated to be the housing vessel (Aerts et al. 2008).

The receivers will be placed on a streamer that is towed behind the source vessel. The streamer will be about 300 m (984 ft) in length and will contain 48 receivers at about 6.25 m (20 ft) spacing.

Seismic data will be acquired on two grids. Grid 1 will contain lines spaced at 150 m (492 ft) with perpendicular 300 m (984 ft) spaced lines. Grid 2 will contain ~20 m (65 ft) spaced lines. The total line length of both grids will be about 550 km (342 mile).

The vessel will travel with a speed of approximately 3-4 knots. The seismic pulse interval is 6.25 m (20.5 ft), which means a shot every 3 to 4 seconds (BPXA 2014a).

Multibeam Echosounder and Sidescan Sonar

A multibeam echosounder and sidescan sonar will be used to obtain high accuracy information regarding bathymetry and isonification of the seafloor. For accurate object detection, a sidescan sonar survey is required to complement a multibeam echosounder survey.

The proposed multibeam echosounder operates at a rms source level of approximately 220 dB re 1 μPa at 1m. The multibeam echosounder emits high frequency energy in a fan-shaped pattern of equidistant or equiangular beam spacing. The beam width of the emitted sound energy along track direction is 2 degrees at 200 kilohertz (kHz) and 1 degree at 400 kHz, while the across track beam width is 1 degree at 200 kHz and 0.5 degrees at 400 kHz (Table 1). The maximum ping rate of the multibeam echosounder is 60 Hz.

The proposed sidescan sonar system will operate at about 100 kHz (120 kHz to 135 kHz) and 400 kHz (400 kHz to 450 kHz). The estimated rms source level is approximately 215 dB re 1μPa at 1m (Table 1). The sound energy is emitted in a narrow fan-shaped pattern, with a horizontal beam width of 1.5 degrees for 100 kHz and 0.4 degrees at 400 kHz, with a vertical beam height of 50 degrees. The maximum ping rate of the sidescan sonar is 30 Hz.

Data acquisition with the multibeam echosounder and sidescan sonar data will take place along all grids in the Sonar Survey area. Additional multibeam echosounder and sidescan sonar infill lines will be added to obtain 150% coverage over certain areas.

In addition, BPXA may conduct a strudel scour survey in the Kadleroshilik and Sagavanirktok River overflood areas for about 3 days, depending on results from reconnaissance flights in June. This data would be collected from a separate vessel equipped with a multibeam echosounder and sidescan sonar (BPXA 2014a).

Subbottom Profiler

The purpose of the subbottom profiler is to provide an accurate digital image of the shallow sub-surface sea bottom, below the mud line. The proposed system emits energy in the frequency bands of 2 to 16 kHz (Table 1). The beam width is 15 to 24 degrees, depending on the center frequency. Typical pulse rate is between 3 and 6 Hz. Subbottom profiler data will be acquired continuously along all grids during phase 2 of the operations, i.e., after 2D seismic data has been obtained (BPXA 2014a).

Magnetometer

A marine magnetometer will be used for the detection of magnetic deflection generated by geologic features, and buried or exposed ferrous objects, which may be related to archaeological artifacts or modern man-made debris. The magnetometer will be towed at a sufficient distance behind the vessel to avoid data pollution by the vessel's magnetic properties. Magnetometers measure changes in magnetic fields over the seabed and do not produce sounds (BPXA 2014a).

2.1.2 Mitigation Measures Proposed by BPXA

BPXA proposes to implement measures to reduce adverse impact on marine mammals to the extent practicable (which includes considerations of personal safety and practicality of implementation). The mitigation measures can be divided into three main groups:

1. General mitigation measures that apply to all vessels involved in the survey
2. Specific mitigation measures that apply to source vessels operating airguns
3. Mitigation measures that apply to Protected Species Observers

General Mitigation Measures

These measures apply at all times to the vessel involved in the Foggy Island Bay geohazard survey. This vessel will operate under additional measures described below during seismic operations.

- When weather conditions require, such as when visibility drops, vessels shall adjust speed to 9 knots or less to avoid the likelihood of marine mammal collisions;
- The vessel operator shall check the waters immediately adjacent to the vessel to ensure that no marine mammals will be injured when the vessel's propellers are engaged;
- The vessel operator shall avoid groups of five whales or more, and the vessel shall not be operated in a way that separates members of a group. When feeding whales or

aggregations of five whales or more are observed, vessel speed shall be less than 10 knots;

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

Seismic Survey Mitigation Measures
Specific mitigation measures will be adopted during airgun operations according to NMFS guidelines, provided that doing so will not compromise operational safety requirements. The mitigation measures outlined below have been established by NMFS to prevent marine mammals from exposures to received sound pressure levels of 190 dB dB re 1µPa (rms) for seals and 180 dB re 1µPa (rms) for whales.

Ramp-Up Procedure

During ramp-up, BPXA intends to implement the common procedure of doubling the number of operating airguns at 5-minute intervals, starting with the smallest gun in the array. For the 30 in^3 array this is estimated to take approximately 10 minutes for the three-airgun array option, and 5 minutes for the two-airgun array option. First the smallest gun in the array will be activated (10 in^3) and after 5 min, the second airgun (10 in^3 or 20 in^3). For the three-airgun array, an additional 5 min are then required to activate the third 10 in^3 airgun. During ramp-up, the exclusion zone for the full airgun array will be observed.

The ramp-up procedures will be applied as follows:

1. A ramp-up, following a cold start (period when no airguns are operating), can be occur if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp-up from a cold start cannot begin.
2. Ramp-up procedures from a cold start will be delayed if a marine mammal is sighted within the exclusion zone during the 30-minute period prior to the ramp-up. The delay will last until the marine mammal(s) has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 minutes (seals) or 30 minutes (whales).
3. A ramp-up, following a shutdown, can be applied if the marine mammal(s) for which the

shutdown occurred has been observed to leave the exclusion zone or until the animal(s) has not been sighted for at least 15 minutes (seals) or 30 minutes (whales).

4. If, for any reason, power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures need to be implemented. Only if the PSO watch has been suspended, a 30-minute clearance of the fully visible exclusion zone is required prior to commencing ramp-up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.
5. The seismic operator and PSOs will maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

Power Down Procedures

A power down is the immediate reduction in the number of operating airguns such that the radii of the 190 dB and 180 dB (rms) zones are decreased to the extent that an observed marine mammal is not in the applicable exclusion zone of the full array. During a power down, one airgun (or some other number of airguns less than the full airgun array) continues firing. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of airgun activity, and (b) retain the option of initiating a ramp up to full operations under poor visibility conditions.

1. The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun;
2. Likewise, if a mammal is already within the exclusion zone when first detected, the airguns will be powered down immediately;
3. If a marine mammal is sighted within or about to enter the applicable exclusion zone of the single mitigation airgun, the airgun will be shutdown; and
4. Following a power down, ramp up to the full airgun array will not occur until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone if it has been visually observed leaving the exclusion zone of the full array, or no marine mammal has been seen within the zone for 15 minutes (seals) or 30 minutes (whales).

Shutdown Procedures

The operating airgun(s) will be shutdown completely if a marine mammal approaches or enters the 190 or 180 dB (rms) exclusion radius of the smallest airgun. Airgun activity will not resume until the marine mammal has cleared the applicable exclusion radius of the full array. The animal will be considered to have cleared the exclusion radius as described above under ramp up procedures.

Poor Visibility Conditions

BPXA plans to conduct 24-hr operations. PSOs will not be on duty during ongoing seismic operations during darkness, given the very limited effectiveness of visual observation at night (there will be no periods of darkness in the survey area until mid-August). The proposed provisions associated with operations at night or in periods of poor visibility include the following:

- If during foggy conditions, heavy snow or rain, or darkness (which may be encountered starting in late August), the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a shut-down; and
- If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

BPXA is aware that available techniques to effectively detect marine mammals during limited visibility conditions (darkness, fog, snow, and rain) are in need of development and has in recent years supported research and field trials intended to improve methods of detecting marine mammals under these conditions. BPXA intends to continue research and field trials to improve methods of detecting marine mammals during periods of low visibility. However, this experimental research is not required mitigation.

Protected Species Observers (PSOs)
Two marine mammal observers (referred to as PSOs) will be present on the vessel during each 12-hour shift. Of these two PSOs, one will be on watch at all times to monitor the 190 and 180 dB exclusion zones for the presence of marine mammals. The main objectives of the vessel-based marine mammal monitoring are as follows:

1. To implement mitigation measures during airgun operations (e.g. course alteration, airgun power-down, shut-down and ramp-up); and
2. To record all marine mammal data needed to estimate the number of marine mammals potentially affected, which must be reported to NMFS within 90 days after the survey ends.

BPXA intends to work with experienced PSOs. At least one Alaska Native resident, who is knowledgeable about Arctic marine mammals and the subsistence hunt, is expected to be included as one of the PSOs aboard the vessels. Before the start of the seismic survey the crew of the seismic source vessels will be briefed on the function of the PSOs, their monitoring protocol, and mitigation measures to be implemented.

At least one observer will monitor for marine mammals at any time during daylight hours (there will be no periods of total darkness until mid-August). PSOs will be on duty in shifts of a maximum of 4 hours at a time, although the exact shift schedule will be established by the lead PSO in consultation with the other PSOs.

The vessel will offer a suitable platform for marine mammal observations. Observations will be made from locations where PSOs have the best view around the vessel. During daytime, the

PSO(s) will scan the area around the vessel systematically with reticle binoculars and with the naked eye. Because the main purpose of the PSO on board the vessel is detecting marine mammals for the implementation of mitigation measures according to specific guidelines, we prefer to keep the information to be recorded as concise as possible. This will allow the observer to focus on detecting marine mammals. The following information will be collected:

- Environmental conditions – consisting of sea state (in Beaufort Windforce scale according to NOAA), visibility (in km, with 10 km indicating the horizon on a clear day), and sun glare (position and severity). These will be recorded at the start and end of each shift, or whenever a change in observers occurs;
- Project activity – consisting of airgun operations (on or off), number of active guns, line number. This will be recorded at the start of each shift, whenever there is an obvious change in project activity, and whenever the observer changes shifts; and
- Sighting information – consisting of the species (if determinable), group size, position and heading relative to the vessel, behavior, movement, and distance relative to the vessel (initial and closest approach). These will be recorded upon sighting a marine mammal or group of animals.

When marine mammals in the water are detected within or about to enter the designated exclusion zones, the airgun(s) power-down or shutdown procedures will be implemented immediately. To assure prompt implementation of power-downs and shutdowns, multiple channels of communication between the PSOs and the airgun technicians will be established. During the power-down and shutdown, the PSO(s) will continue to maintain watch to determine when the animal(s) are outside the applicable exclusion radius. Airgun operations can be resumed with a ramp up procedure (depending on the extent of the power down[1]) if the observers have visually confirmed that the animal(s) moved outside the exclusion zone, or if the animal(s) were not observed within the exclusion zone for 15 minutes (seals) or for 30 minutes (whales). Direct communication with the airgun operator will be maintained throughout these procedures.

All marine mammal observations and any airgun power-down, shutdown, and ramp up will be recorded in a standardized format. Data will be entered into or transferred to a custom database. The accuracy of the data entry will be verified daily through QAQC procedures. Recording procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to other programs for further processing and archiving.

2.1.3 Mitigation and Monitoring Measures Proposed by PR1

The mitigation and monitoring measures described below are required per the NMFS IHA stipulations, and will be implemented by BPXA to reduce potential impacts to marine mammals from survey activities and vessel movements.

[1] Ramp up procedures are only required from when airguns have been shutdown for more than 10 minutes. If the shutdown lasted less than 10 minutes, then the ramp up procedure is not required as long as the PSO continued monitoring during the 1-9 minute period.

Detection-based measures intended to reduce near-source acoustic exposures and impacts on marine mammals under NMFS' authority within a given distance of the source

Monitoring and Mitigating the Effects of Seismic Survey

1. Protected Species Observers ([PSOs], formerly referred to as Marine Mammal Observers or [MMOs]) are required on all vessels engaged in activities that may result in an incidental take through acoustic exposure.

    - Two NMFS-qualified, PSOs shall be onboard the vessel. Of these two PSOs, one will be on watch at all times to monitor the 190 and 180 dB exclusion zones for the presence of marine mammals during airgun operations. The main objectives of the vessel-based marine mammal monitoring are as follows:
        - To implement mitigation measures during seismic operations (e.g. course alteration, airgun power down, shut-down and ramp-up); and
        - To record all marine mammal data needed to estimate the number of marine mammals potentially affected, which must be reported to NMFS within 90 days after the survey.
    - PSO shifts shall last no longer than 4 hours at a time and shall not be on watch more than 12 hours in a 24-hour period. PSOs shall also make observations during daytime periods when active operations are not being conducted for comparison of animal abundance and behavior, when feasible;
    - The vessel will offer a suitable platform for marine mammal observations. Observations will be made from locations where PSOs have the best view around the vessel. During daytime, the PSO(s) will scan the area around the vessel systematically with reticle binoculars and with the naked eye. Because the main purpose of the PSO on board the vessel is detecting marine mammals for the implementation of mitigation measures according to specific guidelines, BPXA prefers to keep the information to be recorded as concise as possible, allowing the PSO to focus on detecting marine mammals. The following information will be collected by the PSOs:
        - Environmental conditions- consisting of sea state (in Beaufort Wind force scale according to NOAA), visibility (in km, with 10 km indicating the horizon on a clear day), and sun glare (position and severity). These will be recorded at the start of each shift, whenever there is an obvious change in one or more of the environmental variables, and whenever the observer changes shifts;
        - Project activity- consisting of airgun operations (on or off), number of active funs, line number. This will be recorded at the start of each shift, whenever there is an obvious change in project activity, and whenever the observer changes shifts; and
        - Sighting information- consisting of the species (if determinable), group size, position and heading relative to the vessel, behavior, movement, and distance relative to the vessel (initial and closest approach). These will be recorded upon sighting a marine mammal or group of animals.

- When marine mammals in the water are detected within or about to enter the designated exclusion zones, the airgun(s) power down or shut-down procedures will be implemented immediately. To assure prompt implementation of power downs and shut-downs, multiple channels of communication between the PSOs and the airgun technicians will be established.
- During the power down and shut-down, the PSO(s) will continue to maintain watch to determine when the animal(s) are outside the exclusion radius. Airgun operations can be resumed with a ramp-up procedure (depending on the extent of the power down) if the observers have visually confirmed that the animal(s) moved outside the exclusion zone, or if the animal(s) were not observed within the exclusion zone for 15 minutes (seals) or for 30 minutes (cetaceans). Direct communication with the airgun operator will be maintained throughout these procedures.
- All marine mammal observations and any airgun power down, shut-down, and ramp-up will be recorded in a standardized format. Data will be entered into or transferred to a custom database. The accuracy of the data entry will be verified daily through QA/QC procedures. Recording procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to other programs for further processing and archiving.

2. Use of small-volume airgun during turns and transits

   - Throughout the seismic survey, particularly during turning movements, and short transits, BPXA will employ the use of a small-volume airgun to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration (turns may last two to three hours for the proposed project).
   - In cases when the next start-up a turn is expected during lowlight or visibility, use of the mitigation airgun may be initiated 30 minutes before darkness or low visibility conditions occur and may be operated until the start of the next seismic acquisition line. The mitigation gun must still be operated at approximately one shot per minute.

Monitoring Measures

3. Fish and Airgun Sound Monitoring

   - Conduct research on fish species in relation to airgun operations, including prey species important to ice seals, during the proposed seismic survey.
     - Monitoring study will occur over a 2-month period during the open water season.
     - Fish are counted and sized every day, unless sampling is prevented by weather, the presence of bears, or other events.
     - Fish mortality will be noted.

   - To document relationships between fish catch in each fyke net and received levels, BP will attempt to instrument each fyke net location with a recording hydrophone.

- Recording hydrophones, to the extent possible, will have a dynamic range that extends low enough to record near ambient sounds and high enough to capture sound levels during relatively close approaches by the airgun array (i.e., likely levels as high as about 200 dB re 1 uPa). Bandwidth will extend from about 10 Hz to at least 500 Hz.

o BP will attempt to instrument each fyke net location with a recording particle velocity meter.

4. Peer Review Monitoring Plan Recommendations

Because of the extremely short duration of BPXA's proposed survey, the fact that activities will be completed prior to any fall bowhead whale subsistence hunts, and that seal hunts occur more than 50 mi from the proposed survey activities, NMFS determined that the proposed survey did not meet the trigger for requiring an independent peer review of the monitoring plan.

Reporting Measures

1. 90-Day Technical Report

o A report will be submitted to NMFS within 90 days after the end of the proposed geohazard survey. The report will summarize all activities and monitoring results conducted during in-water seismic surveys. The Technical Report will include the following:

- Summary of project start and end dates, airgun activity, number of guns, and the number and circumstances of implementing ramp-up, power down, shutdown, and other mitigation actions;
- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);
- 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), and group sizes;
- Analyses of the effects of survey operations;
- Sighting rates of marine mammals during periods with and without seismic survey activities (and other variables that could affect detectability), such as:
    - o Closest point of approach versus survey activity state;
    - o Observed behaviors and tyes of movement versus survey activity

state;

- o Number of sightings/individuals seen versus survey activity state;
- o Distribution around the source vessels versus survey activity state; and
- o Estimates of exposures of marine mammals to Level B harassment thresholds based on presence in the 160 dB harassment zone.

2. Fish and Airgun Sound Report
   - o BPXA proposes to present the results of the fish and airgun sound study to NMFS in a detailed report that will also be submitted to a peer reviewed journal for publication, presented at a scientific conference, and presented in Barrow and Nuiqsut.

3. Notification of Dead or Injured Marine Mammals
   - o In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA (if issued), such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), BPXA would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the Alaska Regional Stranding Coordinators. The report would include the following information:
     - Time, date, and location (latitude/longitude) of the incident;
     - Name and type of vessel involved;
     - Vessel's speed during and leading up to the incident;
     - Description of the incident;
     - Status of all sound source use in the 24 hours preceding the incident;
     - Water depth;
     - Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
     - Description of all marine mammal observations in the 24 hours preceding the incident;
     - Species identification or description of the animal(s) involved;
     - Fate of the animal(s); and
     - Photographs or video footage of the animal(s) (if equipment is available).
   - o Activities would not resume until NMFS is able to review the circumstances of the prohibited take. NMFS would work with BPXA to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance.

BPXA would not be able to resume their activities until notified by NMFS via letter, email, or telephone.

- o In the event that BPXA discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), BPXA would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators. The report would include the same information identified in the paragraph above. Activities would be able to continue while NMFS reviews the circumstances of the incident. NMFS would work with BPXA to determine whether modifications in the activities are appropriate.
- o In the event that BPXA discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), BPXA would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators, within 24 hours of the discovery. BPXA would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network.

2.2 Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this reason, the action area is typically larger than the project area and extends out to a point where no measurable effects from the proposed action occur.

The action area for this biological opinion will include: (1) 2D seismic survey area in nearshore waters of Foggy Island Bay in the U.S. Beaufort Sea; (2) sonar survey area in Foggy Island Bay; (3) sound propagation buffer area; and (4) vessel transit area. We define the action area for this consultation to include the area within which project-related noise levels are ≥120 dB, and are expected to approach ambient noise levels (i.e. the point where no measureable effect from the project would occur). The project area encompasses approximately 876 square kilometers, comprised of approximately 31 square kilometers of 2D seismic survey area, 74 square kilometers of sonar survey area, 701 square kilometers for the seismic and sonar sound propagation buffers, and 70 square kilometers for the transit area (see Figure 2).

BPXA is proposing to conduct 2D seismic surveys in the nearshore waters of the Foggy Island Bay in the U.S. Beaufort Sea (see Figure 1). The total 2D seismic survey area is 31 km^2 (12 mi^2) (BPXA 2014a).

In addition, BPXA is proposing to conduct sonar surveys using multibeam echosounder, sidescan sonar, and subbottom profiler equipment. The sonar survey will cover the seismic survey area again, and add an additional survey area over the subsea pipeline corridor area in Foggy Island Bay (see Figure 1). The total sonar survey area will be 74 km^2 (29 mi^2)(BPXA 2014a).

The seismic and sonar survey areas are enclosed by barrier islands. These islands effectively serve as a sound barrier. However, the gaps between the barrier islands potentially serve as funnels through which sound can propagate seaward, so the action area includes an area outside the barrier islands. During a 2008 survey in Foggy Island Bay, median received pulse SPLs at the gaps between islands were >120 dB re 1 µPa about 25% of the time. At these times, and depending on the spreading loss term, the 120 dB isopleth could have been located up to 20 km seaward of the barrier islands (Aerts et al. 2008). On average noise is anticipated to reach the 120 isopleth at approximately 7.2 km from the seismic source, and 5.1 km from the subbottom profiler source (which is the farthest reaching of the sonar sources)(BPXA 2014a). While we anticipate that the noise transmission from seismic and sonar sources will be limited by the existence of barrier islands, we have included the 7.2 km sound propagation buffer that stretches around the 2D seismic survey area, and the 5.1 km sound propagation buffer that stretches around the sonar survey area to be precautionary.

Mobilization, demobilization, and support activities are primarily planned to occur at West Dock and Endicott, but may also occur out of East Dock in Prudhoe Bay. Equipment staging and onshore support will primarily occur at West Dock, but may also take place at other existing road-accessible pads within the Prudhoe Bay Unit area as necessary (BPXA 2014a). For these reasons, we have included a transit route from Prudhoe Bay mobilization sites into the Foggy Island Bay seismic and sonar survey locations (see Figure 2).

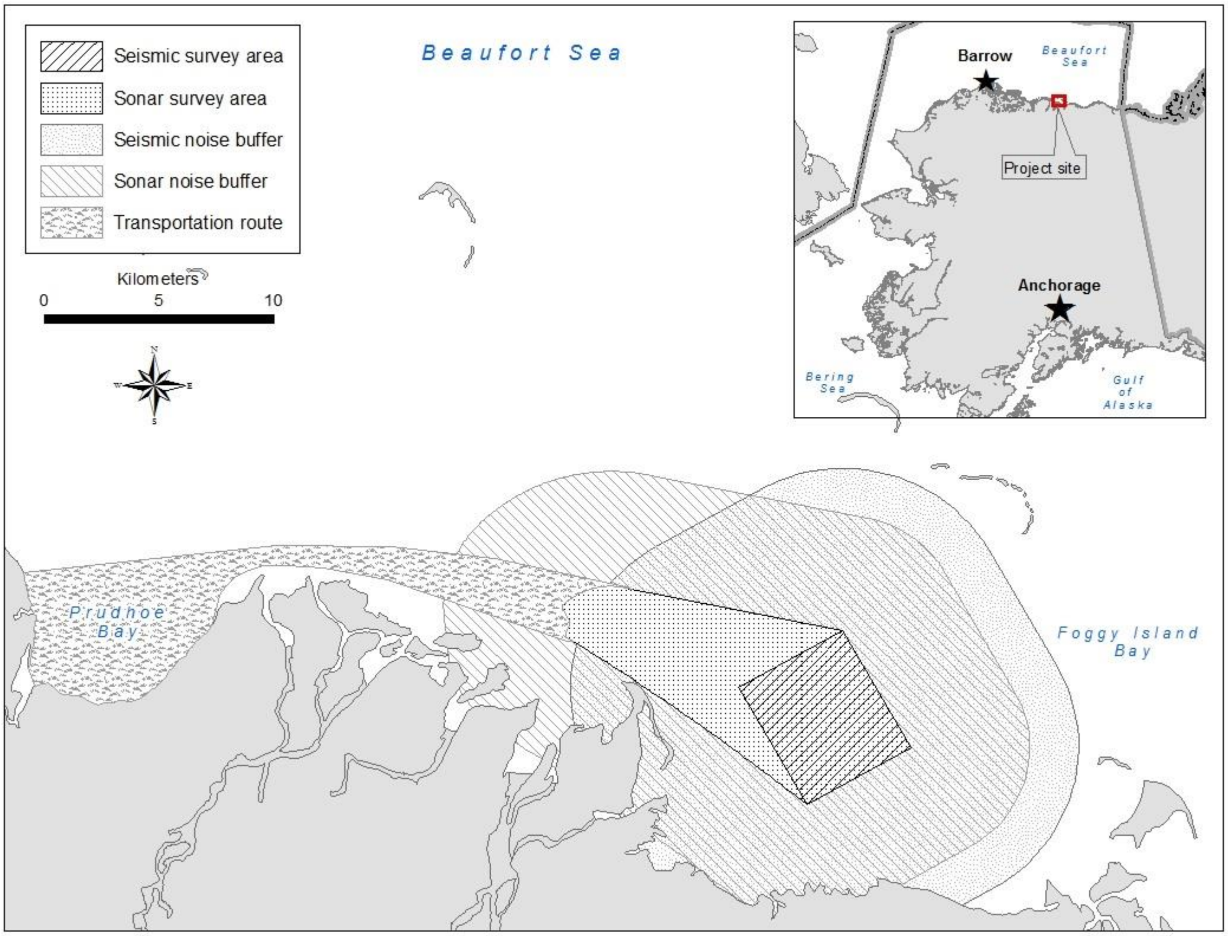

Figure 2. Action Area for BPXA 2D seismic geohazard project including seismic survey area, sonar survey area, sound propagation buffers, and transit area.

3. APPROACH TO THE ASSESSMENT

3.1 Introduction to the Biological Opinion

Section 7(a)(2) of the ESA requires federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). As NMFS explained when it promulgated this definition, NMFS considers the likely impacts to a species' survival as well as likely impacts to its recovery. Further, it is possible that in certain, exceptional circumstances, injury to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 2, 1986).

3.1.1 Approach to the Assessment

We will use the following approach to determine whether the proposed action described in Section 2 is likely to jeopardize listed species:

- Identify those aspects of proposed action that are likely to have direct and indirect effects on the physical, chemical, and biotic environment of the project area. As part of this step, we identify the action area – the spatial extent of these direct and indirect effects.

- Identify the rangewide status of the species likely to be adversely affected by the proposed action. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 4.

- Describe the environmental baseline for the proposed action. The environmental baseline includes the past and present impacts of federal, state, or private actions and other human activities *in the action area*. It includes the anticipated impacts of proposed federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 5 of this opinion.

- Analyze the effects of the proposed actions. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. The effects of the action are described in Section 6 of this opinion with the exposure analysis described in Section 6.2 of this opinion.

- Once we identify which listed species are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed species are likely to respond given their exposure (these represent our *response analyses*). Response analysis is considered in Section 6.3 of this opinion.

- Describe any cumulative effects. Cumulative effects, as defined in NMFS's implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area. Future federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 7 of this opinion.

- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to appreciably reduce the likelihood of survival or recovery of the species in the wild by reducing its numbers, reproduction, or distribution. Integration and synthesis with risk analyses occurs in Section 8 of this opinion.

- Reach jeopardy and adverse modification conclusions. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 9. These conclusions flow from the logic and rationale presented in the Integration and Synthesis section 8.

- If necessary, define a reasonable and prudent alternative to the proposed action. If, in completing the last step in the analysis, NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a reasonable and prudent alternative (RPA) to the action.

3.1.2 Risk Analysis

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been defined by the ESA. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations is determined by the fate of the individuals that comprise them.

Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individuals' risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

4. RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Three species of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area (Western Arctic Bowhead whale [*Balanea mysticetus*], the Arctic subspecies of the Ringed seal [*Phoca hispida hispida*] and the Beringia DPS of the [*Erignathus barbatus barbatus*] subspecies of the Bearded seal) (Table 2). The action area does not include designated critical habitat because NMFS has not yet designated, or proposed for designation, critical habitat for any of the listed species covered in this opinion.

Table 2. Listing status and critical habitat designation for marine mammal species considered in this opinion.

Species	Status	Listing	Critical Habitat
Balanea mysticetus (Bowhead Whale)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Phoca hispida hispida (Arctic Ringed Seal)	Threatened	NMFS 2012, 77 FR 76706	Not proposed
Erignathus barbatus barbatus (Beringia DPS Bearded Seal)	Threatened	NMFS 2012, 77 FR76740	Not proposed

4.1 Climate Change

One threat is or will be common to all of the species we discuss in this opinion: global climate change. Because of this commonality, we present this narrative here rather than in each of the species-specific narratives that follow.

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing (warming) and that this will continue for at least the next several decades (Watson and Albritton 2001, Oreskes 2004). There is also consensus within the scientific community that this warming trend will alter current weather patterns and patterns associated with climatic phenomena, including the timing and intensity of extreme events such as heat waves, floods, storms, and wet-dry cycles. Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average seal level (Pachauri and Reisinger 2007).

The Intergovernmental Panel on Climate Change (IPCC) estimated that average global land and sea surface temperature has increased by 0.6°C (±0.2) since the mid-1800s, with most of the change occurring since 1976. This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley 2000). The IPCC reviewed computer simulations of the effect of greenhouse gas emissions on observed climate variations that have been recorded in the past and evaluated the influence of natural phenomena such as solar and volcanic activity. Based on their review, the IPCC concluded that natural phenomena are insufficient to explain the increasing trend in land and sea surface temperature, and that most of the warming observed over the last 50 years is likely to be attributable to human activities (Stocker et al. 2013).

Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century (Watson and Albritton 2001). According to the IPCC (Stocker et al. 2013), it is likely that there has been an anthropogenic contribution to the very substantial Arctic warming over the past 50 years. In addition, anthropogenic forcings are very likely to have contributed to Arctic sea ice loss since 1979 (Stocker et al. 2013).

The rate of decline of Arctic sea ice thickness and September sea ice extent has increased considerably in the first decade of the 21st century (Stocker et al. 2013). It is estimated that three quarters of summer Arctic sea ice volume has been lost since the 1980s (Stocker et al. 2013). There was also a rapid reduction in ice extent, to 37% less in September 2007 and 49% less in September 2012 relative to the 1979-2000 climatology (Stocker et al. 2013). All recent years have ice extents that fall at least two standard deviations below the long-term sea ice trend (Stocker et al. 2013).

Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Houghton 2001, McCarthy 2001, Parry 2007). The direct effects of climate change would result in increases in atmospheric temperatures, changes in sea surface temperatures, changes in patterns of precipitation, and changes in sea level. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet, although the magnitude of these changes remain unknown (Stocker et al. 2013).

The indirect effects of climate change for listed marine mammals would result from changes in the distribution of temperatures suitable for many stages of their life history, the distribution and abundance of prey, and the distribution and abundance of competitors or predators. For example, variations in the recruitment of krill (*Euphausia superba*) and the reproductive success of krill predators have been linked to variations in sea-surface temperatures and the extent of sea-ice cover during the winter months. Thinning and reduced coverage of Arctic sea ice are likely to substantially alter ecosystems that are in close association with sea ice (Loeng et al. 2005). A decrease in the availability of suitable sea ice conditions may not only lead to high mortality of ringed seal pups but may also produce behavioral changes in seal populations (Loeng et al. 2005). Bowhead whales are dependent on sea-ice organisms for feeding and polynyas for breathing, so the early melting of sea ice may lead to an increasing mismatch in the timing of these sea-ice organisms and secondary production (Loeng et al. 2005). 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 2013).

4.3 Status of Listed Species

The remainder of this section of our opinion consists of narratives for each of the endangered and threatened species that occur in the action area and that may be adversely affected by the proposed seismic surveys. 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 opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

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 the proposed 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 (2013). Cameron et al. (2010) and Kelly *et al.* (2010b) provided status reviews of bearded and ringed seals. Richardson *et al.* (1995) and Tyack (2000, 2009) provided detailed analyses of the functional aspects of cetacean communication and their responses to active seismic. Finally, Croll *et al.* (1999), NRC (2000, 2003, 2005), and Richardson *et al.* (1995) provide information on the potential and probable effects of active seismic activities on the marine animals considered in this opinion.

4.3.1 Bowhead Whale

Population Structure

The International Whaling Commission (IWC) historically recognized five stocks of bowhead whales for management purposes (IWC 1992, Rugh et al. 2003). Three of these stocks occur in the North Atlantic: the Spitsbergen, Baffin Bay-Davis Straight, and Hudson Bay-Foxe Basin stocks. The remaining two stocks occur in the North Pacific: the Sea of Okhotsk and Western Arctic (Bering-Chukchi-Beaufort seas) stocks. The current working hypothesis is that the Davis Strait and Hudson Bay bowhead whales comprise a single Eastern Arctic stock. Confirmation of stock structure awaits further scientific analyses. Out of all of the stocks, the Western Arctic stock is the largest, and the only stock to inhabit U.S. waters (Allen and Angliss 2013). It is also the only bowhead stock within the action area.

Distribution

Bowhead whales have a circumpolar distribution in high latitudes in the Northern Hemisphere, and ranges from 54º to 85ºN latitude. They live in pack ice for most of the year, typically wintering at the southern limit of the pack 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 (Nerini et al. 1984, Moore and Reeves 1993b). 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 majority of the western Arctic stock migrates annually from wintering areas (December to March) in the northern Bering Sea, through the Chukchi in spring (April through May), to the Beaufort Sea where they spend much of the summer (June through August) before returning again to the Bering Sea in fall (September through December) to overwinter (Allen and Angliss 2013) (see Figure 3). Fall migrating whales typically reach Cross Island in September and October, although some whales might arrive as early as late August. Some of the animals remain in the eastern Chukchi and western Beaufort seas during the summer (Ireland et al. 2009, Clarke et al. 2011c).

In the Chukchi Sea, bowheads are generally found in waters between 50 and 200 m deep (Clarke and Ferguson. 2010b). However, individuals in the Beaufort Sea appear to strongly favor shallower areas less than 50 m and preferably shallower than 20 m (Clarke and Ferguson. 2010a). Feeding appears to preferentially occur in 154-157º longitude in the Beaufort Sea (Clarke and Ferguson. 2010a). Hauser et al. (2008) conducted surveys for bowhead whales near the Colville River Delta during August and September 2008, and found most bowheads between 25 and 30 kilometers (15.5 and 18.6 miles) north of the barrier islands (Jones Islands), with the nearest in 18 meters (60 feet) of water about 25 kilometers (16 miles) north of the Colville River Delta. No bowheads were observed inside the 18-meter (60-foot) isobath.

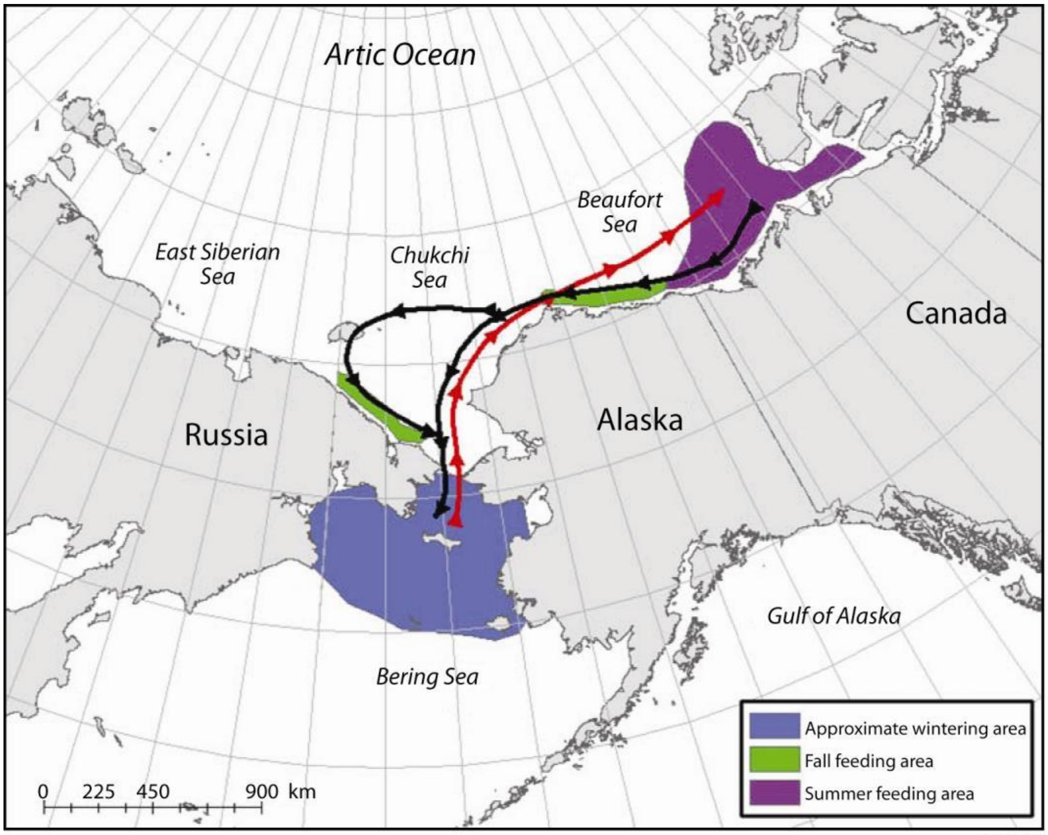

Figure 3. Generalized Migration Route, Feeding Areas, and Wintering Area for Western Arctic Bowhead Whale

Bowhead whales may be encountered during the Prudhoe Bay seismic survey during the summer season, but likely in low numbers. Historically, few bowhead whales have been recorded during the summer season close to shore (e.g., ASAMM 1979-2011 database), although this might have coincided with limited survey effort during this period. During the 2013 ASAMM aerial survey, a larger number of bowhead whales were seen in nearshore waters than would be expected based on historical data (daily flight summaries, available: http://www.afsc.noaa.gov/NMML/cetacean/bwasp). Vessel-based observers recorded one multiple species sighting of six animals, consisting of a few bowheads on August 16 near Narwhal Island during the OBC Liberty seismic survey (Aerts et al. 2008). During 2008 and 2010 aerial surveys from early July through early October, conducted as part of industrial operations in Harrison and Prudhoe Bay, only a few bowheads were seen before mid-August. None of these whales were close to shore (Funk et al. 2010a, Reiser et al. 2011). Bowhead whales were more commonly observed later in the season, but most animals were seen at distances of more than 15 mi from shore (BPXA 2014a).

In the North Atlantic Ocean, three additional populations are found in the Atlantic and Canadian Arctic in the Davis Strait and in Baffin Bay, Hudson Bay, and Foxe Basin, as well as Spitsbergen Island and the Barents Sea.

Threats to the Species

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 Alaskan subsistence harvest (1976-92), only 8 had been wounded by killer whales. Also, 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 (NWMB (Nunavut Wildlife Management Board) 2000). Most beached carcasses found in the eastern Canadian Arctic are of young bowhead whales, and they may be more vulnerable than adults 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.

ANTHROPOGENIC THREATS. Historically, bowhead whales were severely depleted by commercial harvesting, which ultimately led to the listing of bowhead whales as an endangered species in 1970 (35 FR 8495). Bowhead whales have also been targeted by subsistence whaling. Subsistence harvest is regulated by quotas set by the International Whaling Commission (IWC) and is allocated and enforced by the Alaska Eskimo Whaling Commission. Bowhead whales are harvested by Alaskan Natives in the Beaufort, Bering, and Chukchi Seas. Alaska Native subsistence hunters take approximately 0.1-0.5% of the population per annum, primarily from ten Alaska communities (Philo et al. 1993). 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. This quota includes an allowance of 5 animals to be taken by Chukotka Natives in Russia (Allen and Angliss 2013). At the end of the 2012 harvest, there were 15 strikes available for carry-forward, so the combined strike quota for 2013 is 82 (67 +15). The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2005-2009 was 39.6 bowhead whales (Allen and Angliss 2012).

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 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 2013). 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 (Allen and Angliss 2013). During the 2011 spring aerial survey of bowhead 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 five year period from 2007-2011 is 0.4; however, the overall rate is currently unknown (Allen and Angliss 2013).

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 Alaskan Inupiat 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, Richardson et al. 1995), which compromise health and reproductive performance.

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 of wild flora and fauna and the Marine Mammal Protection Act (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 Alaskan villages.

WESTERN ARCTIC. 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 (2006b) 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 (Allen and Angliss 2013).

From 1978-2011, the Western Arctic stock of bowhead whales has increased at a rate of 3.7% (95% Confidence Interval (CI) = 2.8-4.7%) during which time abundance tripled from approximately 5,000 to approximately 16,000 whales (Givens et al. 2013) Similarly, Schweder et al. (2010) estimated the yearly growth rate to be 3.2% between 1984 and 2003 using a sight-resight analysis of aerial photographs. The ice-based abundance estimate, based on surveys conducted in 2001, is 10,545 (Coefficient of Variation (CV) = 0.128) (updated from (George et al. 2004a) by (Zeh and Punt 2005)). Ten years later in 2011, the ice-based abundance estimate was 16,892 (95% CI 15,704-18,928) (Givens et al. 2013). See Table 3 for summary of population abundance estimates (Allen and Angliss 2013). Using the 2004 population estimate of 12,631 and its associated CV= 0.2442, the minimum population estimate for the Western Arctic stock of bowhead whales is 10,314 (Allen and Angliss 2013). The population may be approaching carrying capacity despite showing no sign of a slowing in the population growth rate (Brandon and Wade 2006a).

Table 3. Summary of population abundance estimates for the Western Arctic stock of bowhead whales (Allen and Angliss 2013).

Year	Abundance estimate (CV)	Year	Abundance estimate (CV)
Historical estimate	10,400-23,000	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)	2011	16,892 (0.244)

The current estimate for the rate of increase for this stock of bowhead whales is 3.2-3.4% (George et al. 2004a, Schweder et al. 2010). However, it is recommended that the cetacean maximum theoretical net productivity rate (R_{max}) of 4% be used for the Western Arctic stock of bowhead (Wade and Angliss 1997).[2]

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

The potential biological removal (PBR) for this stock is 103 animals (10,314 x 0.02 x 0.5) (see Allen and Angliss 2013). However, the IWC bowhead whale quota takes precedence over the PBR estimate for the purpose of managing the Alaska Native subsistence harvest for this stock. For 2013-2018, the IWC established a block quota of 336 landed bowheads. Because some animals are struck and lost, a strike limit of 67 (plus up to 15 previously unused strikes) could be

[2] The R_{max} value of 3.2-3.4% should not be used because the population is currently being harvested and because the population has recovered to population levels where the growth is expected to be significantly less than R_{max} (Allen and Angliss 2013).

taken each year. At the end of the 2012 harvest, there were 15 strikes available for carry-forward, so the combined strike quota for 2013 was 82 (67 +15) (Allen and Angliss 2013).

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 1993a).

NORTH ATLANTIC. The estimated abundance of the Spitsbergen stock was 24,000 prior to commercial exploitation, but currently numbers less than one hundred. The Baffin Bay-Davis Strait stock was estimated at about 11,750 prior to commercial exploitation (Woodby and Botkin 1993) and the Hudson Bay-Foxe Basin stock at about 450. The current abundance of the Baffin Bay-Davis Straight is estimated at about 350 (Zeh et al. 1993), and recovery is described as “at best, exceedingly slow” (Davis and Koski 1980). No reliable estimate exists for the Hudson Bay-Foxe Basin stock; however, Mitchell and Reeves (1981) place a conservative estimate at 100 or less. More recently, estimates of 256-284 whales have been presented for the number of whales within Foxe Basin (Cosens et al. 2006). There has been no appreciable recovery of this population.

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 1993a). 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 (BOEM 2011). 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).

Feeding and Prey Selection

Bowheads are filter feeders, filtering prey from the water through baleen. 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 or 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 (Lowry et al. 2004, Moore et al. 2010). 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. Estimated rate of consumption is 50,000 individual copepods, each weighing about 0.004 g, per minute of feeding time (BOEM 2011).

Available data indicate that Western Arctic bowhead whales feed in both the OCS of the Chukchi and Beaufort Seas 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., (Carroll et al. 1987, Ljungblad et al. 1987)). Stomach contents from bowheads harvested off St. Lawrence Island during May, and between St. Lawrence and Point Barrow during April into June also indicated it is likely that some whales feed during the spring migration (Hazard and Lowry. 1984, Carroll et al. 1987, Shelden and Rugh 1995). The stomach contents of the one bowhead harvested in the northern Bering Sea indicated that the whale had fed entirely on benthic organisms, predominantly gammarid amphipods and cumaceans (not copepods, euphausiids, or other planktonic ogranisms) (Hazard and Lowry. 1984). 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 (1993) 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. Shelden and Rugh (1995) concluded that "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 2010b). BOEM-funded Bowhead Whale Feeding Ecology Study (BWASP) surveys show areas off Kaktovik as areas that are sometimes of high use by bowhead whales (NMFS 2010a, Clarke et al. 2011a)). 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 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).

Bowhead whales feed in the Canadian Beaufort in the summer and early fall (e.g., (Würsig et al. 1989), and in the Alaskan Beaufort in late summer/early fall, (Lowry and Frost 1984, Ljungblad et al. 1986, Schell and Saupe 1993, Lowry et al. 2004, Ashjian et al. 2010, Clarke et al. 2011c, a, b, Clarke et al. 2011d, Okkonen et al. 2011, Clarke et al. 2012). 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.

Local residents report having seen a small number of bowhead whales feeding off Barrow or in the pack ice off Barrow during the summer. Bowhead whales may also occur in small numbers in the Bering and Chukchi seas during the summer (Rugh et al. 2003). Ireland et al. (2009) also reported bowhead sightings in 2006 and 2007 during summer aerial surveys in the Chukchi Sea.

The Inupiat believe that whales follow the ocean currents carrying food organisms (e.g., (Napageak 1996). 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 (MMS 2002). Some bowheads appear to feed east of Barter Island as they migrate westward (Thomson and Richardson 1987).

Diving and Social Behavior

Bowhead diving behavior is situational (Stewart 2002). Calves dive for very short periods and their mothers tend to dive less frequently and for shorter durations. Feeding dives tend to last from 3 to 12 minutes and may extend to the relatively shallow bottom in the Beaufort Sea. “Sounding” dives average between 7 and 14 minutes.

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

Bowhead whale calls might help maintain social cohesion of groups (Wursig and Clark 1993). (Würsig et al. 1989) 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.

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 Würsing 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 et al. 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).

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 2002b). Vocalization bandwidths vary. Tonal FM modulated vocalizations have a bandwidth of 25 to 1200 Hz with the dominant range between 100 and 400 Hz and lasting 0.4- 3.8 seconds. 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 seconds (Clark and Johnson 1984, Wursig and Clark 1993, Erbe 2002b).

Bowhead whales in western Greenland waters produced songs of an average source level of 185 ±2 dB rms re 1 mPa @ 1 m centered at a frequency of 444 ±48 Hz (Roulin et al. 2012). Given background noise, this allows bowheads whales an active space of 40-130 km (Roulin et al. 2012).

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 (Rexford 1997, 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.

4.3.2 Arctic Ringed Seal

Population Structure

A single Alaskan stock of ringed seal is currently recognized in U.S. waters. This stock is part of the Artic 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.

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 1958). 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 et al. 1988, Kelly et al. 2010b). 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. 2010a).

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, Kelly et al. 2010b). 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.

Threats to the Species

Current threats to Arctic ringed seals are described in detail the species' Status Review (Kelly et al. 2010b) 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 the *Environmental Baseline* section.

Predation. Polar bears are the main predator of ringed seals, but other predators include Arctic and red foxes, walruses, wolves, wolverines, killer whales, and ravens (Burns and Eley 1976, Heptner et al. 1976b, Fay et al. 1990, 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).

Parasites and Diseases. Ringed seals have co-evolved with numerous parasites and diseases, and these relationships are presumed to be stable. Since July 2011, more than 60 dead and 75 diseased seals, mostly ringed seals, have been reported in Alaska. The underlying cause of the disease remains unknown, and is under investigation. Kelly *et al.* (2010b) 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.

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. 2010b).

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. 2010b).

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. As of August 2000; the subsistence harvest database indicated that the statewide annual ringed seal subsistence harvest is 9,567 (Allen and Angliss 2013). Data on community subsistence harvests are no longer being collected and no new annual harvest estimates exist. Kelly *et al.* (2010b) concluded that although subsistence harvest of Arctic ringed seals is currently substantial in some parts of their range, harvest levels appear to be sustainable.

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 and 2009, there have been an average of 1.75 (CV=0.01) mortalities of ringed seals incidental to commercial fishing operations per year (Allen and Angliss 2013).

For indirect interactions, Kelly *et al.* (2010b) 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 et al. 1988).

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 avoid areas of ice. This necessarily mitigates many of the risks of shipping to ringed seals. 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.

Contamination. Contaminants research on Arctic ringed seals has been conducted in most parts of the subspecies' range. Pollutants such as organochlorine (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. 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.

Status

NMFS listed the Arctic ringed seals as threatened under the ESA on December 28, 2012 (77 FR 76706). Critical habitat for the Arctic ringed seal in U.S. waters will be proposed in future rulemaking.

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 for 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). However, the estimates from 1999 and 2000 in the Chukchi Sea only covered a portion of this stocks range (Allen and Angliss 2013). 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 (0.98/km^2), but did not derive abundance estimates.

As these surveys represent only a fraction of the stock's range and occurred more than a decade ago, current and reliable data on trends in population abundance for the Alaska stock of ringed seals are considered unavailable. PBR for this stock is also unknown at this time (Allen and Angliss 2013).

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.

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 4 summarizes the approximate annual timing of reproduction and molting for Arctic ringed seals.

Arctic Ringed Seals

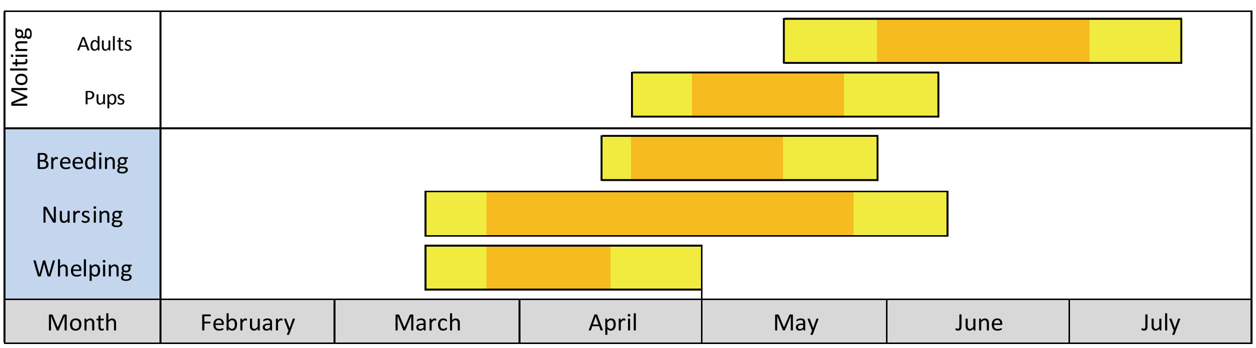

Figure 4. **Approximate annual timing of reproduction and molting for Arctic ringed seals. Yellow bars indicate the "normal" range over which each event is reported to occur and orange bars indicated the "peak" timing of each event (source: (Kelly et al. 2010b).**

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.

Ringed seal pups spend 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 and Lydersen 1991, Lydersen and Hammill 1993).

Tagging studies revealed that Arctic ringed seals are capable of diving for at least 39 minutes (Teilmann et al. 1999) and to depths of over 500 m (Born et al. 2004); however, most dives reportedly lasted less than 10 minutes 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. 2000a). 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. 2010b). 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.

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. 1995). 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. 2010b). 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. 2010b).

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). 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).

4.3.3 Beringia DPS of Bearded Seals

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. 1976a). Geographic boundaries for the divisions between the two subspecies are subject to the caveat that distinct boundaries do not appear to exist (Cameron et al. 2010). Two distinct population segments 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.

Distribution

Bearded seals are a boreoarctic species with a circumpolar distribution (Fedoseev 1965, Johnson et al. 1966, Burns 1967, Burns and Frost 1979, Frost et al. 1979, Burns 1981, Smith 1981, Kelly et al. 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. 1976a, 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. Cameron *et al.* (2010) 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 Alaskan 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. 1976a, Burns 1981).

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 *Environmental Baseline* section.

<u>Predation.</u> Polar bears are the primary predator of bearded seals. Other predators include brown bears, killer whales, sharks, and walruses (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).

<u>Parasites and Diseases</u>. 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 have been reported in Alaska. The cause of the Arctic seal disease remains unknown, and is under investigation. 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.

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. With loss of sea ice, 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.

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 1.5X 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.

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.

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 et al. 1988). Allen and Angliss (2013) reported that based on subsistence harvest data maintained by ADFG primarily for the years 1990 to 1998, the mean estimated annual harvest level in Alaska averaged 6,788 bearded seals as of August 2000 (Riewe and Amsden 1979, Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarbrough 1999, Allen and Angliss 2013). Data on community subsistence harvests are no longer being collected and no new annual harvest estimates exist (Allen and Angliss 2013). 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 and Koski 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.

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).

<u>Commercial Fisheries Interactions</u>. 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. Estimates of bearded seal bycatch could only be found for commercial fisheries that operate in Alaska waters. Between 2007 and 2009, there were incidental serious injuries and mortalities of bearded seals in the Bering Sea/Aleutian Islands Pollock trawl and the Bering Sea/Aleutian Islands flatfish trawl. The estimated minimum mortality rate incidental to commercial fisheries is 2.70 (CV= 0.21) bearded seals per year, based exclusively on observer data (Allen and Angliss 2013). For indirect impacts, Cameron *et al.* (2010) noted that commercial fisheries target a number of known bearded seal prey species, such as walleye pollock (*Theragra chalcogramma*) 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.

<u>Shipping.</u> 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 avoid areas of ice. This necessarily mitigates many of the risks of shipping to bearded seals. 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.

<u>Research.</u> Mortalities may occasionally occur incidental to marine mammal research activities authorized under the MMPA permits issued to a variety of government, academic, and other research organizations. Between 2003-2007, there was one mortality resulting from research on the Alaska stock of bearded seals, which results in an average of 0.2 mortalities per year from this stock (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, pers comm. as cited in (Allen and Angliss 2013).

<u>Contamination.</u> Research on contaminants and bearded seals is limited compared to the extensive information available for ringed seals. Pollutants such as OC compounds 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.

Oil and Gas. Within the range of the Beringia DPS, offshore oil and gas exploration and production activities are underway in the United States, Canada, and Russia. Oil and gas exploration, development, and production 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 impact bearded seals, primarily through noise, physical disturbance, and pollution, particularly in the event of an 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. 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.

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.

The precise number for the present population of the Beringia DPS is highly uncertain. 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), 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). Based on these numbers, the Alaskan stock of bearded seals is considered greater than approximately 155,000 (77 FR 76740) and may be as large as 250,000-300,000 (Popov 1976, Burns 1981).

At present, reliable data on the minimum population estimate, trends in population abundance or the maximum net productivity rate of the Alaska stock of bearded seals are unavailable (Allen and Angliss 2013). Because a reliable estimate of minimum abundance is currently not available, the PBR for this stock is unknown (Allen and Angliss 2013).

In the East Siberian Sea, sightings were rare, with sighting typically of 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).

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 (Burns 1981, Kelly et al. 1988, Reeves et al. 1992, Hjelset et al. 1999, Cameron et al. 2010). They primarily feed on or near the bottom, diving is 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. 2000b). 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, Marshall et al. 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 et al. 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.

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. 2000b, 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 6 weeks of age most pups had exceeded the maximum dive depth of lactating females (448-480 m versus 168-472 m) (Gjertz et al. 2000b). 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. 1994).

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. 1976a). From July to April, three males (2 subadults and 1 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.[3]

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 three 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. 1994, Lydersen et al. 1996, Watanabe et al. 2009). 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 h and 2100 h (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 et al. 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 et al. 1983, Atkinson 1997, Risch et al. 2007). Bearded seals are solitary throughout most of the year except for the breeding season.

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

[3] M. Cameron, Unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, as cited in (Cameron et al. 2010).

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.

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. 1995). 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.

5. 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, 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.

5.1 Stressors for Species in the Action Area

The following discussion summarizes the principal stressors that affect these endangered and threatened species.

1. Targeted Hunts

Whaling in the Alaskan Arctic and sub-arctic 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. In addition to subsistence hunting, commercial whaling occurred during the late 19th and early 20th centuries.

Historical Commercial Whaling.

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 (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.

Ringed and Bearded Seals

While substantial commercial harvest of both ringed and bearded seals in the late 19th and 20th Centuries led 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.

Subsistence Harvest.

Bowhead Whale

Alaska Natives have been taking bowhead whales for subsistence purposes for at least 2,000 years (Marquette and Bockstoce. 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 et al. (2004) summarize Alaskan subsistence harvests of bowheads from 1974 to 2003 reporting a total of 832 whales landed by hunters from 11 villages with Barrow landing the most whales (n = 418) while Little Diomede and Shaktoolik each 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%, the mean for 2000-2009 was 77% (SD=7%), and in 2010 it was 63% (Suydam et al. 2011).

For 2013-2018, the IWC established a block quota of 336 landed bowheads. Because some animals are struck and lost, a strike limit of 67 plus up to 15 previously unused strikes could be taken each year (Allen and Angliss 2013). At the end of the 2012 harvest, there were 15 strikes available for carry-forward, so the combined strike quota for 2013 was 82 (67 +15). For 2013, the U.S. received 75 strikes and Russia 7 strikes.

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. Eight whales were harvested by Russian subsistence hunters between 1999-2005 (Borodin 2005, IWC 2007). No catches were reported by either Canadian or Russian hunters for 2006-2007 (IWC 2008) or by Russia in 2009 (IWC 2010), but two bowheads were taken in Russia in 2008 (IWC 2009), and in 2010 (IWC 2011). The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2006 to 2010 was 38 bowhead whales (Allen and Angliss 2013).

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 et al. 1988).

The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. As of August 2000; the subsistence harvest database indicated that the estimated number of ringed seals harvested for subsistence use per year was 9,567. Data on community subsistence harvests are no longer being collected and no new annual harvest estimates exist (Allen and Angliss 2013). Kelly *et al.* (2010b) concluded that although subsistence harvest of Arctic ringed seals is currently substantial in some parts of their range, harvest levels appear to be sustainable.

Bearded Seal

Bearded seals are an important species for Alaska subsistence hunters, with estimated annual harvests of 1,784 (SD = 941) from 1966 to 1977 (Burns 1981). Between August 1985 and June 1986, 791 bearded seals were harvested in five villages in the Bering Strait region based on reports from the Alaska Eskimo Walrus Commission (Kelly et al. 1988).

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-Scarbrough 1999) and a report from the Eskimo Walrus Commission (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. As of August 2000; the subsistence harvest database indicated that the estimated number of bearded seals harvested for subsistence use per year is 6,788 (Allen and Angliss 2013). Data on community subsistence harvests are no longer being collected and no new annual harvest estimates exist.

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 and Koski 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 (Allen and Angliss 2013).

2. Acoustic Noise

Ambient Noise. Generally, a signal would be detectable only if it is stronger than the ambient noise at similar frequencies. The lower the intensity of ambient noise, the farther signals would travel. There are many sources of ambient noise in the ocean, including wind, waves, ice, rain, and hail; sounds produced by living organisms; 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.

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 also 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 (BOEM 2011). 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 and Moore 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 ices edge and the breaking up and rafting of ice floes (Milne and Ganton 1964).

Presence of Marine Life. At least seasonally, marine mammals can contribute to the background sounds in the acoustic environment of the Beaufort Sea. 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 µPa at 1 m (Ray et al. 1969b, Stirling 1983, Richardson et al. 1995, Thomson and Richardson 1995). Ringed seal calls have a source level of 95-130 dB re 1 µPa at 1 m, with the dominant frequency under 5 kHz (Stirling 1973, Cummings et al. 1986, 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 µPa 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.

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. 1995).

Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994, Richardson et al. 1995, NRC 1996, NRC 2000, NRC 2003, Jasny et al. 2005, NRC 2005). 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).

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

The types of vessels in the Beaufort 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. In the Beaufort and Chukchi seas, vessel traffic and associated noise presently is limited primarily to late spring, summer, and early autumn.

Shipping sounds are often at source levels of 150-190 dB re 1 μPa at 1m (BOEM 2011). Shipping traffic is mostly at frequencies from 20-300 Hz (Greene and Moore 1995). Sound produced by smaller boats typically is at a higher frequency, around 300 Hz (Greene and Moore 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 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 μPa-m. 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.

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, on-ice, and in-ice seismic surveys in the 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.

Two-dimensional (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/three-dimensional (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, Greene and Moore 1995), Hall *et al.* 1994. 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 10-250m) 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 listed cetacean species under consideration in this opinion.

Since July 2010, NMFS issued an IHA to Shell to take 8 species of marine mammals by Level B behavioral harassment incidental to conducting site clearance and shallow hazards surveys in the Beaufort Sea on August 6, 2010 (75 FR 49710; August 13, 2010). No seismic surveys were conducted in the Beaufort Sea in 2011. In 2012, NMFS issued an IHA to BP Exploration (Alaska), Inc. and ION Geophysical (ION) to take small numbers of marine mammals by harassment incidental to conducting open-water 3D OBC seismic surveys in the Simpson Lagoon of the Beaufort Sea (77 FR 40007; July 6, 2012) and in-ice 2D seismic surveys in the Beaufort and Chukchi Seas (77 FR 65060; October 24, 2012), respectively. Recently in 2013, NMFS issued a proposed rule for Shell to take small numbers of marine mammals by harassment incidental to conducting site clearance and shallow hazard surveys and equipment recovery and maintenance activities in the Chukchi Sea OCS (78 FR 28412; May 14, 2013).

Oil and gas exploration has also occurred in the eastern Beaufort Sea, off the Mackenzie River 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 2013b).

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.

Available information does not indicate that marine and seismic surveys for oil and gas exploration activities have had detectable long-term adverse population-level effects on the overall health, current status, or recovery of marine mammals in the Arctic region. For example, data indicate that the BCB bowhead whale population has continued to increase over the timeframe that oil and gas activities have occurred. There is no evidence of long-term displacement from habitat (although studies have not specifically focused on addressing this issue). Past behavioral (primarily avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. Monitoring studies indicate that most fall migrating whales avoid an area with a radius about 20 - 30 km around a seismic vessel operating in nearshore waters (Miller et al. 2005). NMFS is not aware of data that indicate that such avoidance is long-lasting after cessation of the activity (NMFS 2013a).

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 km^2 (0.004 mi^2). 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 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). 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 (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 (BOEM 2011).

Shell conducted two abbreviated exploratory drilling activities at wells in the Beaufort (77 FR 27284; May 9, 2012) and Chukchi (77 FR 27322; May 9, 2012) Seas, Alaska, during the 2012 Arctic open-water season (July through October). 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).

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, acoustic Doppler current profilers, mid-frequency sonar systems, and navigational acoustic pingers (LGL 2005, 2006). These active sonar systems emit transient sounds that vary widely in intensity and frequency (BOEM 2011).

3. Ship Strikes

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 2010c). 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.

Shipping and vessel traffic is expected to increase in the Arctic OCS if warming trends continue; however, no substantial increase in shipping and vessel traffic has occurred to date in the action area.

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 Alaskan subsistence harvest (George et al. 1994). The low number of observations of ship-strike injuries (along with the very long lifespan of these animals) suggests that bowhead whales either do not often encounter vessels or they avoid interactions with vessels.

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. Commercial Fishing Interactions

While currently no commercial fishing is authorized in the Beaufort Sea OCS, the species present in the action area may be impacted by commercial fishing interactions as they migrate through the Bering Sea to the Beaufort Sea.

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 2013).

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. NMFS 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. The average annual entanglement rate in U.S. commercial fisheries is unknown (Allen and Angliss 2013).

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, December 2, 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska.

Between 2007 and 2009, there were incidental serious injuries and mortalities of ringed seals in the Bering Sea/Aleutian Islands flatfish trawl fishery, and the Bering Sea/Aleutian Islands pollock trawl. Based on data from 2007 to 2009, there have been an average of 1.75 (CV = 0.01) mortalities of ringed seals incidental to commercial fishing operations (see **Error! Reference source not found.**) (Allen and Angliss 2013).

Table 4. Summary of incidental mortality of ringed seals (Alaska stock) due to commercial fisheries from 2007 to 2009 and calculation of the mean annual mortality rate (Allen and Angliss 2013).

Fishery name	**Years**	**Data type**	**Observer coverage**	**Observed mortality (in given yrs.)**	**Estimated mortality (in given yrs.)**	**Mean annual mortality**
Bering Sea/Aleutian Is. flatfish trawl	2007 2008 2009	obs data	72 100 100	0 2 1	0 2.0 1.0	1.00 (CV = 0.01)
Bering Sea/Aleutian Is. pollock trawl	2007 2008 2009	obs data	85 85 86	0 1 1	0 1.13 1.11	0.75 (CV = 0.23)
Total estimated annual mortality						1.75 (CV = 0.01)

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 2013).

Between 2007 and 2009, there were incidental serious injuries and mortalities of bearded seals in the Bering Sea/Aleutian Islands pollock trawl and the Bering Sea/Aleutian Islands flatfish trawl (**Error! Reference source not found.**). The estimated minimum mortality rate incidental to commercial fisheries is 2.70 (CV = 0.21) bearded seals per year, based exclusively on observer data (Allen and Angliss 2013).

Table 5. Summary of incidental mortality of bearded seals (Alaska stock) due to commercial fisheries from 2007-2009 and calculation of the mean annual mortality rate. Details of how percent observer coverage is measured is included in Allen and Angliss (Allen and Angliss 2013).

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality	Mean Annual Takes (CV in parentheses)
BSAI Pollock Trawl	2007	Obs. data	85.0	1	1.03	2.37 (CV=0.24)
	2008		85.0	4	4.65	
	2009		86.0	1	1.44	
BSAI Flatfish Trawl	2007	Obs. data	72	0	0	0.33 (CV= 0.04)
	2008		100	1	1.0	
	2009		100	0	0	
Estimated Total Annual Mortality						2.70 (CV= 0.21)

5. Pollutants and Contaminants

Authorized Discharges

Existing development in the action area provides multiple sources of contaminants that may be bioavailable (NMFS 2013b). 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. 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).

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 Clean Water Act (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.

NMFS consulted on the issuance of the new NPDES permits on April 11, 2012. NMFS concurred with the EPA's determination that the planned actions, "may affect, but are not likely to adversely affect" bowhead, fin, and humpback whales, bearded seals and ringed seals in the Beaufort Sea or Chukchi Sea area of coverage (NMFS 2012a, b).

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 1960s. 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 2013b). 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 Group 2006, 2008).

From 1971-2010 industry drilled 84 exploration wells in the entire Alaska OCS (BOEM 2011). Within 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 (BOEM 2011).

No exploratory drilling blowouts have occurred on the Alaskan OCS. 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 (BOEM 2011).

Contaminants in Bowhead Whales, Ringed Seals, and Bearded Seals

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, polychlorinated biphenyls (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. The metal levels observed in all tissues of the bowhead are similar to levels reported in the literature 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 were many times lower than that in beluga whales or northern fur seals. 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.

Ringed Seal

Contaminants research on ringed seals is extensive throughout the Arctic environment where ringed seals are an important part of the diet for coastal human communities. Pollutants such as OC compounds 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 Norton Sound than ringed seals taken by residents of Point Hope, Point Lay, and Barrow. Arsenic levels in ringed seals from Norton Sound were quite high for marine mammals, which might reflect localized natural arsenic sources.

Bearded Seal

Research on contaminants and bearded seals is limited compared to the 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 (Tynan and Demaster 1997).

6. Research

Mortalities may occur occasionally incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2003-2007, there was one mortality resulting from research of the Alaska stock of bearded seals, which results in an average of 0.2 mortalities per year from this stock. No other mortalities of listed marine mammals were reported in the 2013 stock assessment report.

7. 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 1000 years” (Walsh 2008). The changes have been sufficiently large in some areas of the 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 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).

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 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. It is generally thought that the Arctic will become ice free in summer, but at this time there is considerable uncertainty about when that will happen.

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 (Parry 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 et al. 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 in the foreseeable future. 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.

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).

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. Shelden *et al.* (2003) notes that there is a high probability that bowhead abundance will increase under a warming global climate.

5.2 Summary of Stressors Affecting Listed Species in 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 bowhead stock of the bowhead whale is showing marked recovery with numbers approaching the low end of the historic population estimates.

- 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. Subsistence harvest of Arctic ringed seals and bearded seals is currently substantial in some regions but is not considered a threat at the population level.

- 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.

- 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 ringed and bearded seals may cause some 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 organochlorine and metal contaminants in tissues of baleen whales are low, 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.

- Mortalities incidental to marine mammal research activities authorized under MMPA permits appears to be low. There was only one documented mortality resulting from research on the Alaska stock of bearded seals, which results in an average of 0.2 mortalities per year from this stock.

- 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 2013).

- 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, particularly the forecast reduced depth of snow on ice for forming birth lairs. Bearded seals 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.

6. EFFECTS OF THE ACTION

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

This biological opinion relies on the best scientific and commercial information available. We try to make note of areas of uncertainty, or situations where data is not available. In analyzing the effects of the action, NMFS gives the benefit of the doubt to the listed species by minimizing the likelihood of false negative conclusions (concluding that adverse effects are not likely when such effects are, in fact, likely to occur).

We organize our effects analyses using a stressor identification – exposure – response – risk assessment framework for the proposed exploration activities. Then we provide a description of the potential effects that could arise from BPXA's proposed activity.

We conclude this section with an *Integration and Synthesis of Effects* that integrates information presented in the *Status of the Species* and *Environmental Baseline* sections of this opinion with the results of our exposure and response analyses to estimate the probable risks the proposed action poses to endangered and threatened species.

The ESA does not define "harassment" nor has NMFS defined this term, pursuant to the ESA, through regulation. The MMPA defines "harassment" as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild" or "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." The latter portion of these definitions (that is, "...causing disruption of behavioral patterns including…migration, breathing, nursing, breeding, feeding, or sheltering") is almost identical to USFWS's definition of harass[4] for the purposes of the ESA. For the purposes of this consultation, "harassment" is defined such that it corresponds to the MMPA and USFWS's definitions.

6.1 Project Stressors

Seismic surveys have been conducted in the Chukchi and Beaufort Seas since the late 1960s and early 1970s, resulting in extensive coverage over the area. PR1 has issued incidental harassment authorizations to the oil and gas industry for the non-lethal taking of small numbers of marine mammals related to seismic surveys since the early 1990s. The seismic surveys BPXA plans to conduct during the open water season in 2014 are similar to the data acquisition programs conducted in the Beaufort Sea by Shell beginning in 2006, BP beginning in 2008, and ION Geophysical beginning in 2012. Thus, the potential stressors associated with the activities PR1 may authorize have occurred previously in the action area.

During our assessment, we considered several potential stressors associated with the proposed

[4] An intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding feeding, or sheltering (50 CFR 17.3).

action. Magnetometers are not considered a stressor to NMFS's ESA-listed species because the magnetometer measures changes in magnetic fields over the seabed and does not produce sounds, and thus will not expose marine species (BPXA 2014a). Based on our review of the data available, 2D geohazard seismic surveys, sonar operations, and vessel activities may cause these primary stressors:

1. continuous sound fields produced by the source vessel;

2. pulsed sounds from 2D geohazard seismic surveys, echosounder, sidescan sonar, and subbottom profiler; and

3. risk of collisions associated with proximity to the source vessel involved in those exploration activities.

6.2 Exposure Analysis

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent.

6.2.1 Exposure to Active Seismic Surveys

Noise sources from the proposed action include: seismic survey equipment (30,20,10, and 5 cui airgun arrays), sonar devices (multi-beam echosounder, sidescan sonar, and subbottom profiler), and source vessel associated with these surveys (see Table 1for full list). All of the source types have operated in the Beaufort Sea environment for commercial oil and gas exploration projects since 2006 (NMFS 2013b). Most of these projects operated under IHAs that required acoustic measurements of underwater noise sources, and the results are cataloged in a series of monitoring reports submitted to NMFS (Austin and Laurinolli 2007, Blackwell 2007, MacGillivray and Hannay 2007, Aerts et al. 2008, Warner et al. 2008, Hannay et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Chorney et al. 2011, Warner and McCrodan 2011, Beland et al. 2013). The reports dating back to 2006 are publicly available on NMFS' ITA website: http://www.nmfs.noaa.gov/pr/permits/incidental.htm.

Airgun arrays are the most common source of seismic survey noise. For the proposed action, airguns will be operating during the open-water season (approximately July 15 through August 25).

Mitigation Measures to Minimize the Likelihood of Exposure to Active Seismic

Mitigation measures are described in detail in Sections 2.1.2 and 2.1.3. The following mitigation measures will be required through the MMPA permitting process to reduce the adverse effects of seismic exposure on marine mammals from the proposed oil and gas exploration activities.

1. Two PSOs are required on the seismic vessel during each 12-hour shift, and will implement mitigation measures and record marine mammal observations.

2. Establishment of radii associated with received sound level thresholds for 180 dB shutdown/power down for cetaceans and 190 dB shutdown/power down for pinnipeds under NMFS authority.

3. Use of start-up and ramp-up procedures for airgun arrays.

Approach to Estimating Exposures to Active Seismic

We relied on exposure estimates provided by BPXA in its IHA application (BPXA 2014a), and PR1 in their initiation of consultation (NMFS 2014a). The narratives that follow present the approach BPXA and PR1 used to estimate the number of marine mammals that might be exposed to certain sound levels and therefore "taken" during seismic activities PR1 plans to permit (which is described in the *Proposed Action* section of this opinion).

The instances of exposure for bowhead whales to received levels of pulsed sound ≥160 dB rms were estimated by multiplying:

- the expected bowhead density in summer;
- the anticipated average area to be ensonified to the specified levels based on existing sound source verification measurements of similar airgun arrays in similar environments and;
- the estimated number of 24-hr days that the source vessels are operating

The instances of exposure for ringed and bearded seals to received levels of pulsed sound ≥160 dB rms were estimated by multiplying:

- that expected species specific sighting rate; and
- the total number of hours that each source vessel will be operating during the data acquisition period

Anticipated Densities of Listed Species in the Beaufort Sea

Assumptions taken into account when determining marine mammal density estimates:

- Data acquisition of the proposed seismic survey will take place only in summer, so BPXA estimated only summer densities.

- If ice cover within or close to the seismic survey area is more than approximately 10%, seismic survey activities will not start or will be halted. Therefore densities related to ice conditions are not included in this consultation.

- Taking into account the shallow water operations of the proposed seismic survey area, and the associated area of influence, BPXA used data from the nearshore zone of the Beaufort Sea for calculation of densities (if available).

- Due to uncertainties in temporal and spatial variation, correction factors, and availability bias, the maximum density estimates were used in calculating potential exposures.

- Because survey effort in kilometers was only reported for one of the four shallow water OBC surveys in the Beaufort, BPXA used sighting rate (ind/h) for calculating potential seal exposures. No distinction is made in seal density between summer and autumn season. Also, no correction factors have been applied to the reported seal sighting rates.

Bowhead Whale Density Estimates

To estimate summer bowhead whale densities, BPXA used data from the 2012 and 2013 ASAMM aerial surveys flown in the Beaufort Sea ((Clarke et al. 2013); www.asfc.noaa.gov/nmml/). The 1979–2011 ASAMM database contains only one on-transect bowhead whale sighting during July and August (in 2011), likely due to the limited summer survey effort. In contrast, the 2012 and 2013 surveys include substantial effort during the summer season and are thus considered to be the best available data, even though the 2013 daily flight summaries have not undergone post-season QA/QC.

To estimate the density of bowhead whales in the Foggy Island Bay area, BPXA used the 2012 on-transect bowhead sighting and effort data from surveys flown in July and August in block 1 (Table 4 in (Clarke et al. 2013)). In addition, BPXA used the on-transect bowhead sighting and effort data of the 2013 survey, as reported in the daily flight summaries. BPXA intended to only select flights that covered block 1. However, in many cases the aerial surveys flown in block 1 also covered blocks 2 and 10, which were much farther from shore. Because it was difficult to determine the survey effort specific to block 1 from the available information, BPXA included the sighting and effort data from block 2 and 10 in the calculations (Table 6). To convert the number of individuals per line transect (ind/km) to a density per area (ind/km2), BPXA used the effective strip width of 1.15 km for bowheads, calculated from 2008-2012 aerial survey data flown with the Commander aircraft (M. Ferguson, NMML, pers. comm., 30 Oct 2013) (BPXA 2014a).

Table 6. Summary of bowhead sightings and effort data from 2012 and 2013 ASAMM aerial surveys flown in July and August in the Beaufort Sea (BPXA 2014a).

Year	Effort (ind/km)	NR. Ind	Ind/Km	Ind/Km^2
2012	1493	5	0.0033	0.0015
2013	3973	88	0.0221	0.0096
			Average	0.0055
			Maximum	0.0096
			Minimum	0.0015

BPXA used the minimum density estimate from Table 6 (0.0015) as their average density. The reason for this decision is that the 2012 data only covered block 1 and were considered more representative. To derive a maximum estimated number of exposures, BPXA used the average densities from Table 6 (0.0055). BPXA considered this approach reasonable because the 2013 bowhead whale sightings data included areas outside the exposure zone of the proposed project (BPXA 2013a). PR1 concurred with this approach. Table 7 summarizes the densities used in the calculation of potential exposures.

Seal Density Estimates

Ice seals of the Beaufort Sea are mostly associated with sea ice, and most census methods count seals when they are hauled out on the ice. To account for the proportion of animals present but not hauled out (availability bias) or seals present on the ice but missed (detection bias), a correction factor should be applied to the "raw" counts. This correction factor is dependent on the behavior of each species. To estimate what proportion of ringed seals were generally visible resting on the sea ice, radio tags were placed on seals during spring 1999-2003 (Kelly et al. 2006a). The probability that seals were visible, derived from the satellite data, was applied to seal abundance data from past aerial surveys and indicated that the proportion of seals visible varied from less than 0.4 to more than 0.75 between survey years. The environmental factors that are important in explaining the availability of seals to be counted were found to be time of day, date, wind speed, air temperature, and days from snow melt (Kelly et al. 2006a). Besides the uncertainty in the correction factor, using counts of basking seals from spring surveys to predict seal abundance in the open-water period is further complicated by the fact that seal movements differ substantially between these two seasons. Data from nine ringed seals that were tracked from one subnivean period (early winter through mid-May or early June) to the next showed that ringed seals covered large distances during the open-water foraging period (Kelly et al. 2006b). Ringed seals tagged in 2011 close to Barrow also show long distances traveled during the open-water season (Herreman et al. 2012).

To estimate densities for ringed and bearded seals, BPXA used data collected during four shallow water OBC seismic surveys in the Beaufort Sea (Harris et al. 2001, Aerts and Richardson 2008, Hauser et al. 2008, BPXA 2014a). Habitat and survey specifics are very similar to the proposed survey; therefore, these data were considered to be more representative than basking seal densities from spring aerial survey data (e.g., (Frost et al. 2002, Moulton and Lawson 2002, Frost et al. 2004). NMFS PR1 agreed that these data are likely more representative and appropriate for use. However, since these data were not collected during surveys designed to determine abundance, NMFS PR1 used the maximum estimates for the proposed number of takes in this proposed IHA.

Because survey effort in kilometers was only reported for one of the surveys, BPXA used sighting rate (ind/h) for calculating potential seal exposures. No distinction is made in seal density between summer and autumn season. Also, no correction factors have been applied to the reported seal sighting rates.

<u>Seal species ratios:</u> During the 1996 OBC survey, 92% of all seal species identified were ringed

seals, 7% bearded seals and 1% spotted seals (Harris et al. 2001). Based on the number of identified individuals the ratio ringed, bearded, and spotted seal was 75%, 8%, and 17%, respectively in Foggy Island Bay(Aerts and Richardson 2008), 22%, 39%, and 39%, respectively at Oliktok Point (Hauser et al. 2008), and 62%, 15%, and 23%, respectively in Simpson Lagoon (BPXA 2013b). Because it is often difficult to identify seals to species, a large proportion of seal sightings were unidentified in all four OBC surveys described here. The total seal sighting rate was therefore used to calculate densities for each species, using the average ratio over all four surveys for ringed, bearded, and spotted seals, i.e., 63% ringed, 17% bearded, and 20% spotted seals.

<u>Seal sighting rates:</u> During the 1996 OBC survey (Harris et al. 2001) the sighting rate for all seals during periods when airguns were not operating was 0.63 ind/h. The sighting rate during non-seismic periods was 0.046 ind/h for the survey in Foggy Island Bay, just east of Prudhoe Bay (Aerts and Richardson 2008). The OBC survey that took place at Oliktok Point recorded 0.0674 ind/h when airguns were not operating (Hauser et al. 2008), and the maximum sighting rate during the Simpson Lagoon OBC seismic survey was 0.030 ind/h (BPXA 2013b).

The average seal sighting rate, based on these four surveys, was 0.193 ind/h. The maximum was 0.63 ind/h and the minimum 0.03 ind/h. Using the proportion of ringed and bearded seals as mentioned above, BPXA estimated the average and maximum sighting rates (ind/h) for each of the ESA-listed seal species (see Table 7).

Table 7. Estimated summer densities of whales and sightings rate of seals (average and maximum) for the proposed Foggy Island Bay survey (BPXA 2014a).

Species	**Summer Densities (ind/km^2)**	
	Average	**Maximum**
Bowhead whale	0.0015	0.0055
	Summer Sighting Rates (ind/hr)	
	Average	**Maximum**
Ringed seal	0.122	0.397
Bearded seal	0.033	0.107

Anticipated Area Ensonified to Specified Levels from Noise Sources Associated with the Proposed Action

2D Seismic Surveys

The area of water (in km^2) to be ensonified to ≥160 dB re 1 μPa (rms) (see Table 9) was determined based on the average distance to 160 dB isopleth as determined from the previous sound source verification measurements from similar sized airgun arrays in similar environments (see Table 8) (BPXA 2014a).

BPXA used the average distance of the combined 20-40 cui sound source measurements to determine their anticipated ensonified areas to various isopleths. Although the discharge volumes of the proposed subarray (30 cui) are different than the airgun arrays measured before, the acoustic properties are very similar due to the airgun configuration (number of guns and sizes) (see Table 8). BPXA and PR1 considered the distances derived from the existing airgun arrays as summarized in Table 8 representative for the proposed 30 cui arrays.

Table 8. Distances (in meters) to four received rms SPLs (in dB re 1 μPa) calculated from existing SSV measurements of airgun arrays with discharge volumes of 20-40 and 10 in^3 (BPXA 2014a).

Airgun Discharge Volume (in^3)		190 dB re 1 μPa	180 dB re 1 μPa	160 dB re 1 μPa	120 dB re 1 μPa
20-40 in^3	**AVG**	**58**	**160**	**944**	**6,423**
(n=7)	MAX	138	293	1,602	12,000
	MIN	6	67	640	2,300
5 in^3	**AVG**	**16**	**45**	**451**	**10,783**
(n=4)	MAX	53	120	600	16,000
	MIN	3	20	280	5,000

The area expected to be ensonified by the 30 cui array was determined based on the average distance to the 160 dB re 1 μPa (rms) sound pressure level as determined from the average 20-40 cui array measurements (Table 8), rounded up to the nearest 100 m.[5] For example based on a radius of 944 m, rounded up to the nearest 100 m (1,000 m) the ensonified area for the 160dB isopleth is anticipated to be 3.14 km^2 (see Table 9).

Table 9. Ensonified area estimates associated with various received sound levels from 30 cui airgun array during BPXA's 2014 anticipated summer 2D seismic geohazard surveys (ensonified area is provided in km^2) (BPXA 2014a).

Sound Source		190	180	160	120
30 cui Airgun	Ensonified Area (km^2)	0.015	0.126	3.14	153.86

Estimated Number of 24-hr Days and Number of Hours of Airgun Operation

The estimated number of 24-hr days of airgun operations is 7.5 days (180 hours), not including

[5] The distance (in meters) to be used for monitoring and mitigation purposes for the proposed 30 cui airgun array is 70m for 190dB re 1μPa, 200m for 180 dB re 1 μPa, and 1000m for 160 dB re 1 μPa. These distances were used to calculate the anticipated ensonified area shown in Table 9.

potential downtime related to weather, equipment maintenance, mitigation implementation, or other circumstances.

Results of Exposure Analysis (Seismic Surveys)

The estimated instances of exposure (see Table 10) are likely overestimates for the following reasons (BPXA 2014a):

- The estimates assume that marine mammals would not show localized avoidance of seismic or vessel noise;
- Exposure estimates include a multiplier for the estimated number of 24-hr days that source vessels are operating (7.5 days), and does not include potential downtime. This takes into account that different whales may be migrating through the area during seismic operaitons;
- Mitigation measures will be employed if any marine mammal is sighted within or near the designated exclusion zone, and will result in the shut down or power down of seismic operations (see Sections 2.1.2 and 2.1.3).
- If exposure estimates indicated a fraction of an exposure, we rounded up to the nearest single exposure.

BPXA and PR1 estimated bowhead whales, ringed seals and bearded seals might be exposed to received levels ≥160 dB (rms) from seismic operations during the 2014 open-water season (**Error! Reference source not found.**). Estimates assume the full 30 cui array is operating on all survey lines and the single mitigation airgun is operating on turns and transits between survey lines. Received levels of seismic source sounds are expressed in dB re 1 µPa (rms). Estimates include exposures anticipated in the Beaufort Sea (BPXA 2014a).

Table 10. Potential instances of exposure of listed marine mammals to received sound levels ≥160 dB 1 µPa (rms) to airgun pulses during BPXA's planned 2D seismic geohazard surveys in Foggy Island Bay. The range of exposures represent the average vs. the maximum number of exposures that are anticipated to occur (BPXA 2014a).

Species	Estimated Instances of Exposure to ≥160 dB	
	AVG	MAX
Bowhead Whale	0.04	0.13[6]
Bearded Seal	6	19
Ringed Seal	22	71

These numbers represent the total potential instances of exposure to marine mammals from pulsed sound associated with seismic airgun use during BPXA's 2014 2D geohazard surveys.

[6] Since we cannot have a fraction of an instance of exposure, we will round this exposure up to a single instance of exposure in order to be precautionary.

We used the exposures estimates as a proxy for the number of instances in which whales and pinnipeds might be exposed to energy accumulations equivalent to a particular exposure level (which we call the estimated instances of exposure). To accumulate energy, we had to assume that a single animal was exposed multiple times as they moved through sound fields generated by a survey and that the time interval between subsequent exposures was small enough for animals not to recover from earlier exposures. Using bowhead whales as an example, the exposures listed in Table 11, mean that we might expect on average .04 instances and a maximum of 0.13 instances in which bowhead whales would be exposed to energy equivalent to a single one-second exposure between 160 and 180 dB (which we define as an "instance of exposure"). However, we recognize we cannot have a partial instance of exposure. In order to be precautionary we will round a fraction of exposure up to a single instance of exposure. The data we would need to estimate the number of times individual whales are likely to be exposed are unavailable. By focusing on "instances of exposure" rather than "number of individuals exposed," we do not need to make any assumptions about the number of times an individual whale might be exposed.

In the *Response Analysis* (Section 6.3) we will discuss what (if any) instances of exposures are assumed to constitute a "take" as defined under the ESA.

6.2.2 Exposure to Vessel Noise

Mitigation Measures to Minimize the Likelihood of Exposure to Vessel Noise

Mitigation measures are described in detail in Sections 2.1.2 and 2.1.3. The following mitigation measures will be implemented through the MMPA permitting process to reduce the adverse effects of other acoustic sources on marine mammals from the proposed 2D seismic geohazard activities.

1. Two PSOs are required on the seismic vessel during each 12-hour shift, and will implement mitigation measures and record marine mammal observations.
2. Avoid concentrations or groups of whales by all vessels under the direction of BPXA.

3. BPXA will reduce speed to less than 10 knots in the presence of feeding whales.

4. Avoid multiple changes in direction and speed when within 900 ft of whales.

Approach to Estimating Exposures to Vessel Noise

BPXA is only proposing to use one vessel for their 2D geohazard survey. The noise associated with vessel operation is considered a continuous noise source.

Aerts et al. (2008) found the seismic source vessel to have a source level of approximately 179 dB re 1 μPa, while the housing vessel produced the loudest propeller noise of all the vessels in the fleet (200.1 dB re 1 μPa). While BPXA is not anticipating using a housing vessel for their operations, we will use this source level for our estimates in order to be precautionary (see Table

1).

Similar to the approach BPXA used to estimate the potential instances of exposure to marine mammals associated with 2D seismic geohazard surveys, the instances of exposure for each listed species to received levels of continuous sound associated with vessel noise ≥120 dB rms were estimated by multiplying:

- the anticipated area to be ensonified to the specified levels, by
- that expected species density (bowhead) or sightings rate (pinnipeds)

Anticipated Area Ensonified to Specified Levels from Vessel Operation

Vessel operations in the shallower coastal areas of the Beaufort Sea produce smaller noise footprints due to reduced low frequency sound propagation in shallower water. Acoustic measurements of 10 vessels, including source vessels, crew-change/support vessels, bowpickers, recorder vessel, and housing vessel, were made in 6 m water depth during the LGL 2008 OBC project (Aerts et al. 2008). Their 120 dB re 1 µPa threshold distances ranged from 56 m, for a bow picker vessel to 176 m for a housing vessel (Aerts et al. 2008). BPXA is not proposing to use a housing vessel. However, using the loudest vessel from (Aerts et al. 2008) will provide a conservative estimate for noise associated with vessels. We estimated that a circle with a radius of 176 m results in an estimated area of 0.097 km^2 (.037 mi^2) that may be exposed to continuous sounds ≥120 dB rms (Table 11).

Table 11. Ensonified area estimates associated with various received sound levels for vessel noise during BPXA's 2014 2D geohazard seismic activities (ensonified area provided in km^2) (Aerts et al. 2008).

Sound Source		140	130	120
Vessel Noise	Ensonified Area (km^2)	0.008	0.027	0.097

Expected Densities and Sightings Rate of Listed Species in the Beaufort Sea

The anticipated densities and sightings rates of listed species are the same as those listed in Table 7 above (see Section 6.2.1).

Results of Exposure Analysis (Vessel Noise)

We anticipate that noise associated with vessel operations would drop to 120 dB within 176 m (or less) of the vessel(Aerts et al. 2008). Even if we assume that the seismic source vessel will produce as much noise as a housing vessel (which is not anticipated), and multiply by the maximum density (bowhead) and sightings rate (ringed and bearded seals), the estimated number of marine mammal exposures that could be ensonified by vessel noise was zero due to the small anticipated area ensonified to received levels ≥120 dB (rms).

6.2.3 Exposure to Other Noise Sources

Additional impulsive noise sources associated with the proposed action include noise from: multibeam echosounder, sidescan sonar, and subbottom profiler for BPXA's phase 2 sonar surveys. Sound associated with these sources is anticipated to be in short pulses with narrow beams and at high frequencies (BPXA 2014a).

Mitigation Measures to Minimize the Likelihood of Exposure to Other Noise Sources

Mitigation measures are described in detail in Sections 2.1.2 and 2.1.3. We anticipate that the following mitigation measures will be implemented through the MMPA permitting process to reduce the adverse effects of other acoustic sources on marine mammals from the proposed 2D seismic activities.

1. Two PSOs are required on the seismic vessel that may result in an incidental take through acoustic exposures.

Approach to Estimating Exposures to Other Noise Sources

A multibeam echosounder and sidescan sonar will be used to obtain high accuracy information regarding bathymetry and isonification of the seafloor. The proposed multibeam echosounder operates at rms source level of approximately 220 dB re 1 μPa at 1m, and a frequency range of 200 kHz to 400 kHz. The maximum ping rate of the multibeam echosounder is 60 Hz (see Table 1).

The proposed sidescan sonar system will operate at about 100 kHz (120 kHz to 135 kHz) and 400 kHz (400 kHz to 450 kHz). The estimated rms source level is approximately 215 dB re 1μPa at 1m (Table 1). The sound energy is emitted in a narrow fan-shaped pattern, with a horizontal beam width of 1.5 degrees for 100 kHz and 0.4 degrees at 400 kHz, with a vertical beam height of 50 degrees. The maximum ping rate of the sidescan sonar is 30 Hz (BPXA 2014a).

The subbottom profiler operates at a frequency of 2-16 kHz with a source level of 216 dB re 1μPa. Section 2.1.1.3 describes each of these sound sources, with source levels and frequency ranges, in more detail.

Similar to the approach BPXA used to estimate the potential instances of exposure to marine mammals associated with 2D geohazard seismic surveys, the instances of exposure for each listed species to received levels of impulsive sound associated with echosounder, sidescan sonar, and subbottom profiler operations to ≥160 dB rms were estimated by multiplying: the anticipated area to be ensonified to the specified levels (see Table 12), by that expected species density (bowhead whales) or sightings rate (ringed and bearded seals) (see Table 7).

Anticipated Area Ensonified to Specified Levels from Other Noise Sources Associated with the Proposed Action

Table 12. Ensonified area estimates associated with various received sound levels for other noise sources during BPXA's 2014 seismic operations (ensonified area provided in km^2)(Hartin et al. 2011, BPXA 2014a).

Sound Source		**190**	**180**	**160**	**120**
Multibeam Echosounder	Ensonified Area (km^2)	-	-	-	.342
Sidescan Sonar	Ensonified Area (km^2)	0.002	0.007	0.166	81.7
Subbottom Profiler	Ensonified Area (km^2)	-	-	0.003	0.636

Expected Densities and Sightings Rate of Listed Species in the Beaufort Sea

The anticipated densities and sightings rate of listed species are the same as those listed in Table 7 above (see Section 6.2.1).

Results of Exposure Analysis (Other Noise Sources)

Both the echosounder and sidescan sonar devices operate at frequency ranges (120-450 kHz) that are anticipated to be outside the hearing range of low frequency cetaceans like bowhead (7-22 kHz) and pinnipeds like ringed and bearded seals (75Hz-75kHz). Underwater sound propagation from the multibeam echosounder is anticipated to drop to 150 dB within 27 m (or less), and the sidescan sonar's underwater propagation is anticipated to drop to 160 dB within 230 m (or less) of the vessel (Hartin et al. 2011). In addition, both devices produce a narrow beam in the fore-aft extent and wider in the cross-track extent. Any given marine mammal at depth near the track line would be in the main beam for only a fraction of a second, and are unlikely to be subjected to repeated pulses)(Hartin et al. 2011). The beam is narrowest closest to the sources, further reducing the likelihood of exposure to marine mammals.

The subbottom profiler operates at a frequency range of 2-16 kHz and is anticipated to be within the hearing range of both bowhead whales (7-22 kHz) and ringed and bearded seals (75Hz-75 kHz). The subbottom profiler's beam is directed downward and underwater sound propagation is anticipated to drop to 160 dB within 30 m (or less) of the vessel (Hartin et al. 2011). Kremser *et al.* (2005) noted that the probability of a cetacean swimming though the areas of exposure when a bottom profiler emits a ping is small. If an animal were in the area, it would have to pass the transducer at close range.

Given the directionality, short pulse duration, and small beam widths for multibeam echosounders, sidescan sonar, and subbottom profilers; it is not anticipated that baleen whales or pinnipeds would be exposed to these sources. If exposed, whales and seals would not be anticipated to be in the direct sound field for more than one to two pulses (NMFS 2013b). Based on the information provided, most of the energy created by these potential sources is outside the estimated hearing range of baleen whales, and pinnipeds generally (Southall et al. 2007), and the energy that is within hearing range is high frequency, and as such is only expected to be audible in very close proximity to the mobile source. As previously mentioned, we do not anticipate these sources to be operating in isolation, and expect co-occurrence with other acoustic sources including airguns. Many whales and seals would move away in response to the approaching airgun noise or the vessel noise before they would be in close enough range for there to be exposure to the non-airgun related sources (NMFS 2013b). In the case of whales and seals that do not avoid the approaching vessel and its various sound sources, mitigation measures that would be applied to minimize effects of seismic sources (see Section 6.2.1) would further reduce or eliminate any potential effect from non-airgun acoustic sources.

Based on the information provided by BPXA there is the potential for a few exposures to ringed at bearded seals at low received levels (≤ 120dB) from sidescan sonar.[7] No exposures are anticipated to occur at received levels ≥160 dB. In addition, if marine mammals are exposed, noise levels are anticipated to be outside the hearing range of pinnipeds, and they are not likely to respond to that exposure as described in the Response Analysis below. No exposures to multi-beam echosounder or subbottom profiler operations are anticipated.

All of these factors reduce the probability of bowhead whales being exposed to sound fields associated with echosounders, sidescan sonar, and subbottom profiler sources to levels that we would consider discountable,[8] and reduce to probability of exposure to ringed seals and bearded seals to levels that we would consider insignificant.[9]

6.2.4 Exposure to Vessel Strike

Mitigation Measures to Minimize the Likelihood of Exposure to Vessel Strike

Mitigation measures are described in detail in Sections 2.1.2 and 2.1.3. The following mitigation measures will be implemented through the MMPA permitting process to reduce the potential for vessel strike on marine mammals from the proposed action.

1. PSOs required on all seismic source vessels;

[7] We would anticipate 32 instances of exposure to ringed seals, and 9 instances of exposure to bearded seals from sidescan sonar operations based on the anticipated ensonified area out to the 120 dB isopleth and sightings rates for these species in the area.
[8] Discountable effects are those extremely unlikely to occur. Exposures to bowhead whales are not anticipated to occur based on the small ensonified area associated with these impulsive sources and the low density of bowhead anticipated to be in the area. In addition, if exposures were to occur in association with echosounder or sidescan sonar devices, we would not anticipate a response because noise is outside the anticipated hearing range of bowhead whales.
[9] Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. In this situation, exposures may occur to a few pinnipeds at ≤120 dB, but at received levels far below what would be considered "take" as defined under the ESA (≥160 dB).

2. Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals;

3. Check waters immediately adjacent to vessels with propellers to ensure that no marine mammals will be injured;

4. Avoid concentrations of group of whales and not operating vessels in a way that separates members of a group;

5. Reduce vessel speeds to less than 10 knots in presence of feeding whales; and

6. Avoid multiple changes in direction and speed when within 900 ft of whales.

Approach to Estimating Exposures to Vessel Strike

The activities PR1 proposes to authorize for BPXA's 2014 2D geohazard surveys in the Beaufort Sea could increase the risk of exposure between vessels and marine mammals.

Assumptions of vessel operations related to 2D seismic activities in the Beaufort Sea are as follows:

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

- The vessel will be transported to the North Slope by truck.

- The maximum number of vessels associated with the proposed action is anticipated to be one vessel for 2D seismic and sonar surveys.

- Timing of seismic operations would commence on or after approximately July 1 and end by August 25, 2014, depending on weather. Demobilization of equipment and support crew will be completed by the end of September.

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). Vessels transiting at speeds >10 knots present the greatest potential hazard of collisions (Jensen and Silber 2004, Silber et al. 2009). Most lethal and severe injuries resulting from ship strikes have occurred from vessels travelling at 14 knots or greater (Laist et al. 2001).

While most seismic survey operations occur at relatively low speeds (1-5 knots), large vessels are capable of transiting up to 20 knots and operate in periods of darkness and poor visibility

(BOEM 2011). In addition, large vessels when traveling cannot perform abrupt turns and cannot slow speeds over short distances to react to encounters with marine mammals (BOEM 2011). All of these factors increase the risk of collisions with marine mammals (BOEM 2011).

Bowhead Whale Exposure

Available information indicates that vessel strikes of whales in the region are low and there is no indication that strikes will become a major source of injury or mortality in the action area (BOEM 2011).

Vessels will primarily transit during seismic operations (~July 15-August 25). While most bowhead whales occur farther offshore during July or August, some animals have been observed in nearshore areas in the past few years (Clarke et al. 2013), and there is the potential for overlap with vessels.

Several behavioral factors of bowhead whales help determine whether transiting vessels may be able to detect the species or whether bowhead would be at depths to avoid potential collision. Bowhead whales typically spend a high proportion of time on or near the ocean floor when feeding. Even when traveling, bowhead whales visit the bottom on a regular basis (Quakenbush et al. 2010). Bowhead foraging dives are twice as long as most fin and humpback whales, even at equivalent depths, their dives are followed by shorter recovery times at the surface (Krutzikowsky and Mate 2000). This behavior may make bowhead whales less likely to encounter a vessel transiting in the action area, and lowers their likelihood of colliding with such vessels. However, calves have shorter dive duration, surface duration, and blow intervals than their mothers (BOEM 2011), which put them at a higher risk of ship strike. Bowhead whale neonates have been reported in the Arctic as early as March and as late as early August (BOEM 2011). Most bowhead whales show strong avoidance reactions to approaching ships which may help them avoid collisions with vessels (NMFS 2013b). However, Alaska Native hunters report that bowheads are less sensitive to approaching boats when they are feeding (George et al. 1994), leaving them more vulnerable to vessel collisions. In addition, bowhead whales are also among the slowest moving of whales, which may make them particularly susceptible to ship strikes if they happen to be on the surface when a vessel is transiting. The low number of observed ship-strike injuries suggests that bowhead whales either do not often encounter vessels or they avoid interactions with vessels.

For bowhead whales, there were no records found of whales killed by ship strike in the Arctic. However, George *et al.* (1994) reported propeller scars on 2 of the 236 (0.8%) bowhead whales landed by Alaska Native whalers between 1976 and 1992. Even if vessel-related deaths were several times greater than observed levels of propeller scars, it would still be a small fraction of the total bowhead population (Laist et al. 2001). Bowhead whales are long lived and scars could have been from decades prior to the whale being harvested.

Vessels would have a transitory and short-term presence in any specific location. NMFS is not able to quantify existing traffic conditions across the entire Beaufort Sea to provide context for the addition of a single vessel. However, the rarity of collisions involving vessels and listed marine mammals in the Arctic despite decades of spatial and temporal overlap suggests that the probability of collision is low.

Based on the single vessel associated with the proposed activities in the Beaufort, the limited number of sightings of bowhead whales in the nearshore area during the survey time, and the decades of spatial and temporal overlap that have not resulted in a known vessel strike or mortality from vessel strike in the Beaufort, Chukchi or Bering Seas, we conclude that the probability of a BPXA vessel striking an endangered bowhead whale in the Beaufort Sea is sufficiently small as to be discountable.

Pinniped Exposure (ringed and bearded seals)

Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities and their reactions have been recorded by PSOs on board source vessels and monitoring vessels. These data indicate that seals tend to avoid on-coming vessels and active seismic arrays (NMFS 2013b). Available information indicates that vessel strikes of seals in the region are low and there is no indication that strikes will become a significant source of injury or mortality (BOEM 2011).

Ringed seals are year-round residents in the Beaufort Sea, and are anticipated to be in the action area during any time seismic activities may occur. Bearded seals spend the summer and early fall at the southern edge of the Chukchi and Beaufort Sea pack ice and at the wide fragmented margin of multi-year ice (Burns 1981, Nelson et al. 1984), and are anticipated to overlap with seismic activities and vessel operations associated with the proposed action but in lower numbers than ringed seals.

During the open water foraging period for ringed seals there is a possibility that vessels could strike seals (BOEM 2011). Seals that closely approach larger vessels also have some potential to be drawn into bow-thrusters or ducted propellers (BOEM 2011). 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 (BOEM 2011). To date, no similar incidents such as these have been documented in Alaska (BOEM 2011). Sternfield (2004) documented a single spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike. There have been no incidents of ship strike with bearded or ringed seals documented in Alaska (BOEM 2011) despite the fact that PSOs routinely sight bearded and ringed seals during oil and gas exploration activities.

Ringed seals have routinely been observed during previous seismic surveys in this region and time period (e.g., (Aerts et al. 2008, Funk et al. 2008, Savarese et al. 2010, Reiser et al. 2011), during monitoring from Northstar Island (e.g., (Aerts and Richardson 2008, Aerts 2009, 2010) and during aerial surveys flown for bowhead whales (Clarke et al. 2011a). They are typically the most abundant seal species seen in the Beaufort Sea. Based on the data available, ringed seals are likely to be the most abundant marine mammal species encountered in the area of the proposed activities. Despite being the most abundant seal species, the number of seals that we expect to encounter during the proposed OBS survey is low. This is based on seal observation data from recent similar shallow water seismic surveys in the central Beaufort Sea (Aerts et al. 2008, Hauser et al. 2008, BPXA 2014a).

Since bearded seals are benthic feeders, they generally associate with seasonal sea ice over shallow water of less than 200m (656 ft) (NMFS 2013b). Bearded seals were commonly sighted during aerials surveys conducted in the Beaufort Sea (Moulton and Lawson 2002, Clarke et al. 2011a, Clarke et al. 2012, 2013). During BPXA's OBC seismic survey in Foggy Island Bay, observers recorded a limited number of seal sightings (18) of which one was a confirmed bearded seal (Aerts et al. 2008). Based on available data, bearded seals are expected to occur in the survey area, but the numbers are expected to be small (BPXA 2014a).

Ringed seals molt from around mid-May to mid-July when they spend quite a bit of time hauled out on ice at the edge of the permanent pack, or on remnant land-fast ice along coastlines (Reeves 1998). While ringed seals do not cease foraging entirely during their molting period, the higher proportion of time spent hauled out (Kelly and Quakenbush 1990, Kelly et al. 2010b) may make them less likely to encounter a transiting vessel.

Vessels would have a transitory and short-term presence in any specific location. NMFS is not able to quantify existing traffic conditions across the entire Beaufort Sea to provide context for the addition of a single vessel. However, the absence of collisions involving vessels and ice seals in the Arctic despite decades of spatial and temporal overlap suggests that the probability of collision is low.

Based on the single vessel associated with the proposed activities in the Beaufort Sea, the small number of vessels used for the proposed action, and the decades of spatial and temporal overlap that have not resulted in a known vessel strike or mortality from vessel strike in the Beaufort Sea for ice seals, the mitigation measures in place to minimize exposure of pinnipeds to vessel activities, we conclude that the probability of a BPXA vessel striking a threatened ringed or bearded seal in the Beaufort Sea sufficiently small as to be discountable.

6.3 Response Analysis

As discussed in the *Approach to the Assessment* section of this opinion, response analyses determine how listed species are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. Our assessments try to detect the probability of lethal responses, physical damage, physiological responses (particular stress responses), behavioral responses, and social responses that might result in reducing the fitness of listed individuals. Ideally, our response analyses consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

6.3.1 Responses to Seismic Noise

Of all of the stressors we consider in this opinion, the potential responses of marine mammals upon being exposed to low-frequency seismic noise from airgun pulses have received the greatest amount of attention and study. Nevertheless, despite decades of study, empirical evidence on the responses of free-ranging marine animals to seismic noise is very limited.

Bowhead Whales

NMFS estimated between zero and one instance where bowhead whales might be exposed to seismic activities in state and federal waters in Foggy Island Bay of the Beaufort Sea during the open-water season (see Section 6.2.1., *Exposure to Active Seismic,* Table 10). This potential instance of exposure is likely to be an overestimate because we assume a uniform distribution of animals, do not account for avoidance or mitigation measures being in place, and round any fraction of exposure up to a single instance of exposure (see Section 6.2.1 for full list). In addition, BPXA will cease all airgun operations by midnight on August 25 prior to the beginning of the fall westward migration of bowhead through the Beaufort Sea (BPXA 2014a). In addition, BPXA will cease all airgun operations prior to the beginning of the fall westward migration of bowhead through the Beaufort Sea (BPXA 2014a). Since we used the average ensonified area (3.14 km^2) in our exposure calculation versus the maximum ensonified area (8 km^2), we will use the upper range of anticipated instances of exposure for our response analysis to be conservative.

During the proposed action, we anticipate up to one instance in which bowhead whales might be exposed to sounds produced by seismic airguns at received levels between 160 dB and 179dB, during 2D geohazard seismic operations using ~30 cui airgun array (see Table 10). Instances of exposure to bowhead whales from BPXA's 2014 2D seismic operations are anticipated to be low based upon past seismic operations in the area and lack of sightings and exposures to cetaceans. During the 2012 Simpson Lagoon seismic survey when BPXA employed three source vessels, all with PSOs, for a total of 1,239 observable hours, PSOs did not detect a single cetacean during the seismic survey (BPXA 2013b, 2014a, NMFS 2014b).

Given the large size of bowhead whales, and their pronounced vertical blow, it is likely that PSOs would be able to detect bowhead whales at the surface. The implementation of mitigation measures to reduce exposure to high levels of seismic sound, and the short duration and intermittent exposure to seismic airgun pulses, reduces the likelihood that exposure to seismic sound would cause a behavioral response that may affect vital functions (reproduction or survival), or result in temporary threshold shift (TTS) or permanent threshold shift (PTS). However, despite observer effort to mitigate exposure to sounds ≥180 dB re 1 μPa rms, some cetaceans may enter within the exclusion radii. In the Chukchi Sea in 2006 and 2008, 13 cetaceans were sighted within the ≥180 dB re 1 μPa rms radius and exposed to noise levels above that range before appropriate mitigation measures could be implemented (Haley et al. 2010).[10] The majority of cetaceans exhibited no reaction to vessels regardless of received sound levels (~96% of sightings). An increase in speed and splash were the next commonly observed reactions (Haley et al. 2010).

As discussed in the *Status of the Species* section, we have no data on bowhead whale hearing so we assume that whale vocalizations are partially representative of their hearing sensitivities. Bowhead whales are among the more vocal of the baleen whales (Clark and Johnson 1984). 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,

[10] These are considered minimum estimates since they are based on direct observation.

inflected, downsweeps, and constant frequency calls). 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 2002a). Vocalization bandwidths vary. Tonal FM modulated vocalizations have a bandwidth of 25 to 1200 Hz with the dominant range between 100 and 400 Hz and lasting 0.4- 3.8 seconds. 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 seconds (Clark and Johnson 1984, Cummings and Holliday 1987, Wursig and Clark 1993) in (Erbe 2002a). As previously mentioned, Cumming and Holliday (1987) calculated source level measures for bowhead whales songs to be between 158 and 189 dB.

This information leads us to conclude that bowhead whales exposed to sounds produced by seismic airguns are likely to respond if they are exposed to low-frequency (20-5000 Hz) sounds. However, because bowhead whales are not likely to communicate at source levels that would damage the tissues of other members of their species, this evidence suggests that received levels of up to 189 dB are not likely to damage the tissues of bowhead whales.

Seismic activity in the Beaufort Sea would likely impact bowhead whales, although the level of disturbance depends on whether the whales are feeding or migrating, as well as other factors such as the age of the animal, whether it is habituated to the sound, etc.

Tolerance

Numerous studies have shown that underwater sounds from industry activities are often readily detectable by marine mammals in the water at distances of many kilometers. Despite industry activities occurring at distances of only a few kilometers away, often times marine mammals show no apparent response to industry activities of various types (Miller et al. 2005, Bain and Williams 2006). This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Weir (2008) observed marine mammal responses to seismic pulses from a 24 airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. Weir recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17) and reported that there were no significant differences in encounter rates (sightings/hr) for humpback and sperm whales according to the airgun array's operational status (i.e., active versus silent). The airgun arrays used in the Weir (2008) study were much larger than the array proposed for use during this seismic survey (total discharge volume of 30 in^3).

Masking

Masking occurs when anthropogenic sounds and marine mammal signals overlap at both spectral and temporal scales. For the airgun sound generated from the proposed seismic survey, sound will consist of low frequency (under 500 Hz) pulses with extremely short durations (less than one second). Lower frequency man-made sounds are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise.

There is little concern regarding masking near the sound source due to the brief duration of these pulses and relatively longer silence between airgun shots (approximately 5-6 seconds). However, at long distances (over tens of kilometers away), due to multipath propagation and reverberation, the durations of airgun pulses can be “stretched” to seconds with long decays (Madsen et al. 2006), although the intensity of the sound is greatly reduced. This could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (e.g., (Clark et al. 2009) and cause increased stress levels (e.g., (Foote et al. 2004, Holt et al. 2009)). However, marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior by shifting call frequencies, and/or increasing call volume and vocalization rates. For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Lorio and Clark 2010). In addition, the sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson et al. 1995).

Responses While Feeding

Feeding bowheads tend to show less avoidance of sound sources than do migrating bowheads (BOEM 2011). Bowhead whales feeding in the Canadian Beaufort Sea in the 1980s showed no obvious behavioral changes in response to airgun pulses from seismic vessels 6 to 99 km (3.7 to 61.5 mi) away, with received sound levels of 107 to 158 dB rms (Richardson et al. 1986). They did, however, exhibit subtle changes in surfacing–respiration–dive cycles. Seismic vessels approaching within approximately 3 to 7 km (2 to 4 mi), with received levels of airgun sounds of 152 to 178 dB, elicited avoidance (Richardson et al. 1986, Ljungblad et al. 1988, Richardson et al. 1995, Miller et al. 2005). Richardson *et al.* (1986) observed feeding bowheads start to turn away from a 30-airgun array with a source level of 248 dB re 1 μPa at a distance of 7.5 km (4.7 mi) and swim away when the vessel was within about 2 km (1.2 mi); other whales in the area continued feeding until the seismic vessel was within 3 km (1.9 mi).

While the ranges at which bowhead whales respond to approaching seismic vessels varied, the responses that have been reported point to a general pattern. First, the responses of bowhead whales appear to be influenced by their pre-existing behavior: bowhead whales are more tolerant of higher sound levels when they are feeding than during migration (Miller et al. 2005, Harris et al. 2007). Data from an aerial monitoring program in the Alaskan Beaufort Sea during 2006 to 2008 also indicate that bowheads feeding during late summer and autumn did not exhibit large-scale distribution changes in relation to seismic operations (Funk et al. 2011). Feeding bowheads may be so highly motivated to stay in a productive feeding area that they remain in an area with noise levels that could, with long term exposure, cause adverse effects (NMFS 2010a).

The absence of changes in the behavior of foraging bowhead whales should not be interpreted to mean that the whales were not affected by the noise. Animals that are faced with human disturbance must evaluate the costs and benefits of relocating to alternative locations; those decisions would be influenced by the availability of alternative locations, the distance to the alternative locations, the quality of the resources at the alternative locations, the conditions of the animals faced with the decision, and their ability to cope with or “escape” the disturbance (Lima and Dill 1990, Gill and Sutherland 2001, Frid and Dill. 2002, Beale and Monaghan 2004a, b, Bejder et al. 2006, Bejder et al. 2009). Specifically, animals delay their decision to flee from predatory stimuli they detect until they decide that the benefits of abandoning a location are greater than the costs of remaining at the location or, conversely, until the costs of remaining at a location are greater than the benefits of fleeing (Ydenberg and Dills 1986). Ydenberg and Dill (1986) and Blumstein (2003) presented an economic model that recognized that animals will almost always choose to flee a site over some short distance to a predator; at a greater distance, animals will make an economic decision that weighs the costs and benefits of fleeing or remaining; and at an even greater distance, animals will almost always choose not to flee. For example, in a review of observations of the behavioral responses of 122 minke whales, 2,259 fin whales, 833 right whales, and 603 humpback whales to various sources of human disturbance, Watkins (1986) reported that fin, humpback, minke, and North Atlantic right whales ignored sounds that occurred at relatively low received levels, had most of their energy at frequencies below or above the hearing capacities of these species, or were from distant human activities, even when those sounds had considerable energies at frequencies well within the whale's range of hearing. Most of the negative reactions that had been observed occurred within 100 m of a sound source or when sudden increases in received sound levels were judged to be in excess of 12 dB, relative to previous ambient sounds.

As a result of using this kind of economic model to consider whales' behavioral decisions, we would expect to continue foraging in the face of moderate levels of disturbance. Similarly, a cow accompanied by her calf is less likely to flee or abandon an area at the cost of her calf's survival. By extension, we assume that animals that choose to continue their pre-disturbance behavior would have to cope with the costs of doing so, which will usually involve physiological stress responses and the energetic costs of stress physiology (Frid and Dill 2002, MMS 2008).

Responses While Migrating

As we discussed previously, migrating bowhead whales respond more strongly to seismic noise pulses than do feeding whales. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn showed avoidance out to 20 to 30 km (12.4 to 18.6 mi) from a medium-sized airgun source at received sound levels of around 120 to 130 dB re 1 μPa rms (Miller et al. 1999, Richardson 1999). Avoidance of the area did not last more than 12 to 24 hours after seismic shooting stopped. Deflection might start as far as 35 km (21.7 mi) away and may persist 25 to 40 km (15.6 to 24.9 mi) to as much as 40 to 50 km (24.9 to 31.1 mi) after passing seismic-survey operations (Miller et al. 1999). Preliminary analyses of recent data on traveling bowheads in the Alaskan Beaufort Sea also showed a stronger tendency to avoid operating airguns than was evident for feeding bowheads (Christie et al. 2009, Koski et al. 2009). Most bowheads would be expected to avoid an active source vessel at received levels of as low as 116 to 135 dB re 1 μPa rms when migrating (MMS 2008). Richardson *et al.* (1999) suggests that migrating bowheads start to show significant behavioral disturbance from multiple pulses at received levels around 120 dB re 1 μPa.

Studies of bowhead, gray, and humpback whales have determined that received levels of pulses in the 160-170 dB re 1 μPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. It is anticipated that for the airgun array (30 cui) that will be used for the planned 2D seismic geohazard surveys in Foggy Island Bay during the 2014 open water season, the distances to the 160 dB isopleth range from 640-1,600 m depending on water depth (BPXA 2014a). The average distance to the 160 dB isopleth is anticipated to be 1,000 m (BPXA 2014a).

Avoidance is one of many behavioral responses a bowhead whales may exhibit when exposed to impulsive noise. Other behavioral responses include evasive behavior to escape exposure or continued exposure to a sound that is painful, noxious, or that they perceive as threatening, which we would assume would be accompanied by acute stress physiology; increased vigilance of an acoustic stimulus, which would alter their time budget (that is, during the time they are vigilant, they are not engaged in other behavior); and continue pre-disturbance behavior and cope with the physiological consequences of continued exposure.

In addition to these behavioral responses, whales alter their vocal communications when exposed to anthropogenic sounds. Communication is an important component of the daily activity of animals and ultimately contributes to their survival and reproductive success. Animals communicate to find food (Marler et al. 1986, Elowson et al. 1991), acquire mates (Ryan 1985), assess other members of their species (Parker 1974, Owings et al. 2002), evade predators (Greig-smith 1980), and defend resources (Zuberbuhler et al. 1997). Human activities that impair an animal's ability to communicate effectively might have significant effects on the survival and reproductive performance of animals experiencing the impairment.

At the same time, most animals that vocalize have evolved with an ability to make adjustments to their vocalizations to increase the signal-to-noise ratio, active space, and recognizability of their vocalizations in the face of temporary changes in background noise (Cody and Brown 1969, Brumm 2004, Patricelli and Blickley 2006). A few studies have demonstrated that marine mammals make the same kind of vocal adjustments in the face of high levels of background noise. For example, two studies reported that some mysticete whales stopped vocalizing – that is, adjust the temporal delivery of their vocalizations – when exposed to active sonar (see (Miller et al. 2000, Melcon et al. 2012). Melcón *et al*. (2012) reported that during 110 of the 395 d-calls (associated with foraging behavior) they recorded during mid-frequency active sonar transmissions, blue whales stopped vocalizing at received levels ranging from 85 to 145 dB, presumably in response to the sonar transmissions. These d-calls are believed to attract other individuals to feeding grounds or maintain cohesion within foraging groups (Oleson et al. 2007). It should also be noted that mid-frequency sonar is not in the frequency range of most baleen whale calls, and a response by blue whales to mid-frequency sonar suggests that they have the ability to perceive and respond to these sounds (Erbe 2002a, Southall et al. 2007, Melcon et al. 2012).

Another study by Pirotta et al. (2014) showed that the probability of recording a harbor porpoise "buzz" (inter-click interval associated with attempted prey captures or social communication) declined by 15% in the ensonified area of a 2D seismic operation. The probability of occurrence of buzzes increased significantly with distance from the seismic source. This suggests that the likelihood of buzzing was dependent upon received noise intensity. Observed changes in buzzing occurrence could reflect disruption of either foraging or social activities. These effects may result from prey reactions to noise, leading to reduced porpoise foraging rates. Alternatively, foraging effort may change if porpoises adjust time budgets or diving behavior to avoid noise (Pirotta et al. 2014).

The effect of seismic airgun pulses on bowhead whale calling behavior has been extensively studied in the Beaufort Sea and is similar to the patterns reports in other whales. During the autumn season in 2007 and 2008, calling rates decreased significantly in the presence (<30 km [<18.6 mi]) of airgun pulses (Blackwell et al. 2010). There was no observed effect when seismic operations were distant (>100 km [>62 mi]). Call detection rates dropped rapidly when cumulative sound exposure levels (CSELs) were greater than 125 dB re 1 μPa2·s over 15 minutes. The decrease was likely caused by a combination of less calling by individual whales and by avoidance of the area by some whales in response to the seismic activity. Calls resumed near the seismic operations area shortly after operations ended. Aerial surveys showed high sighting rates of feeding, rather than migrating, whales near seismic operations (Miller et al. 2005, Blackwell et al. 2010). In contrast, reduced calling rates during a similar study in 1996 to 1998 were largely attributed to avoidance of the area by whales that were predominantly migrating, not feeding (Miller et al. 1999, Richardson 1999). Greene *et al.* (1999) concluded that the patterns seen were consistent with the hypothesis that exposure of bowhead whales to airgun sound resulted in diversion away from airguns, a reduction in calling rate, or a combination of both. Funk *et al.* (2010b) findings are generally consistent with Greene *et al.* (1999), i.e., seismic surveys lead to a significant decrease in the call detection rates of bowhead whales. Blackwell *et al.* (2013) found a statistically significant drop in bowhead call localization rates with the onset of airgun operations nearby. This effect was evident for whales that were "near" the seismic operation (median distance 41-45 km) and exposed to median received levels (SPL) of at least 116 dB re 1 µPa. In these whales, call localization rates dropped from an average of 10.2 calls/h before the onset of seismic operations to 1.5 call/h during and after airgun use (Blackwell et al. 2013).

Based on this information, we would not anticipate migrating bowhead to devote attention to a seismic stimulus beyond the 120 dB isopleth, which may be more than 12 kilometers from the source. At these distances, a whale that perceived a signal is likely to ignore such a signal and devote its attention to stimuli in its local environment. Because of their distance from the seismic source, we would also not anticipate bowhead whales would change their behavior or experience physiological stress responses at received levels ≤ 120 dB; these animals may exhibit slight deflection from the noise source, but this behavior is not likely to result in adverse consequences for the animals exhibiting that behavior. Feeding bowhead, however, may cease calling or alter vocalization at significantly lower received levels. While calling rates may change for feeding bowhead in response to seismic noise at low received levels (85 dB-145 dB), we do not anticipate that low-level avoidance or short-term vigilance would occur until noise levels are >150 dB. Again, these behaviors are not likely to result in adverse consequences for the animals exhibiting the behavior.

During the anticipated single exposure event where received levels may be ≥ 160 dB, some whales are likely to reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming angle or direction to avoid seismic operations, change their respiration rates, increase dive times, or reduce feeding behavior, alter vocalizations, and social interactions (Richardson et al. 1986, Ljungblad et al. 1988, Richardson and Malme 1993, Greene et al. 1999, Frid and Dill. 2002, Christie et al. 2009, Koski et al. 2009, Blackwell et al. 2010, Funk et al. 2010b, Melcon et al. 2012). We assume that these responses are more likely to occur when bowhead whales are aware of multiple vessels in their surrounding area.

Some whales may be less likely to engage in these responses because they are feeding. The whales that are likely to be exposed to these sounds probably have prior experience with similar seismic stressors resulting from their exposure during previous years; that experience will make some whales more likely to avoid the seismic activities while other whales would be less likely to avoid those activities. Some whales might experience physiological stress (but not "distress") responses if they attempt to avoid one seismic vessel, and encounter another seismic vessel while they are engaged in avoidance behavior.

Pinnipeds (ringed and bearded seals)

We estimated a total of 71 possible instances where ringed seals and 19 possible instances where bearded seals might be exposed to seismic activities during the proposed action (see Section 6.2.1., *Exposure to Active Seismic,* Table 10). All instances of exposure are anticipated to occur at received levels ≥ 160 dB. These instances of exposure are likely to be overestimates because they assume a uniform distribution of animals and do not account for avoidance or mitigation measures being in place (see Section 6.2.1 for full list).

While a single individual may be exposed multiple times, the short duration and intermittent transmission of seismic airgun pulses, combined with a moving vessel, and implementation of mitigation measures to reduce exposure to high levels of seismic sound, reduce the likelihood that exposure to seismic sound would cause a behavioral response that may affect vital functions, or cause TTS or PTS.

Ringed and bearded seals traveling across a broad area may encounter more than one seismic exploration activity in a season and may therefore be disturbed repeatedly by the presence of vessels or seismic survey sound or both. It is not known if multiple disturbances within a certain timeframe add to the stress of an animal and, if so, what frequency and intensity may result in biologically important effects. There is likely to be a wide range of individual sensitivities to multiple disturbances, with some animals being more sensitive than others.

Ringed and bearded 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. 1995). 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 sources being proposed for this project are anticipated to be between 50 Hz to 200 Hz, and should be within the auditory bandwidth for ringed and bearded seals.

Ringed seals are known to make barks, clicks and yelps with a frequency range between 0.4-16 kHz, and have dominant frequencies <5 kHz (Cummings et al. 1986), as cited in (Stirling 1973, Richardson et al. 1995). Ringed seal sounds are less complex and much lower in source level than bearded seal sounds (Richardson et al. 1995). Ringed seal sounds include 4 kHz clicks, rub sound with peak energy at 0.5-2 kHz and durations of 0.08-0.3 s, squeaks that are shorter in duration and higher in frequency; quaking barks at 0.4-1.5 kHz and durations of 0.03-0.12 s; yelps; and growls (Schevill et al. 1963, Stirling 1973, Cummings et al. 1986). Ringed seals may produce sounds at higher frequencies, given their most sensitive band of hearing extends up to 45kHz (Terhune and Ronald 1976) and most equipment used in studies is unsuitable for frequencies >15 kHz (Richardson et al. 1995). Ringed seals are known to vocalize at sources levels of up to 130 dB (Stirling 1973, Cummings et al. 1986, Richardson et al. 1995).

Male bearded seals rely on underwater vocalizations to find mates. As background noise increases, underwater sounds are increasingly masked and uni-directional, deteriorate faster, and are detectable only at shorter ranges (Cameron et al. 2010). Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz (Richardson et al. 1995), and seismic operations are anticipated to operate as frequencies <1 kHz. The frequency range of the predominant “trill” and “moan” calls (130 Hz-10.6 kHz and 130 Hz-1.3 kHz, respectively) that are broadcast during the mating season, overlaps the range (10 Hz-3kHz) of proposed airgun sources.

Bearded seals are a dominant component of the ambient noise in many Arctic areas during the spring (Thiele 1988). The song is thought to be a territorial advertisement call or mating call by the male (Ray et al. 1969a, Budelsky 1992). Cummings *et al.* (1983) estimated source levels of up to 178 dB re 1µ Pa m. Parts of some calls may be detected 25+ km away (Cleator et al. 1989). Because bearded seals are not likely to communicate at source levels that would damage the tissues of other members of their species, this evidence suggests that received levels of up to 178 dB are not likely to damage tissues of this species.

Information on behavioral reactions of pinnipeds in water to multiple pulses involves exposures to small explosives used in fisheries interactions, impact pile driving, and seismic surveys. Several studies lacked matched data on acoustic exposures and behavioral responses by individuals. As a result, the quantitative information on reactions of pinnipeds in water to multiple pulses is very limited (Southall et al. 2007). However, based on the available information on pinnipeds in water exposed to multiple noise pulses, exposures in the ~150-180 dB re 1µ Pa range (RMS values over the pulse duration) generally have limited potential to induce avoidance behavior in pinnipeds (Southall et al. 2007). We anticipate this would also apply to bearded seals since they are known to make calls with source levels up to 178 dB (Cummings et al. 1983). Received levels exceeding 190 dB re 1µ Pa are likely to elicit avoidance responses, at least in some ringed seals (Harris et al. 2001, Blackwell et al. 2004, Miller et al. 2005). Harris *et al.* (2001) reported 112 instances when seals were sighted within or near the exclusion zone based on the 190 dB radius (150-250m of the seismic vessel).[11] The results

[11] It should be noted that visual observations from the seismic vessel were limited to the area within a few hundred

suggest that seals tended to avoid the zone closest to the boat (<150m) (or noise levels greater than 190 dB). However, overall, seals did not react dramatically to seismic operations. Only a fraction of the seals swam away, and even this avoidance appeared quite localized (Harris et al. 2001). In the case of ringed seals exposed to sequences of airgun pulses from an approaching seismic vessel, most animals showed little avoidance unless the received level was high enough for mild TTS to be likely (Southall et al. 2007). We assume that bearded seals will behave in a similar manner to ringed seals when exposed to seismic sounds.

Seals have been noted to tolerate high levels of sounds from airguns (Arnold 1996, Harris et al. 2001, Moulton and Lawson 2002). In any case, the observable behavior of seals to passing active source vessels is often to just watch it go by or swim in a neutral way relative to the ship rather than swimming away. Seals at the surface of the water would experience less powerful sounds than if they were the same distance away but in the water below the seismic source. This may also account for the apparent lack of strong reactions in ice seals (NMFS 2013b).

During the open water season (July 15 through August 25) when the proposed activities would occur (for about 20 days), ringed seals are anticipated to be making short and long distance foraging trips (Smith 1973, 1976, Smith and Stirling 1978, Teilmann et al. 1999, Gjertz et al. 2000a, Harwood and Smith 2003). Bearded seals are anticipated to occur at the southern edge of the Chukchi and Beaufort Sea pack ice and at the wide, fragmented margin of multi-year ice (Burns 1981, Nelson et al. 1984). Bearded seals are less likely to encounter seismic surveys during the open water season than ringed seals because of the bearded seals preference for sea ice habitat (BOEM 2011). However, bearded seals are often spotted by PSOs during surveys so there is still the potential for exposure.

While the potential instances of exposure derived from ringed and bearded seal sighting rates multiplied by the number of hours the source vessel will be operating associated with 2D seismic surveys estimate a number of exposures, the anticipated received levels would be ~ 160 dB. Even if exposure occurred at higher received levels, the tendency of pinnipeds such as ringed and bearded seals to raise their heads above water, or haul out to avoid exposure to sound fields, as well as mitigation measures being in place, reduce the potential for harassment of these species. Ringed and bearded seals that avoid these sound fields or exhibit vigilance are not likely to experience significant disruptions of their normal behavior patterns because the vessels are transiting and the ensonified area is temporary, and seals seem rather tolerant of low frequency noise.

Based on this information, we would not expect ringed and bearded seals that are more than one kilometer from the seismic sound source to devote attentional resources to that stimulus, even though received levels might be as high as 160 dB. Similarly, we would not expect ringed and bearded seals that find themselves more than 0.2 kilometer from seismic surveys to change their behavioral state, despite being exposed to received levels ranging up to 189 dB; these seals might engage in low-level avoidance behavior or short-term vigilance behavior. Ringed and bearded seals that occur within 0.2 kilometers of sounds produced by equipment employed during

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meters, and 79% of the seals observed were within 250m of the vessel (Harris et al. 2001).

seismic surveys are likely to change their behavioral state to avoid slight TTS, although this avoidance is anticipated to be localized. In addition, if ringed or bearded seals are spotted within the 190 dB isopleth a power down/shutdown of seismic operations would occur.

6.3.2 Responses to Vessel Noise and Other Acoustic Sources

Vessel Noise

Based on ensonified area estimates provided by BPXA and PR1, we do not anticipate that listed marine mammals will be exposed to continuous noise associated with vessel traffic in the Beaufort Sea (see Section 6.2.2., *Exposure to Vessel Noise*).

As discussed in the *Approach to the Assessment* section above, animals that are not exposed to a potential stressor cannot respond to that stressor. An action that is not likely to reduce the fitness of individual whales or pinnipeds would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). For this reason we will not consider this stressor any further in our analysis.

Echosounder, Sidescan Sonar, and Subbottom Profiler Noise

No exposure to bowhead whales is anticipated to occur from echosounder, sidescan sonar, or subbottom profiler operations. As discussed in the *Approach to the Assessment* section of this opinion, endangered or threatened animals that are not directly or indirectly exposed to a potential stressor cannot respond to that stressor.

No exposures to pinnipeds from multi-beam echosounder or subbottom profiler operations are anticipated. NMFS estimated that 32 instances of exposure to ringed seals and 9 instances of exposure to bearded seals might occur due to the impulsive noise associated with sidescan sonar activities PR1 plans to permit in the Beaufort Sea (see Section 6.2.3, *Exposure to Other Noise Sources*) during the open-water season of 2014. However, out of these total exposures during the open water season, NMFS would classify zero instances where ringed and bearded seals might be exposed to sounds at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment.[12]

While the operation of sidescan sonar is likely to expose some ringed and bearded seals, these exposures are anticipated to occur at low received levels. In addition, most of the energy created by this potential source is outside the estimated hearing range of pinnipeds generally (Southall et al. 2007), and the energy that is within hearing range is high frequency, and as such is only expected to be audible in very close proximity to the mobile source. As previously mentioned,

[12] For the open-water season, behavioral harassment is not anticipated to occur until received levels are ≥160 dB. This is consistent with NMFS's longstanding MMPA permitting thresholds. There is some recent evidence, however, indicating that, for pinnipeds, behavioral harassment may occur at higher thresholds (Harris et al. 2001, Blackwell et al. 2004, Miller et al. 2005, Southall et al. 2007). NMFS is currently reviewing relevant acoustic criteria, and the relevant thresholds may change in the future (78 FR 78822).

we do not anticipate these sources to be operating in isolation, and expect co-occurrence with other higher-power acoustic sources including airguns. These exposures may cause some individual seals to experience changes in their behavioral states (e.g. slight avoidance), however, these responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individual ringed or bearded seals in ways or to a degree that would reduce their fitness.

As a result, the sidescan sonar operations PR1 plans to permit in Foggy Island Bay of the Beaufort Sea during the 2014 open water season would not appreciably reduce the ringed or bearded seal's likelihood of surviving or recovering in the wild.

In addition to the noise associated with sidescan sonar operations, baleen whales and pinnipeds are anticipated to react to the other noises associated with project operations which will reach much farther (seismic operations). For this reason we will not consider this stressor any further in our analysis.

6.3.3 Responses to Vessel Strike

As we indicated in *Section 6.2.4 Exposure to Vessel Strike*, the likelihood of a vessel strike occurring to a listed baleen whale or pinniped in the Beaufort Sea is sufficiently small as to be considered discountable.

As we discussed in the *Approach to the Assessment* section of this opinion, endangered or threatened animals that are not directly or indirectly exposed to a potential stressor cannot respond to that stressor. Because listed baleen whales and pinnipeds are not likely to be directly or indirectly exposed to vessels in close enough proximity for a strike to occur in the Beaufort Sea, they are not likely to respond to that exposure or experience reductions in their current or expected future reproductive success as a result of those responses. An action that is not likely to reduce the fitness of individual whales or pinnipeds would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

For this reason we will not consider this stressor any further in our analysis.

7. CUMULATIVE EFFECTS

"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 (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 Act.

NMFS reviewed recent environmental reports, NEPA compliance documents, BOEM's biological evaluation, and other source documents to evaluate and identify actions that were anticipated to occur within the analytical timeframe of this opinion (open water season of 2014). Reasonably foreseeable future state, tribal, local or private actions include: oil and gas exploration, development, and production activities; military training exercises; air and marine transportation; and tourism.

Oil and Gas Projects

State of Alaska: There are a number of onshore and nearshore exploration wells being proposed on State oil and gas leases in the Beaufort Sea region. However, these prospects are primarily onshore or inshore with little potential for affecting the proposed area.

In the past, many oil industry applicants have applied for MMPA authorization for proposed activities on State leases creating a federal nexus for ESA consultation. Also depending on the proposed activity and location there may be a nexus through wastewater discharge or federal air permits, or dredge and fill permits. Whether there will be a federal nexus for ESA consultation is not known at this time, so we will consider these activities under cumulative effects. While the projects described below would not occur in the Beaufort Sea portion of the action area, they would potentially increase vessel traffic within the Beaufort Sea.

***Point Thomson Project*:** ExxonMobil is proposing to produce gas and hydrocarbon liquids (condensate and oil) from the Thomson Sand reservoir and delineate other hydrocarbon resources in the Point Thomson area. The primary activities that would contribute to cumulative effects include marine and air traffic associated with construction and operation, and an increased level of construction activity on the shoreline over a three-year period.

Sealift by ocean-going barges direct to Point Thomson was selected as the option for moving heavy loads to the site. Module transportation to the project site is scheduled to take place over three open water seasons (2013 through 2015). It is anticipated that the large ocean barges will be in place at the Point Thomson site for approximately 14 days to dock and offload cargo. Once offloaded, the barges will leave the site.

Continuation of Badami Production: The Badami project is located approximately 20 miles east of Prudhoe Bay on the Beaufort Sea coast. It is connected by pipeline to Endicott, but there are no all-season road connections; Badami has a gravel causeway barge dock. The facility went into production around 2001, but was suspended in 2007 after production results were less than expected. In 2010, production was temporarily restarted. Additional winter exploratory drilling is currently being conducted; depending on results, production could be resumed on a continuing basis within a couple of years. Some improvements to the dock and other facilities may be needed. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Chukchi and Beaufort seas, and offloading activity at Badami (Bradner 2011; Petroleum News 2011b; (NMFS 2013b).

Military

Military activity in the Arctic is thought to have increased in recent years, and it may be reasonable to expect that military activity will continue to increase in the foreseeable future. Military activities in the proposed action area include the transit of military vessels through area waters, as well as submarine activity, aircraft overflights, and related maneuvers. However, very little public information is available about future military activity in the region. Military vessel, submarine, and aircraft traffic could contribute to cumulative effects through the disturbance of marine mammals, and the potential for marine fuel spills.

Transportation

It is reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities and Prudhoe Bay area oil and gas facilities will continue. In some specific cases, described below, transportation and associated infrastructure in the proposed activity area may increase as a result of increased 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 a present levels.

Oil and gas industry use of helicopters and fixed wing aircraft to support routine activities and exploration within the project area is likely to increase as a result of increased interest in North Slope exploration.

Vehicle Traffic: None of the anticipated future activities propose to construct permanent roads to the communities in the North Slope. Construction of ice roads could allow industry vehicles access to community roads, and likewise allow residents vehicular access to the highway system.

Vessel traffic within the project 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. 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 project 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.

Increased barge traffic would occur if the Point Thomson Project or the Alaska Pipeline Project were constructed during the time period covered under this opinion. Coastal barges would support these projects by delivering fuel, construction equipment, and materials and sea lift barges would deliver modules for processing and camp facilities. If realized, this would result in additional barge traffic transiting through the project area but potential for congestion would only be expected near Prudhoe Bay docks and only during construction. Offshore oil and gas exploration drilling would also result in some additional tug and barge, support, icebreaker, and other vessel traffic (Petroleum News 2011) that could contribute to congestion if they used Prudhoe Bay area docks.

Community Development

Community development projects in Arctic communities 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. Major community development projects that are foreseeable at the present time include the construction of a new airport at the village of Kaktovik.

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 Beaufort and Chukchi Sea coasts in small numbers, much of the air sightseeing traffic is concentrated in ANWR and should not impact species in the action area. In addition, future sport hunting and fishing, or other recreation or tourism-related activities are anticipated to continue at current levels and in similar areas in the project area (NMFS 2013b).

8. INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of NMFS' assessment of the risk posed to listed species by the proposed action. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) result in appreciable reductions in the likelihood of survival of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in appreciable reductions in the likelihood of recovery of the species in the wild by reducing its numbers, reproduction, or distribution. These assessments are made in full consideration of the status of the species (Section 4).

As we discussed in the *Approach to the Assessment* section of this opinion, we begin our risk analyses by asking whether the probable physical, physiological, behavioral, or social responses of endangered or threatened species are likely to reduce the fitness of endangered or threatened individuals or the growth, annual survival or reproductive success, or lifetime reproductive success of those individuals. If we would not expect listed species exposed to an action's effects to experience reductions in the current or expected future survivability or reproductive success (that is, their fitness), we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Stearns 1977, Brandon 1978, Mills and Beatty 1979, Stearns 1992, Anderson 2000). Therefore, if we conclude that listed species are not likely to experience reductions in their fitness, we would conclude our assessment because we would not expect the effects of the action to affect the performance of the populations those individuals represent or the species those population comprise. If, however, we conclude that listed species are likely to experience reductions in their fitness as a result of their exposure to an action, we then determine whether those reductions would reduce the viability of the population or populations the individuals represent and the "species" those populations comprise (in section 7 consultations, the "species" represent the listed entities, which might represent species, subspecies, or distinct populations segments of vertebrate taxa).

As part of our risk analyses, we consider the consequences of exposing endangered or threatened species to the stressors associated with the proposed action, individually and cumulatively, given that the individuals in the action area for this consultation are also exposed to other stressors in the action area and elsewhere in their geographic range.

8.1 Bowhead Whale Risk Analysis

Based on the results of the exposure analysis, we would expect one instance in which bowhead whales may by exposed to low-frequency active seismic noise. Exposure to vessel noise from transit, potential for vessel strike, and exposure to noise from echosounders, sidescan sonar, and subbottom profiler operations is extremely unlikely and therefore considered discountable.

Our consideration of probable exposures and responses of bowhead whales to seismic airgun noise associated with the proposed action is designed to help us assess whether those activities are likely to increase the extinction risks or jeopardize the continued existence of listed whales.

The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animal's energy budget, time budget, or both (the two are related because foraging requires time). Bowhead whales have an ability to store substantial amounts of energy, which allows them to survive for months on stored energy during migration and while in their wintering areas, and their feeding patterns allow them to acquire energy at high rates. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of bowhead whales. As a result, the whales' probable responses to close approaches by seismic vessels and their probable exposure to active seismic noise are not likely to reduce the current or expected future reproductive success of bowhead whales or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent.

8.1.1 Probable Risk to Bowhead Whales

During low-frequency 2D seismic activities from the proposed action, NMFS estimated up to one instance of exposure (see Section 6.2.1, *Exposure to Active Seismic*), at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment (see

Section 6.3.1, *Responses to Seismic Noise*).[13] No bowhead whales are anticipated to be exposed to sound levels that could result in PTS.

Although the seismic activities are likely to cause individual whales to experience changes in their behavioral states that might have adverse consequences (Frid and Dill 2002), these responses are not likely to alter the physiology, behavioral ecology, and social dynamics of individual whales in ways or to a degree that would reduce their fitness because the whales are actively foraging in waters around the seismic operations or migrating through the seismic operations.

While a single individual may be exposed multiple times over the course the open water season, the short duration and intermittent transmission of seismic airgun pulses, combined with a moving vessel, and implementation of mitigation measures to reduce exposure to high levels of seismic sound, reduce the likelihood that exposure to seismic sound would cause a behavioral response that may affect vital functions, or cause TTS or PTS.

This exposure may cause individual bowhead whales to experience changes in their behavioral states (e.g. slight avoidance); however, these responses are not likely to alter the physiology, behavioral ecology, and social dynamics of individual bowhead whales in ways or to a degree that would reduce their fitness because the whales are actively foraging in waters around the seismic operations or migrating through the seismic operations.

As a result, the activities PR1 plans to authorize in the Beaufort Sea during the open water season in 2014 are not likely to appreciably reduce the bowhead whales' likelihood of surviving or recovering in the wild.

The strongest evidence supporting the conclusion that seismic operations will likely have minimal impact on bowhead whales is the estimated growth rate of the bowhead whale population in the Arctic. The Western Arctic stock of bowhead whales has been increasing at approximately 3.2-3.4 percent per year (George et al. 2004b, Schweder and Sadykova. 2009), despite exposure to oil and gas exploration activities in the Beaufort and Chukchi Seas since the late 1960s (BOEM 2011). This increase in the number of bowhead whales suggests that the stress regime these whales are exposed to has not prevented these whales from increasing their numbers. As discussed in the *Environmental Baseline* section of this opinion, bowhead whales have been exposed to active seismic activities in the Arctic, including vessel traffic, aircraft traffic, and seismic noise, for more than a generation. Although we do not know if more bowhead whales might have used the action area or the reproductive success of bowhead whales in the Arctic would be higher absent their exposure to these activities, the rate at which bowhead whales occur in the Arctic suggests that bowhead whale numbers have increased substantially in these important migration and feeding areas despite exposure to seismic operations. The proposed action is less in number and smaller in magnitude as compared to previous activities in the area, and we do not believe these permitted activities are likely to affect the rate at which

[13] For the open-water season, behavioral harassment is not anticipated to occur until received levels are ≥160 dB.

bowhead whale counts in the Arctic are increasing.

8.2 Pinniped Risk Analysis (ringed seal and bearded seal)

Based on the results of the *Exposure Analysis*, we expect ringed and bearded seals to be exposed to low-frequency active seismic noise. No exposure to vessel noise or potential for vessel strike is anticipated, and if exposure to noise from echosounder, sidescan sonar, or subbottom profiler operations were to occur, it is anticipated that these exposures would be at very low received levels, and the effects of the exposures would be considered insignificant.

As we discussed in the narratives for cetaceans listed above, our consideration of probable exposures and responses of pinnipeds to seismic stressors associated with exploration activities in the action area are designed to help us answer the question of the whether those activities are likely to increase the extinction risks facing listed pinnipeds.

The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animal's energy budget, time budget, or both (the two are related because foraging requires time). Fall and early winter periods, prior to the occupation of breeding sites, are important in allowing female ringed seals to accumulate enough fat stores to support estrus and lactation (Kelly et al. 2010b). However, the early fall time period is not anticipated to overlap with the seismic activities PR1 plans to permit. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of ringed and bearded seals. As a result, the ringed and bearded seal's probable responses to close approaches by seismic vessels and their probable exposure to seismic airgun pulses are not likely to reduce the current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent.

8.2.1 Probable Risk to Ringed Seals

We estimated 71 instance of ringed seal exposure to seismic activities from the proposed action (see Section 6.2.1, *Exposure to Active Seismic*) at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment (see Section 6.3.1, *Responses to Seismic Noise*).[14] No ringed seals are anticipated to be exposed to sound levels that could result in PTS.

Although these seismic activities are likely to cause some individual ringed seals to experience changes in their behavioral states that might have adverse consequences (Frid and Dill. 2002), these responses are not likely to alter the physiology, behavioral ecology, and social dynamics of individual ringed seals in ways or to a degree that would reduce their fitness because the seals

[14] For the open-water season, behavioral harassment is not anticipated to occur until received levels are ≥160 dB. This is consistent with NMFS's longstanding MMPA permitting thresholds. There is some recent evidence, however, indicating that, for pinnipeds, behavioral harassment may occur at higher thresholds (Harris et al. 2001, Blackwell et al. 2004, Miller et al. 2005, Southall et al. 2007). NMFS is currently reviewing relevant acoustic criteria, and the relevant thresholds may change in the future (78 FR 78822).

are actively foraging in waters around the seismic operations, have their heads above water, or hauled out. While a single individual may be exposed multiple times over the course the open water season, the short duration and intermittent transmission of seismic airgun pulses, combined with a moving vessel, and implementation of mitigation measures to reduce exposure to high levels of seismic sound, reduce the likelihood that exposure to seismic sound would cause a behavioral response that may affect vital functions, or cause TTS or PTS.

Our *Exposure Analysis* concluded that we would expect 32 instances in which ringed seals might be exposed to impulsive noise from sidescan sonar operations. However, none of these exposures are anticipated to rise to the level of take under the ESA due to exposures occurring at very low received levels (≤ 120dB), outside the general hearing range of pinnipeds, and the directionality, short pulse duration, and small beam width of the source. All of these factors reduce the probability of exposure of ringed seals to sidescan sonar operations to levels we consider discountable.

In addition, our *Exposure Analysis* concluded that ringed seals were not likely to be exposed to vessel noise or the potential for vessel strike because only one vessel is anticipated for the proposed action and noise associated with the vessel operations is anticipated to drop to 120 dB within 176 m (or less). The single vessel and small ensonified area reduce the probability of exposure to ringed seals to levels we would consider discountable.

The implementation of mitigation measures will further reduce the instances of exposure and minimize the effects on the species.

As a result, the proposed action would not appreciably reduce the ringed seal's likelihood of surviving or recovering in the wild.

8.2.2 Probable Risk to Bearded Seals

In our *Exposure Analysis* we estimated 19 instances of bearded seal exposure to seismic activities at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment (see Section 6.2.1, *Exposure to Active* Seismic).[15]

While a single individual may be exposed multiple times over the course of a season, the short duration and intermittent transmission of seismic airgun pulses, combined with a moving vessel, and implementation of mitigation measures to reduce exposure to high levels of seismic sound, reduce the likelihood that exposure to seismic sound would cause a behavioral response that may affect vital functions, or cause TTS or PTS.

Seals have been noted to tolerate high levels of sounds from airguns (Arnold 1996, Harris et al. 2001, Moulton and Lawson 2002). In any case, the observable behavior of seals to passing active source vessels is often to just watch it go by or swim in a neutral way relative to the ship rather than swimming away. Seals at the surface of the water would experience less powerful sounds

[15] For the open-water season, behavioral harassment is not anticipated occur until received levels are ≥160 dB.

than if they were the same distance away but in the water below the seismic source. This may also account for the apparent lack of strong reactions in ice seals (NMFS 2013b).

In most circumstances, bearded seals are likely to avoid certain ensonified areas that may cause TTS. Bearded seals that avoid these sound fields or exhibit vigilance are not likely to experience significant disruptions of their normal behavior patterns because the vessels are transiting and the ensonified area is temporary, and bearded seals seem rather tolerant of low frequency noise.

Our *Exposure Analysis* concluded that bearded seals were not likely to be exposed to noise associated with vessel operations or vessel strike in the Beaufort Sea because the noise associated with vessel operations would drop to 120 dB within 176 m (or less) and the proposed action only involves one vessel. The limited number of vessels, and small ensonified area reduced their probability of being exposed to levels that we would consider discountable.

In addition, our *Exposure Analysis* concluded that we would expect 9 instances in which ringed seals might be exposed to impulsive noise from sidescan sonar operations. However, none of these exposures are anticipated to rise to the level of take under the ESA due to exposures occurring at very low received levels (≤120 dB), outside the general hearing range of pinnipeds, and the directionality, short pulse duration, and small beam width of the source. All of these factors reduce the probability of exposure of bearded seals to sidescan sonar operations to levels we consider discountable.

Mitigation measures are designed to avoid or minimize adverse impacts associated with seismic and other activities to result in a negligible level of effect to bearded seals.

As a result, the proposed action would not appreciably reduce the bearded seal's likelihood of surviving or recovering in the wild.

9. CONCLUSION

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the endangered bowhead whale (*Balaena mysticetus*), threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*), or the threatened Beringia DPS of bearded seal (*Erignathus barbatus barbatus*).

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. The ESA, however, does not define harassment. USFWS has promulgated a regulation which defines harassment as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." 50 CFR. § 17.3. Under the MMPA, there is a definition of what is referred to as Level B harassment: "any act of pursuit, torment, or annoyance which . . . has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." 16 U.S.C. §1362(18)(A)(ii).

In this opinion and incidental take statement, we have considered potential exposures of listed species to certain sound sources and the effects these sources may have (see Table 13). For any given exposure, it is impossible to predict the exact impact to the individual marine mammal(s) because an individual's reaction depends on a variety of factors (the individual's sex, reproductive status, age, activity engaged in at the time, etc.). Therefore, as a precautionary measure, we rely on the estimated instances of exposure (which are considered to be takes by harassment under the MMPA) as a proxy for the ESA take numbers. We find this approach conservative for evaluating jeopardy under the ESA since the exposure estimates are likely over-estimates, and since an instance of exposure may not actually result in a take by harassment as the USFWS has defined the term. Notwithstanding that fact, the exposure estimates reflect the best scientific and commercial data available.

Under the terms of Section 7(b)(4) and Section 7(o)(2) of the ESA, taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement (ITS).

Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized by Section 101(a)(5) of the MMPA. Accordingly, **the terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here (Section 9 of the ESA, however, does not apply to ringed or bearded seals)**. Absent such authorization, this statement is inoperative.

The terms and conditions described below are nondiscretionary. PR1 has a continuing duty to regulate the activities covered by this incidental take statement. In order to monitor the impact of incidental take, PR1 must monitor the progress of the action and its impact on the species as specified in the incidental take statement (50 CFR 402.14(i)(3)). If PR1 (1) fails to require their permittees to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

10.1 Amount or Extent of Take

The section 7 regulations require NMFS to estimate the number of individuals that may be taken by proposed actions or the extent of land or marine area that may be affected by an action, if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (50 CFR § 402.14 (i); see also 51 FR 19926, 19953-54 (June 3, 1986)). This biological opinion analyzes and this incidental take statement covers the take associated with PR1 permitting BPXA's 2D seismic geohazard surveys associated with oil and gas exploration activities in the Federal and state waters of Foggy Island Bay in the Beaufort Sea during the 2014 open water season (July through September).

This project-specific Section 7 consultation is linked indirectly to the programmatic Arctic Regional Biological Opinion that was issued in April 2013. This tiered process enables NMFS to track the overall take occurring from multiple oil and gas projects occurring in the Arctic, and to issue Incidental Take Statements that more accurately estimate the level of take anticipated to occur.

As discussed in the *Approach to the Assessment* section of this opinion, we used the best scientific and commercial information available to determine whether and how listed individuals in the exposed populations might respond given their exposure to the proposed action. To estimate the number of animals that might be "taken" in this opinion, we classified the suite of responses as one or more forms of "take" and estimated the number of animals that might be "taken" by (1) reviewing the best scientific and commercial information available to determine the likely suite of responses given exposure of listed marine mammals to the proposed action at various received levels; (2) classifying particular responses as one or more form of "take" (as that term is defined by the ESA and implementing regulations that further define "harass"); and (3) adding the number of exposure events that could produce responses that we would consider "take." These estimates include whales and pinnipeds that are likely to be exposed and respond to low-frequency seismic airgun pulses, pinger and transponder pulses at received levels and close approaches to vessels that are likely to result in behavioral changes that we would classify as "harassment." Based on our *Exposure* and *Response* Analyses, we determined that only certain exposures from 2D seismic operations could rise to the level of "take" as defined under the ESA. The results of our estimates are presented in Table 13

For bowhead whales, ringed seals, and bearded seals, based on the best scientific and commercial information available, we would not anticipate responses to impulsive seismic noise at received levels between 120-159 dB would rise to the level of "take" as defined under the ESA. For this reason, the total instances of harassment for these species only considered exposures at received levels ≥ 160 dB.

For purposes of this opinion, the endangered bowhead whale is the only species for which the Section 9 take prohibition applies. This incidental take statement, however, includes limits on taking of ringed and bearded seals since those numbers were analyzed in the jeopardy analysis and to provide guidance to the action agency on its requirement to re-initiate consultation if the take limit for any species covered by this opinion is exceeded.

Table 13. Summary of instances of seismic exposure associated with the proposed action's 2D seismic survey activities resulting in the incidental take of bowhead whales, and ringed and bearded seals.

Species	Estimated Instances of Exposure to ≥160 dB		Amount of Take Associated with Proposed Action	Anticipated Temporal Extent of Take
	AVG	MAX		
Bowhead Whale	0.04	0.13[1]	1	July 1, 2014 through August 25, 2014
Bearded Seal	6	19	19	
Ringed Seal	22	71	71	

[1] Since we cannot have a fraction of an instance of exposure, we rounded this exposure up to a single instance of exposure to be precautionary.

The instances of harassment identified in Table 13 would generally represent changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures shifting to traveling, avoidance, and behavioral states that require higher energy expenditures and, therefore, would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed. We assume animals would respond to a suite of environmental cues that include sound fields produced by seismic airguns, sounds produced by the engine of the surface vessel, and other sounds associated with the proposed activities.

10.2 Effect of the Take

Studies of marine mammals and responses to seismic transmissions have shown that bowhead whales, as well as ringed and bearded seals are likely to respond behaviorally upon hearing low-frequency seismic transmissions. Although the biological significance of those behavioral responses remains unknown, this consultation has assumed that exposure to seismic noise might disrupt one or more behavioral patterns that are essential to an individual animal's life history. However, any behavioral responses of these whales and pinnipeds to seismic transmissions and any associated disruptions are not expected to affect the reproduction, survival, or recovery of these species. Exposures sidescan sonar pulses are not anticipated to rise to the level of "take" as defined under the ESA.

10.3 Reasonable and Prudent Measures (RPM)

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

The RPMs included below, along with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPMs are necessary and appropriate to minimize or to monitor the incidental take of bowhead whales, ringed seals, and bearded seals resulting from the proposed action.

1. This ITS is valid only for the activities described in this biological opinion, and which have been authorized under section 101(a)(5) of the MMPA.

2. The taking of bowhead whales, ringed seals, and bearded seals shall be by incidental harassment only. The taking by serious injury or death is prohibited and may result in the modification, suspension or revocation of the ITS.

3. PR1 shall implement measures to reduce the probability of exposing bowhead whales, ringed seals, and bearded seals to low-frequency seismic transmissions that will occur during the proposed activities.

4. PR1 shall implement a monitoring program that allows NMFS AKR to evaluate the exposure estimates contained in this biological opinion and that underlie this incidental take statement.

5. PR1 shall submit reports to NMFS AKR that evaluate its mitigation measures and the results of its monitoring program.

10.4 Terms and Conditions

"Terms and conditions" implement the reasonable and prudent measures (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

In order to be exempt from the prohibitions of section 9 of the ESA, PR1 must comply with the following terms and conditions, which implement the reasonable and prudent measures described above, the mitigation measures set forth in Sections 2.1.2 and 2.1.3 of this opinion, and reporting/monitoring requirements described in the MMPA authorization.

Partial compliance with these terms and conditions may result in more take than anticipated, and invalidate this take exemption. These terms and conditions constitute no more than a minor change to the proposed action because they are consistent with the basic design of the proposed action.

To carry out RPM #1, PR1 or their authorization holder must undertake the following:

A. At all times when conducting seismic-related activities, PR1 shall require their permitted operators to possess on board the seismic source vessel a current and valid Incidental Harassment Authorization issued by NMFS under section 101(a)(5) of the MMPA. Any take must be authorized by a valid, current, IHA issued by NMFS under section 101(a)(5) of the MMPA, and such take must occur in compliance with all terms, conditions, and requirements included in such authorizations.

To carry out RPM #2, PR1 or their authorization holder must undertake the following:

A. The taking of any marine mammal in a manner other than that described in this ITS must be reported immediately to NMFS AKR, Protected Resources Division at 907-586-7638.

B. In the event that the proposed action causes a take of a marine mammal that results in a serious injury or mortality (e.g. ship-strike, stranding, and/or entanglement), BPXA shall immediately cease operations and immediately report the incident to NMFS AKR, Protected Resources Division at 907-586-7638 and/or by email to Jon.Kurland@noaa.gov, Brad.Smith@noaa.gov, Alicia.Bishop@noaa.gov, the Alaska Regional Stranding Coordinator at 907-586-7248 (Aleria.Jensen@noaa.gov), and PR1 Candace Nachman 301-427-8429 for any MMPA authorization issues.

To carry out RPM #3, PR1 or their authorization holder must undertake the following:

A. The 180 and 190 dB exclusion radii around operating airguns must be fully observed during daylight hours.

To carry out RPM #4, PR1 or their authorization holder must undertake the following:

A. All mitigation measures as outlined in Section 2.1.2 and 2.1.3 of this biological opinion, or better or equivalent measures, must be implemented, as appropriate, upon issuance of an IHA under the MMPA.

B. BPXA will record observations of pinnipeds hauled out and not just in the water

C. BPXA will record observations of estimated exposures of ringed and bearded seals to seismic noise at received levels ≥ 160 dB. [16]

To carry out RPM #5, PR1 or their authorization holder must undertake the following:

A. Establish and monitor a 160 dB (rms) harassment zone for bowhead whales. In the event BPXA takes one bowhead whale, BPXA will extend their exclusion zone for bowhead out to the 160 dB isopleth (which is anticipated to occur 1000m from the source vessel) to ensure no additional takes of bowhead occur. If a bowhead whale is observed approaching or entering the 160 dB (rms) zone, BPXA will shut-down airgun operations completely.

B. PR1 must consult weekly by telephone with Jon Kurland, or his designee, at the Juneau

[16] For ringed and bearded seals, based on the best scientific and commercial information available, we would not anticipate responses to impulsive seismic noise at received levels between 120-169 dB would rise to the level of "take" as defined under the ESA. However, in order to be consistent with the MMPA authorization which includes a more precautionary threshold for harassment at received levels ≥ 160 dB, we will include a monitoring requirement for exposures within the 160 dB isopleth which is anticipated to reach out to 1000m from the seismic source vessel.

Office, Alaska Region, NMFS, at 907-586-7638, providing a status report on the appropriate reporting items, unless other arrangements for monitoring are agreed upon in writing. Status reports should also be emailed to Jon.Kurland@noaa.gov.

C. BPXA must adhere to all monitoring and reporting requirements as detailed in the IHA issued by NMFS under section 101(a)(5) of the MMPA.

D. Submit a draft project specific report that analyzes and summarizes all of the PR1 authorized activities BPXA conducted in Foggy Island Bay during the 2014 open water season (July through September) to the Assistant Regional Administrator, Protected Resources Division, NMFS by email to Jon.Kurland@noaa.gov or his designee. This report will be submitted by January 2015. This report must contain the following information:

- Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort Sea State and wind force), and associated activities during all seismic/sonar operations, equipment recovery, and vessel transits and NMFS's ESA-listed marine mammal sightings;

- Species, number, location, distance from the vessel, and behavior of any ESA-listed marine mammals, associated with seismic/sonar activity (number of power-downs and shut-downs), observed throughout all monitoring activities;

- An estimate of the instances of exposure (by species) of NMFS's ESA-listed marine mammals that: (A) are known to have been exposed to the seismic/sonar activity (based on visual observation) at received levels greater than or equal to 160 dB re 1μPa (rms), 170 dB re 1 μPa (rms), 180 dB re 1 μPa (rms) and 190 dB re 1 μPa (rms) with a discussion of any specific behaviors those individuals exhibited,[17] and (B) may have been exposed to the seismic activity at received levels between 160 dB re 1 μPa (rms) and 190 dB μPa (rms) for all listed marine mammals with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed;

- The report should clearly compare the anticipated takes (i.e. instances of exposure) authorized in the ITS with those observed during seismic operations ("take" being defined as an ESA-listed mysticete or pinniped receiving exposure to seismic pulses at ≥ 160 dB re 1 μPa (rms)).

- The draft report will be subject to review and comments by NMFS AKR. Any recommendations made by NMFS AKR must be addressed in the final report prior to acceptance by NMFS AKR. The draft report will be considered final for the

[17] Based on information provided by BPXA (2014b, a), we anticipate that noise associated with the 30 cui airgun array will reach the 160, 170, 180, and 190 dB isopleths at approximately 1000 m, 450 m, 200 m and 70 m respectively from the source.

activities described in this opinion if NMFS AKR has not provided comments and recommendations within 90 days of receipt of the draft report.

- A description of the implementation and effectiveness of each Term and Condition, as well as any conservation recommendations, for minimizing the adverse effects of the action on ESA-listed marine mammals.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. Operators should use real-time passive acoustic monitoring while in migratory corridors and other sensitive areas to alert ships to the presence of whales, primarily to reduce the ship strike risk.

2. NMFS PR1 should work with BOEM and other relevant stakeholders (the Marine Mammal Commission, International Whaling Commission, and the marine mammal research community) to develop a method for assessing the cumulative impacts of anthropogenic noise on marine mammals. This analysis includes the cumulative impacts on the distribution, abundance, and the physiological, behavioral and social ecology of these species;

In order to keep NMFS Protected Resources Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, PR1 should notify NMFS AKR of any conservation recommendations they implement in their final action.

12. REINITIATION OF CONSULTATION

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion, or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

13. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to three agencies of the Federal government (NMFS, BOEM and BSEE), and the general public. These consultations help to fulfill multiple legal obligations of the named agencies. The information is also useful and of interest to the general public as it describes the manner in which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information and has been improved through interaction with the consulting agency.

This consultation will be posted on the NMFS Alaska Region website http://alaskafisheries.noaa.gov/protectedresources/). The format and name adhere to conventional standards for style.

13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

13.3 Objectivity

Information Product Category: Natural Resource Plan.

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with Alaska Region ESA quality control and assurance processes.

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